DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XD512

Takes of Marine Mammals Incidental to Specified Activities; Low-Energy Marine Geophysical Survey in the Ross Sea, January to February 2015

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

ACTION: Notice; proposed Incidental Harassment Authorization; request for comments.

SUMMARY: NMFS has received an application from the National Science Foundation (NSF) Division of Polar Programs, and Antarctic Support Contract (ASC) on behalf of Louisiana State University, for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment, incidental to conducting a low-energy marine geophysical (seismic) survey in the Ross Sea, January to February 2015. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to NSF and ASC to incidentally harass, by Level B harassment only, 18 species of marine mammals during the specified activity.

DATES: Comments and information must be received no later than December 17, 2014.

ADDRESSES: Comments on the application should be addressed to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. The mailbox address for providing email comments is *ITP.Goldstein@noaa.gov.* NMFS is not responsible for email comments sent to addresses other than the one provided here. Comments sent via email, including all attachments, must not exceed a 25-megabyte file size.

Instructions: All comments received are a part of the public record and will generally be posted to: *http://www.nmfs.noaa.gov/pr/permits/incidental/* without change. All Personal Identifying Information (for example, name, address, etc.) voluntarily submitted by the commenter may be publicly accessible. Do not submit Confidential Business Information or otherwise sensitive or protected information.

A copy of the IHA application may be obtained by writing to the address specified above, telephoning the contact listed here (see **FOR FURTHER INFORMATION CONTACT**) or visiting the Internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental/.* Documents cited in this notice may also be viewed by appointment, during regular business hours, at the aforementioned address.

NSF and ASC have prepared a ''Draft Initial Environmental Evaluation/Environmental Assessment to Perform Marine Geophysical Survey, Collect Bathymetric Measurements, and Conduct Coring by the RVIB *Nathaniel B. Palmer* in the Ross Sea'' (IEE/EA) in accordance with the National Environmental Policy Act (NEPA) and the regulations published by the Council of Environmental Quality (CEQ). It is posted at the foregoing site. NMFS has independently evaluated the IEE/EA and has prepared a separate NEPA analysis titled ''Draft Environmental Assessment on the Issuance of an Incidental Harassment Authorization to the National Science Foundation and Antarctic Support Contract to Take Marine Mammals by Harassment Incidental to a Low-Energy Marine Geophysical Survey in the Ross Sea, January to April 2015.'' Information in the NSF and ASC's IHA application, Draft IEE/EA, Draft EA and this notice of the proposed IHA collectively provide the environmental information related to proposed issuance of the IHA for public review and comment. NMFS will review all comments submitted in response to this notice as we complete the NEPA process, including a decision of whether to sign a Finding of No Significant Impact (FONSI), prior to a final decision on the IHA request.

FOR FURTHER INFORMATION CONTACT: Howard Goldstein or Jolie Harrison, Office of Protected Resources, NMFS, 301–427–8401.

SUPPLEMENTARY INFORMATION:

Background

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

An authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. NMFS has defined ''negligible impact'' in 50 CFR 216.103 as ''. . . an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.''

Section 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. Section 101(a)(5)(D) of the MMPA establishes a 45-day time limit for NMFS's review of an application, followed by a 30-day public notice and comment period on any proposed authorizations for the incidental harassment of small numbers of marine mammals. Within 45 days of the close of the public comment period, NMFS must either issue or deny the authorization.

Except with respect to certain activities not pertinent here, the MMPA defines ''harassment'' as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

Summary of Request

On July 15, 2014, NMFS received an application from NSF and ASC requesting that NMFS issue an IHA for the take, by Level B harassment only, of small numbers of marine mammals incidental to conducting a low-energy marine seismic survey in International Waters (i.e., high seas) in the Ross Sea during January to February 2015. The IHA application includes an addendum which includes incidental take requests for marine mammals related to icebreaking activities.

The research would be conducted by Louisiana State University. NSF and ASC plan to use one source vessel, the RVIB *Nathaniel B. Palmer* (*Palmer*), and a seismic airgun array and hydrophone streamer to collect seismic data in the Ross Sea. The vessel would be operated by ASC, which operates the United

States Antarctic Program (USAP) under contract with NSF. In support of the USAP, NSF and ASC plan to use conventional low-energy, seismic methodology to perform marine-based studies in the Ross Sea, including evaluation of the timing and duration of two grounding events (i.e., advances of grounded ice) to the outer and middle shelf of the Whales Deep Basin, a West Antarctic Ice Sheet paleo ice stream trough in the eastern Ross Sea (see Figures 1 and 2 of the IHA application). The studies would involve a low-energy seismic survey, acquiring core samples from the seafloor, and performing radiocarbon dating of benthic foraminifera to meet a number of research goals. In addition to the proposed operations of the seismic airgun array and hydrophone streamer(s), NSF and ASC intend to operate a single-beam echosounder, multi-beam echosounder, acoustic Doppler current profiler (ADCP), and sub-bottom profiler continuously throughout the survey.

Acoustic stimuli (i.e., increased underwater sound) generated during the operation of the seismic airgun array and from icebreaking activities may have the potential to cause behavioral disturbance for marine mammals in the proposed survey area. This is the principal means of marine mammal taking associated with these activities, and NSF and ASC have requested an authorization to take 18 species of marine mammals by Level B harassment. Take is not expected to result from the use of the single-beam echosounder, multi-beam echosounder, ADCP, and sub-bottom profiler, as the brief exposure of marine mammals to one pulse, or small numbers of signals, to be generated by these instruments in this particular case is not likely to result in the harassment of marine mammals. Also, NMFS does not expect take to result from collision with the source vessel because it is a single vessel moving at a relatively slow, constant cruise speed of 5 knots ([kts]; 9.3 kilometers per hour [km/hr]; 5.8 miles per hour [mph]) during seismic acquisition within the survey, for a relatively short period of time (approximately 27 operational days). It is likely that any marine mammal would be able to avoid the vessel.

Description of the Proposed Specified Activity

Overview

NSF and ASC propose to use one source vessel, the *Palmer,* a two GI airgun array and one hydrophone streamer to conduct the conventional seismic survey as part of the NSF-funded research project ''Timing and Duration of LGM and post-LGM Grounding Events in the Whales Deep Paleo Ice Streams, Eastern Ross Sea Continental Shelf.'' In addition to the airguns, NSF and ASC intend to conduct a bathymetric survey and core sampling from the *Palmer* during the proposed low-energy seismic survey.

Dates and Duration

The *Palmer* is expected to depart from McMurdo Station on approximately January 24, 2015 and arrive at Hobart, Australia on approximately March 20, 2015. Research operations would be conducted over a span of 27 days (from approximately January 24 to February 26, 2015). At the end of the proposed research operations, the *Palmer* would resume other operational activities, and transit to Hobart, Australia. The total distance the *Palmer* would travel in the region to conduct the proposed research activities (i.e., seismic survey, bathymetric survey, transit to coring locations and McMurdo Station) represents approximately 12,000 km (6,479.5 nmi). Some minor deviation from this schedule is possible, depending on logistics and weather (e.g., the cruise may depart earlier or be extended due to poor weather; or there could be additional days of airgun operations if collected data are deemed to be of substandard quality).

Specified Geographic Region

The proposed project and survey sites are located in selected regions of the Ross Sea (located north of the Ross Ice Shelf) and focus on the Whales Deep Basin trough (encompassing the region between 76 to 78° South, and between 165 to 170° West) (see Figure 2 of the IHA application). Figure 2 also illustrates the general bathymetry of the proposed study area and the previously collected data with respect to seismic units and dated cores. The proposed low-energy seismic survey would be conducted in International Waters. Figure 2 of the IHA application illustrates the general bathymetry of the proposed study area near the Ross Ice Shelf. Water depths in the survey area are between 100 to 1,000 m. The proposed low-energy seismic survey would be within an area of approximately 3,882 km^2 (1,131.8 nmi^2). This estimate is based on the maximum number of kilometers for the low-energy seismic survey (1,750 km) multiplied by the area ensonified around the planned tracklines (1.109 km × 2). The ensonified area is based on the predicted rms radii (m) based on modeling and empirical measurements (assuming 100% use of the two 105 in^3 GI airguns in 100 to 1,000 m water depths), which was calculated to be 1,109 m (3,638.5 ft) (see Appendix B of the IHA application).

If icebreaking is required during the course of the research activities in the Antarctica region, it is expected to occur on a limited basis. The research activities and associated contingencies are designed to avoid areas of heavy sea ice condition, and the Ross Sea region is typically clear during the January to February time period due to a large polynya which routinely forms in front of the Ross Ice Shelf.

Researchers would work to minimize time spent breaking ice. The proposed science operations are more difficult to conduct in icy conditions because the ice noise degrades the quality of the geophysical and ADCP data. Also, time spent breaking ice takes away from time supporting research. Logistically, if the vessel were in heavy ice conditions, researchers would not tow the airgun array and streamer, as this would likely damage equipment and generate noise interference. It is possible that the low-energy seismic survey can be performed in low ice conditions if the *Palmer* could generate an open path behind the vessel.

Because the *Palmer* is not rated to routinely break multi-year ice, operations would generally avoid transiting through older ice (i.e., 2 years or older, thicker than 1 m). If sea ice is encountered during the cruise, it is anticipated the *Palmer* would proceed primarily through one year sea ice, and possibly some new, very thin ice, and would follow leads wherever possible. Satellite imagery from the Ross Sea region (*http://www.iup.physik.uni-bremen.de:8084/ssmis/*) documents that sea ice is at its minimum extent during the month of February.

Based on the proposed tracklines, estimated transit to the proposed study area from McMurdo Station, and expected ice conditions (using historical sea ice extent), it is estimated that the *Palmer* may need to break ice along a distance of approximately 500 km (269.9 nmi) or less. Based on the ship's speed of 5 knots under moderate ice conditions, 500 km represents approximately 54 hours of icebreaking operations. It is noted that typical transit through areas of primarily open water containing brash or pancake ice are not considered icebreaking for the purposes of this assessment.

Detailed Description of the Proposed Specified Activity

NSF and ASC propose to conduct a low-energy seismic survey in the Ross

Sea from January to February 2015. In addition to the low-energy seismic survey, scientific research activities would include conducting a bathymetric profile survey of the seafloor using transducer-based instruments such as a multi-beam echosounder and sub-bottom profiler; acquiring bottom imaging, using underwater camera systems; and collecting approximately 32 core samples from the seafloor using various methods and equipment. Water depths in the survey area are 100 to 1,000 meters (m) (328.1 to 3,280.1 feet [ft]). The proposed low-energy seismic survey is scheduled to occur for a total of approximately 200 hours over the course of the entire cruise, which would be for approximately 27 operational days in January to February 2015. The proposed research activities would bisect approximately 25,500 km^2 (7,434.6 nmi^2) in the Ross Sea region (see Figure 2 of the IHA application). The proposed low-energy seismic survey would be conducted during the day (from nautical twilight-dawn to nautical twilight-dusk) and night, and for up to 100 hours of continuous operations at a time. Note that there would be 24-hour or near 24-hour daylight in the proposed study area between January 24 and February 26, 2015 (*http://www.timeanddate.com/sun/antarctica/mcmurdo?month=2&year=2015*). The operation hours and survey length would include equipment testing, ramp-up, line changes, and repeat coverage. Some minor deviation from these dates would be possible, depending on logistics and weather. The Principal Investigator is Dr. Philip Bart of the Louisiana State University (Baton Rouge).

Grounding events in the Whales Deep Basin are represented by seismically resolvable Grounding Zone Wedges. During the proposed activities in the Ross Sea, researchers would acquire additional seismic data and multi-beam bathymetry and imaging to precisely define the depositional and erosional limits of the outer and middle shelf Grounding Zone Wedges. The proposed collection of benthic samples and resulting analyses would test the hypothesis and counter hypothesis regarding the West Antarctic Ice Sheet retreat as it relates to the Whales Deep Basin paleo ice stream through: (1) Radiocarbon dating in situ benthic foraminifera isolated from diamict deposited on the Grounding Zone Wedges foreset; (2) ramped pyrolysis of acid insoluble organic isolated from diatom ooze overlying Grounding Zone Wedges diamict; (3) calculating the duration of the two grounding events; and (4) extracting pore-water from the Grounding Zone Wedges diamict to determine salinity and $\delta^{18}O$ values to test a numerical model prediction regarding the West Antarctic Ice Sheet retreat.

The procedures to be used for the survey would be similar to those used during previous low-energy seismic surveys by NSF and would use conventional seismic methodology. The proposed survey would involve one source vessel, the *Palmer.* NSF and ASC would deploy a two Sercel Generator Injector (GI) airgun array (each with a discharge volume of 105 in^3 [1,720 cm^3], in one string, with a total volume of 210 in^3 [3,441.3 cm^3]) as an energy source, at a tow depth of up to 3 to 4 m (9.8 to 13.1 ft) below the surface (more information on the airguns can be found in Appendix B of the IHA application). A third airgun would serve as a ''hot spare'' to be used as a back-up in the event that one of the two operating airguns malfunctions. The airguns in the array would be spaced approximately 3 m (9.8 ft) apart and 15 to 40 m (49.2 to 131.2 ft) astern of the vessel. The receiving system would consist of one or two 100 m (328.1 ft) long, 24-channel, solid-state hydrophone streamer(s) towed behind the vessel. Data acquisition is planned along a series of predetermined lines, all of which would be in water depths 100 to 1,000 m. As the GI airguns are towed along the survey lines, the hydrophone streamer(s) would receive the returning acoustic signals and transfer the data to the onboard processing system. All planned seismic data acquisition activities would be conducted by technicians provided by NSF and ASC, with onboard assistance by the scientists who have proposed the study. The vessel would be self-contained, and the crew would live aboard the vessel for the entire cruise.

The weather, sea, and ice conditions would be closely monitored, including the presence of pack ice that could hinder operation of the airgun array and streamer(s) as well as conditions that could limit visibility. If situations are encountered which pose a risk to the equipment, impede data collection, or require the vessel to stop forward progress, the equipment would be shut-down and retrieved until conditions improve. In general, the airgun array and streamer(s) could be retrieved in less than 30 minutes.

The planned seismic survey (including equipment testing, start-up, line changes, repeat coverage of any areas, and equipment recovery) would consist of approximately 1,750 kilometers (km) (944.9 nautical miles [nmi]) of transect lines (including turns) in the study area in the Ross Sea (see Figures 1 and 2 of the IHA application). In addition to the operation of the airgun array, a single-beam and multi-beam echosounder, ADCP, and a sub-bottom profiler would also likely be operated from the *Palmer* continuously throughout the cruise. There would be additional airgun operations associated with equipment testing, ramp-up, and possible line changes or repeat coverage of any areas where initial data quality is sub-standard. In NSF and ASC's estimated take calculations, 25% has been added for those additional operations. The portion of the cruise planned for after the low-energy seismic survey in the Ross Sea is not associated with the project; it is associated with McMurdo Station support and would occur regardless of the low-energy seismic survey (i.e., no science activities would be conducted). In addition, the *Palmer* would transit approximately 3,980 km (2,149 nmi) to Australia after the planned support activities for McMurdo Station.

TABLE 1—PROPOSED LOW-ENERGY SEISMIC SURVEY ACTIVITIES IN THE ROSS SEA

Survey length (km)	Total duration (hr) [1]	Airgun array total volume	Time between airgun shots (distance)	Streamer length (m)
1,750 (944.9 nmi)	~200	2 × 105 in^3 (2 × 1,720 cm^3)	5 to 10 seconds (12.5 to 25 m or 41 to 82 ft).	100 (328.1 ft).

[1] Airgun operations are planned for no more than 100 continuous hours at a time.

Vessel Specifications

The *Palmer,* a research vessel owned by Edison Chouest Offshore, Inc. and operated by NSF and ACS (under a long-term charter with Edison Chouest Offshore, Inc.), would tow the two GI airgun array, as well as the hydrophone streamer. When the *Palmer* is towing the airgun array and the relatively short hydrophone streamer, the turning rate of the vessel while the gear is deployed is approximately 20 degrees per minute, which is much higher than the limit of 5 degrees per minute for a seismic vessel towing a streamer of more typical length (much greater than 1 km [0.5 nmi]). Thus, the maneuverability of the vessel is not limited much during operations with the streamer.

The U.S.-flagged vessel, built in 1992, has a length of 94 m (308.5 ft); a beam of 18.3 m (60 ft); a maximum draft of 6.8 m (22.5 ft); and a gross tonnage of 6,174. The ship is powered by four Caterpillar 3608 diesel engines (3,300 brake horsepower [hp] at 900 rotations per minute [rpm]) and a 1,400 hp flush-mounted, water jet azimuthing bowthruster. Electrical power is provided by four Caterpillar 3512, 1,050 kiloWatt (kW) diesel generators. The GI airgun compressor onboard the vessel is manufactured by Borsig-LMF Seismic Air Compressor. The *Palmer's* operation speed during seismic acquisition is typically approximately 9.3 km/hr (5 kts) (varying between 7.4 to 11.1 km/hr [4 to 6 kts]). When not towing seismic survey gear, the *Palmer* typically cruises at 18.7 km/hr (10.1 kts) and has a maximum speed of 26.9 km/hr (14.5 kts). The *Palmer* has an operating range of approximately 27,780 km (15,000 nmi) (the distance the vessel can travel without refueling), which is approximately 70 to 75 days. The vessel can accommodate 37 scientists and 22 crew members.

The vessel also has two locations as likely observation stations from which Protected Species Observers (PSO) would watch for marine mammals before and during the proposed airgun operations. Observing stations would be at the bridge level, with a PSO's eye level approximately 16.5 m (54.1 ft) above sea level and an approximately 270° view around the vessel, and an aloft observation tower that is approximately 24.4 m (80.1 ft) above sea level, is protected from the weather and has an approximately 360° view around the vessel. More details of the *Palmer* can be found in the IHA application and online at: *http://www.nsf.gov/geo/plr/support/nathpalm.jsp* and *http://www.usap.gov/vesselScienceAndOperations/contentHandler.cfm?id=1561*

Acoustic Source Specifications—Seismic Airguns

The *Palmer* would deploy an airgun array, consisting of two 105 in^3 Sercel GI airguns as the primary energy source and a 100 m streamer(s) containing hydrophones. The airgun array would have a supply firing pressure of 2,000 pounds per square inch (psi) and 2,200 psi when at high pressure stand-by (i.e., shut-down). The regulator would be adjusted to ensure that the maximum pressure to the GI airguns is 2,000 psi, but there are times when the GI airguns may be operated at pressures as low as 1,750 to 1,800 psi. Seismic pulses for the GI airguns would be emitted at intervals of approximately 5 seconds. There would be between 360 and 720 shots per hour and the relative linear distance between the shots would be between 15 to 30 m (49.2 to 98.4 ft). During firing, a brief (approximately 0.03 second) pulse sound is emitted; the airguns would be silent during the intervening periods. The dominant frequency components range from two to 188 Hertz (Hz).

The GI airguns would fire the compressed air volume in unison in harmonic mode. The GI airguns would be used in harmonic mode, that is, the volume of the injector chamber (I) of each GI airgun is equal to that of its generator chamber (G): 105 in^3 (1,721 cm^3) for each airgun. The generator chamber of each GI airgun in the primary source is the one responsible for introducing the sound pulse into the ocean. The injector chamber injects air into the previously-generated bubble to maintain its shape, and does not introduce more sound into the water. In harmonic mode, the injector volume is designed to destructively interfere with the reverberations of the generator (source component). Firing the airguns in harmonic mode maximizes resolution in the data and minimizes any excess noise in the water column or data caused by the reverberations (or bubble pulses). The two GI airguns would be spaced approximately 3 m (9.8 ft) apart, side-by-side, between 15 and 40 m (49.2 and 131.2 ft) behind the *Palmer,* at a depth of up to 3 to 4 m during the low-energy seismic survey.

The Nucleus modeling software used at Lamont-Doherty Earth Observatory of Columbia University (L–DEO) does not include GI airguns as part of its airgun library, however signatures and mitigation models have been obtained for two 105 in^3 G airguns that are close approximations. A tow depth of 4 m is assumed and would result in the largest radii. For the two 105 in^3 airgun array, the source output (downward) is 234.1 dB re 1 μPam 0-to-peak and 239.8 dB re 1 μPam for peak-to-peak. These numbers were determined applying the aforementioned G-airgun approximation to the GI airgun and using signatures filtered with DFS V out-256 Hz 72 dB/octave. The dominant frequency range would be 20 to 150 Hz for a pair of GI airguns towed at 4 m depth.

During the low-energy seismic survey, the vessel would attempt to maintain a constant cruise speed of approximately 5 knots. The airguns would operate continuously for no more than 100 hours at a time based on operational constraints. The total duration of the airgun operations would not exceed 200 hours. The relatively short, 24-channel hydrophone streamer would provide operational flexibility to allow the low-energy seismic survey to proceed along the designated cruise tracklines. The design of the seismic equipment is to achieve high-resolution images with the ability to correlate to the ultra-high frequency sub-bottom profiling data and provide cross-sectional views to pair with the seafloor bathymetry.

Metrics Used in This Document

This section includes a brief explanation of the sound measurements frequently used in the discussions of acoustic effects in this document. Sound pressure is the sound force per unit area, and is usually measured in micropascals (μPa), where 1 pascal (Pa) is the pressure resulting from a force of one newton exerted over an area of one square meter. Sound pressure level (SPL) is expressed as the ratio of a measured sound pressure and a reference level. The commonly used reference pressure level in underwater acoustics is 1 μPa, and the units for SPLs are dB re 1 μPa. SPL (in decibels [dB]) = 20 log (pressure/reference pressure).

SPL is an instantaneous measurement and can be expressed as the peak, the peak-to-peak (p-p), or the root mean square (rms). Root mean square, which is the square root of the arithmetic average of the squared instantaneous pressure values, is typically used in discussions of the effects of sounds on vertebrates and all references to SPL in this document refer to the root mean square unless otherwise noted. SPL does not take the duration of a sound into account.

Characteristics of the Airgun Pulses

Airguns function by venting high-pressure air into the water, which creates an air bubble. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by the oscillation of the resulting air bubble. The oscillation of the air bubble transmits sounds downward through the seafloor, and the amount of sound transmitted in the near horizontal directions is reduced. However, the airgun array also emits sounds that travel horizontally toward non-target areas.

The nominal downward-directed source levels of the airgun arrays used by NSF and ASC on the *Palmer* do not represent actual sound levels that can be measured at any location in the water. Rather, they represent the level that would be found 1 m (3.3 ft) from a hypothetical point source emitting the same total amount of sound as is emitted by the combined GI airguns. The actual received level at any location in the water near the GI airguns would not exceed the source level of the strongest individual source. In this case, that would be about 228.3 dB re 1 μPam peak or 234.0 dB re 1 μPam peak-to-peak for the two 105 in³ airgun array. However, the difference between rms and peak or peak-to-peak values for a given pulse depends on the frequency content and duration of the pulse, among other factors. Actual levels experienced by any organism more than 1 m from either GI airgun would be significantly lower.

Accordingly, L–DEO has predicted and modeled the received sound levels in relation to distance and direction from the two GI airgun array. A detailed description of L–DEO's modeling for this survey's marine seismic source arrays for protected species mitigation is provided in the NSF/USGS PEIS. These are the nominal source levels applicable to downward propagation. The NSF/USGS PEIS discusses the characteristics of the airgun pulses. NMFS refers the reviewers to that document for additional information.

Predicted Sound Levels for the Airguns

To determine buffer and exclusion zones for the airgun array to be used, received sound levels have been modeled by L–DEO for a number of airgun configurations, including two 105 in³ G airguns, in relation to distance and direction from the airguns (see Figure 2 in Appendix B of the IHA application). The model does not allow for bottom interactions, and is most directly applicable to deep water. Because the model results are for G airguns, which have more energy than GI airguns of the same size, those distances overestimate (by approximately 10%) the distances for the two 105 in³ GI airguns. Although the distances are overestimated, no adjustments for this have been made to the radii distances in Table 2 (below). Based on the modeling, estimates of the maximum distances from the GI airguns where sound levels of 190, 180, and 160 dB re 1 μPa (rms) are predicted to be received in intermediate water are shown in Table 2 (see Table 1 of Appendix B of the IHA application).

Empirical data concerning the 190, 180, and 160 dB (rms) distances were acquired for various airgun arrays based on measurements during the acoustic verification studies conducted by L–DEO in the northern Gulf of Mexico (GOM) in 2003 (Tolstoy *et al.,* 2004) and 2007 to 2008 (Tolstoy *et al.,* 2009; Diebold *et al.,* 2010). Results of the 18 and 36 airgun array are not relevant for the two GI airguns to be used in the proposed low-energy seismic survey because the airgun arrays are not the same size or volume. The empirical data for the 6, 10, 12, and 20 airgun arrays indicate that, for deep water, the L–DEO model tends to overestimate the received sound levels at a given distance (Tolstoy *et al.,* 2004). For the two G airgun array, measurements were obtained only in shallow water. When compared to measurements in acquired in deep water, mitigation radii provided by the L–DEO model for the proposed airgun operations were found to be conservative. The acoustic verification surveys also showed that distances to given received levels vary with water depth; these are larger in shallow water, while intermediate/slope environments show characteristics intermediate between those of shallow water and those of deep water environments, and documented the influence of a sloping seafloor. The only measurements obtained for intermediate depths during either survey were for the 36-airgun array in 2007 to 2008 (Diebold *et al.,* 2010). Following results obtained at this site and earlier practice, a correction factor of 1.5, irrespective of distance to the airgun array, is used to derive intermediate-water radii from modeled deep-water radii. Estimates of the maximum distances from the GI airguns where sound levels of 160, 180, and 190 dB (rms) are predicted to be received in intermediate water are 739, 74, and 24 m (2,424.5, 242.8, 78.7 ft), respectively, are obtained from L–DEO's model results in deep water, which after multiplication by the correction factor of 1.5 are 1,109, 111, and 36 m (3,638.5, 364.2, and 118.1 ft) (see Table 1 of Appendix B of IHA application)

Measurements were not made for a two GI airgun array in intermediate and deep water; however, NSF and ASC proposes to use the buffer and exclusion zones predicted by L–DEO's model for the proposed GI airgun operations in intermediate water, although they are likely conservative given the empirical results for the other arrays. Using the L–DEO model, Table 2 (below) shows the distances at which three rms sound levels are expected to be received from the two GI airguns. The 160 dB re 1 μPam (rms) is the threshold specified by NMFS for potential Level B (behavioral) harassment from impulsive noise for both cetaceans and pinnipeds. The 180 and 190 dB re 1 μPam (rms) distances are the safety criteria for potential Level A harassment as specified by NMFS (2000) and are applicable to cetaceans and pinnipeds, respectively. If marine mammals are detected within or about to enter the appropriate exclusion zone, the airguns would be shut-down immediately. Table 2 summarizes the predicted distances at which sound levels (160, 180, and 190 dB [rms]) are expected to be received from the two airgun array (each 105 in³) operating in intermediate water (100 to 1,000 m [328.1 to 3,280 ft]) depths.

TABLE 2—PREDICTED AND MODELED (TWO 105 in³ GI AIRGUN ARRAY) DISTANCES TO WHICH SOUND LEVELS ≥160, 180, AND 190 dB RE 1 μPA (rms) COULD BE RECEIVED IN DEEP WATER DURING THE PROPOSED LOW-ENERGY SEISMIC SURVEY IN THE ROSS SEA, JANUARY TO FEBRUARY 2015

Source and total volume	Tow depth (m)	Water depth (m)	Predicted rms radii distances (m) for 2 GI airgun array		
			160 dB	180 dB	190 dB
Two GI Airguns (105 in³).	3 to 4	Intermediate (100 to 1,000).	1,109 (3,638.5 ft).	111 (364.2 ft)	36 (118.1 ft) *100 would be used for pinnipeds as described in NSF/USGS PEIS*.

Based on the NSF/USGS PEIS and Record of Decision, for situations which incidental take of marine mammals is anticipated, NSF and ASC have proposed exclusion zones of 100 m for cetaceans and pinnipeds for all low-energy acoustic sources in water depths greater than 100 m. While NMFS views the 100 m exclusion zone for pinnipeds appropriate, NMFS has proposed to require an exclusion zone of 111 m for cetaceans based on the predicted and modeled values by L–DEO and to be more protective for marine mammals.

NMFS expects that acoustic stimuli resulting from the proposed operation of the two GI airgun array has the potential to harass marine mammals. NMFS does not expect that the movement of the *Palmer,* during the conduct of the low-energy seismic survey, has the potential to harass marine mammals because the relatively slow operation speed of the vessel (approximately 5 kts; 9.3 km/hr; 5.8 mph) during seismic data acquisition should allow marine mammals to avoid the vessel.

Bathymetric Survey

Along with the low-energy airgun operations, other additional geophysical (detailed swath bathymetry) measurements focused on a specific study area within the Ross Sea would be made using hull-mounted sonar system instruments. The proposed bathymetric research would bisect approximately 8,300 km² (2,419.9 nmi²) in the Ross Sea Region (see Figure 2 of the IHA application). In addition, several other transducer-based instruments onboard the vessel would be operated continuously during the cruise for operational and navigational purposes. During bathymetric survey operations, when the vessel is not towing seismic equipment, its average speed would be approximately 10.1 kts (18.8 km/hr). Operating characteristics for the instruments to be used are described below.

Single-Beam Echosounder (Knudsen 3260)—The hull-mounted CHIRP sonar would be operated continuously during all phases of the cruise. This instrument is operated at 12 kHz for bottom-tracking purposes or at 3.5 kHz in the sub-bottom profiling mode. The sonar emits energy in a 30° beam from the bottom of the ship.

Single-Beam Echosounder (Bathy 2000)—The hull-mounted sonar characteristics of the Bathy 2000 are similar to the Knudsen 3260. Only one hull-mounted echosounder can be operated at a time, and this source would be operated instead of the Knudsen 3260 only if needed (i.e., only one would be in continuous operation during the cruise). The specific model to be used is expected to be selected by the scientific researchers. This was also the preferred instrument for many previous low-energy seismic surveys on the *Palmer.*

Multi-Beam Sonar (Simrad EM120)—The hull-mounted multi-beam sonar would be operated continuously during the cruise. This instrument operates at a frequency of 12 kHz, has an estimated maximum source energy level of 242 dB re 1μPa (rms), and emits a very narrow (<2°) beam fore to aft and 150° in cross-track. The multi-beam system emits a series of nine consecutive 15 ms pulses.

Acoustic Doppler Current Profiler (ADCP Teledyne RDI VM–150)—The hull-mounted ADCP would be operated continuously throughout the cruise. The ADCP operates at a frequency of 150 kHz with an estimated acoustic output level at the source of 223.6 dB re 1μPa (rms). Sound energy from the ADCP is emitted as a 30° conically-shaped beam.

Acoustic Doppler Current Profiler (ADCP Ocean Surveyor OS–38)—The characteristics of this backup hull-mounted ADCP unit are similar to the Teledyne VM–150 and would be continuously operated.

Acoustic Locator (Pinger)—A pinger would be deployed with certain instruments (e.g., camera) and equipment (e.g., corers) so these devices can be located in the event they become detached from their lines. A pinger typically operates at a frequency of 12 kHz, generates a 5 ms pulse per second, and has an acoustical output of 162 dB re 1 μPa (rms). A maximum total of 32 coring samples would be obtained using these devices and ranging from 1.5 to 3 hours per sample and require approximately 62 hours per sample. Therefore, it is estimated that the pinger would operate a total of 62 hours.

Passive Instruments—During the low-energy seismic survey in the Ross Sea, underwater imagery would be obtained through deployment of a benthos bottom camera and towing benthic camera system (during the coring activities). In addition, numerous (approximately 50) expendable bathythermograph (XBTs) probes would also be released (and none would be recovered) over the course of the cruise to obtain temperature data necessary to calculate sound velocity profiles used by the multi-beam sonar.

Core Sampling

The primary sampling goals involve the acquisition of sediment cores for analysis. The coring locations would be determined using data generated by the low-energy seismic survey.

It is anticipated that cores would be advanced at a total of 32 coring locations using several different types of equipment designed to meet research specific objectives. Proposed sediment coring activities include: box coring at 3 locations, gravity coring at 3 locations, jumbo piston coring at 4 locations, Kasten coring at 11 locations, and standard piston coring at 11 locations. The proposed coring activities are summarized in Table 3 (see below). The small diameter coring devices would collect sediment from the seafloor at 32 sample locations. At each sampling location up to 176 cm² (27.3 in²) of seafloor would be disturbed by deployment of the coring devices, yielding a cumulative total of approximately 0.6 m² (6.5 ft²) disturbance during the proposed project (see Figure 2 of the IHA application).

TABLE 3—PROPOSED CORING ACTIVITIES IN THE ROSS SEA

Sampling device	Core diameter (cm)	Core length (m)	Number of cores
Box Core (Rectangular Profile)	10	0.5	3
Gravity Core	7.5	3	3
Jumbo Piston Core	12.7	12	4
Kasten Core	15	6	11
Standard Piston Core	8.9	9	11

From the sediment cores, the in situ foraminifera and ramped pyrolysis radiocarbon data would be used to conduct a detailed comparison of acid insoluble organic versus foraminifera radiocarbon dates. The grounding-event duration data generated would provide a test of the two radiocarbon dating strategies. Resolving which of the two interpretations of how near-surface sedimentology and stratigraphy of Glomar Challenger Basin Grounding Zone Wedges stratigraphy in eastern Ross Sea relates to post-Last Glacial Maximum grounding-line migration is the goal of the proposed research; determining which of the strategies is more accurate and/or what offsets exist between the two dating strategies used to support these interpretations is important because constraining the timing of recent grounding events is essential to predict what factors might cause the current stability (i.e., a pause in grounding-line migration) to end with additional West Antarctic Ice Sheet retreat.

Icebreaking

Icebreaking is considered by NMFS to be a continuous sound and NMFS estimates that harassment occurs when marine mammals are exposed to continuous sounds at a received sound level of 120 dB SPL or above. Potential takes of marine mammals may ensue from icebreaking activity in which the *Palmer* is expected to engage in Antarctic waters (i.e., along the Ross Sea region, between 76 to 78° South, between 165 to 170° West). While breaking ice, the noise from the ship, including impact with ice, engine noise, and propeller cavitation, would exceed 120 dB (rms) continuously. If icebreaking does occur in Antarctic waters, NMFS, NSF and ASC expect it would occur on a limited basis during transit and non-seismic operations to gain access to coring or other sampling locations and not during seismic airgun operations. The research activities and associated contingencies are designed to avoid areas of heavy sea ice condition, and the Ross Sea region is typically clear during the January to February time period. If the *Palmer* breaks ice during transit within the Antarctic waters (within the Ross Sea or other areas of the Southern Ocean), airgun operations would not be conducted concurrently.

In 2008, acousticians from Scripps Institution of Oceanography Marine Physical Laboratory and University of New Hampshire Center for Coastal and Ocean Mapping conducted measurements of SPLs of the U.S. Coast Guard Cutter (USCGC) *Healy* icebreaking under various conditions (Roth and Schmidt, 2010). The results indicated that the highest mean SPL (185 dB) was measured at survey speeds of 4 to 4.5 kts in conditions of 5/10 ice and greater. Mean SPL under conditions where the ship was breaking heavy ice by backing and ramming was actually lower (180 dB). In addition, when backing and ramming, the vessel is essentially stationary, so the ensonified area is limited for a short period (on the order of minutes to tens of minutes) to the immediate vicinity of the vessel until the ship breaks free and once again makes headway.

The 120 dB received sound level radius around the *Healy* while icebreaking was estimated by researchers (USGS, 2010). Using a practical spreading model, a source level of 185 dB decays to 120 dB in about 21.54 km (11.6 nmi). This model is corroborated by Roth and Schmidt (2010). Therefore, as the ship travels through the ice, a swath 43.08 km (23.3 nmi ft) wide would be subject to sound levels greater than or equal to 120 dB. This results in potential exposure of 21, 540 km^2 (6,280.1 nmi^2) to sounds greater than or equal to 120 dB from icebreaking.

Data characterizing the sound levels generated by icebreaking activities conducted by the *Palmer* are not available; therefore, data for noise generating from an icebreaking vessel such as the USCGC *Healy* would be used as a proxy. It is noted that the *Palmer* is a smaller vessel and has less icebreaking capability than the U.S. Coast Guard's other polar icebreakers, being only capable of breaking ice up to 1 m thick at speeds of 3 kts (5.6 km/hr or 3 nmi). Therefore, the sound levels that may be generated by the *Palmer* are expected to be lower than the conservative levels estimated and measured for the USCGC *Healy*. Researchers would work to minimize time spent breaking ice as science operations are more difficult to conduct in icy conditions since the ice noise degrades the quality of the seismic and ADCP data and time spent breaking ice takes away from time supporting scientific research. Logistically, if the vessel were in heavy ice conditions, researchers would not tow the airgun array and streamer, as this would likely damage equipment and generate noisy data. It is possible that the low-energy seismic survey can be performed in low ice conditions if the *Palmer* could generate an open path behind the vessel.

Because the *Palmer* is not rated to break multi-year ice routinely, operations generally avoid transiting through older ice (i.e., 2 years or older, thicker than 1 m). If sea ice is encountered during the cruise, it is anticipated the *Palmer* would proceed primarily through one year sea ice, and possibly some new, very thin ice, and would follow leads wherever possible. Based on historical sea ice extent and the proposed cruise tracklines, it is estimated by NSF and ASC that the *Palmer* may actively break up ice to a distance of 500 km (270 nmi). Based on a ship's speed of 5 kts under moderate ice conditions, this distance represents approximately 54 hours of icebreaking operations. It is noted that typical transit through areas primarily open water and containing brash ice or pancake ice would not be considered icebreaking.

Description of the Marine Mammals in the Specified Geographic Area of the Proposed Specified Activity

Various international and national Antarctic research programs (e.g., Antarctic Pack Ice Seals Program, Commission for the Conservation of Antarctic Marine Living Resources, Japanese Whale Research Program under Special Permit in the Antarctic, and NMFS National Marine Mammal Laboratory), academic institutions (e.g., University of Canterbury, Tokai University, Virginia Institute of Marine Sciences, University of Genova), and other organizations (e.g., National Institute of Water and Atmospheric Research Ltd., Institute of Cetacean Research, Nippon Kaiyo Co., Ltd., H.T. Harvey & Associates, Center for Whale Research) have conducted scientific cruises and/or examined data on marine mammal sightings along the coast of Antarctica, Southern Ocean, and Ross Sea, and these data were considered in evaluating potential marine mammals in the proposed action area. Records from the International Whaling Commission's International Decade of Cetacean Research (IDCR), Southern Ocean Collaboration Program (SOC), and Southern Ocean Whale and Ecosystem Research (IWC–SOWER) circumpolar cruises were also considered.

The marine mammals that generally occur in the proposed action area belong to three taxonomic groups: Mysticetes (baleen whales), odontocetes (toothed whales), and pinnipeds (seals and sea lions). The marine mammal species that could potentially occur within the Southern Ocean in proximity to the proposed action area in the Ross Sea include 20 species of cetaceans and 7 species of pinnipeds.

The Ross Sea and surrounding Southern Ocean is a feeding ground for a variety of marine mammals. In general, many of the species present in the sub-Antarctic study area may be present or migrating through the Southern Ocean in the Ross Sea during the proposed low-energy seismic survey. Many of the species that may be potentially present in the study area seasonally migrate to higher latitudes near Antarctica. In general, most large whale species (except for the killer whale) migrate north in the middle of the austral winter and return to Antarctica in the early austral summer.

The five species of pinnipeds that are found in the Southern Ocean and most likely be present in the proposed study area include the crabeater (*Lebodon carcinophagus*), leopard (*Hydrurga leptonyx*), Ross (*Ommatophoca rossii*), Weddell (*Leptonychotes weddellii*), and southern elephant (*Mirounga leonina*) seal. Many of these pinniped species breed on either the pack ice or subantarctic islands. Crabeater seals are more common in the northern regions of the Ross Sea, concentrated in the pack ice over the Antarctic Slope Front. Leopard seals are often seen during the austral summer off the Adelie penguin (*Pygoscelis adeliae*) rookeries of Ross Island. Ross seals are often found in pack ice and open waters, they seem to prefer dense consolidated pack ice rather than the open pack ice that is frequented by crabeater seals. The Weddell seal is considered to be common and frequently encountered in the Ross Sea. Southern elephant seals may enter the Ross Sea in the austral summer from breeding and feeding grounds further to the north. They are considered uncommon in the Ross Sea. The southern elephant seal and Antarctic fur seal have haul-outs and rookeries that are located on subantarctic islands and prefer beaches. Antarctic (*Arctocephalus gazella*) and Subantarctic (*Arctocephalus tropicalis*) fur seals preferred habitat is not in the proposed study area, and thus it is not considered further in this document.

Marine mammal species likely to be encountered in the proposed study area that are listed as endangered under the U.S. Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq.*), includes the southern right (*Eubalaena australis*), humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and sperm (*Physeter macrocephalus*) whale.

In addition to the 13 species known to occur in the Ross Sea, there are 7 cetacean species with ranges that are known to potentially occur in the waters of the proposed study area: southern right, Cuvier's beaked (*Ziphius cavirostris*), Gray's beaked (*Mesoplodon grayi*), Hector's beaked (*Mesoplodon hectori*), and spade-toothed beaked (*Mesoplodon traversii*) whale, southern right whale dolphin (*Lissodelphis peronii*), and spectacled porpoise (*Phocoena dioptrica*). However, these species have not been sighted and are not expected to occur where the proposed activities would take place. These species are not considered further in this document. Table 4 (below) presents information on the habitat, occurrence, distribution, abundance, population, and conservation status of the species of marine mammals that may occur in the proposed study area during January to February 2015.

TABLE 4—THE HABITAT, OCCURRENCE, RANGE, REGIONAL ABUNDANCE, AND CONSERVATION STATUS OF MARINE MAMMALS THAT MAY OCCUR IN OR NEAR THE PROPOSED LOW-ENERGY SEISMIC SURVEY AREA IN THE ROSS SEA

[See text and Tables 6 and 7 in NSF and ASC's IHA application for further details]

Species	Habitat	Occurrence	Range	Population estimate	ESA [1]	MMPA [2]
Mysticetes:						
Southern right whale (*Eubalaena australis*).	Coastal, pelagic	Rare	Circumpolar 20 to 55° South	8,000 [3] to 15,000 [4]	EN	D
Humpback whale (*Megaptera novaeangliae*).	Pelagic, near-shore waters, and banks.	Common	Cosmopolitan	35,000 to 40,000 [3]—Worldwide 9,484 [5]—Scotia Sea and Antarctica Peninsula.	EN	D
Minke whale (*Balaenoptera acutorostrata* including dwarf sub-species).	Pelagic and coastal.	Common	Circumpolar—Southern Hemisphere to 65° South.	NA	NL	NC
Antarctic minke whale (*Balaenoptera bonaerensis*).	Pelagic, ice floes	Common	7° South to ice edge (usually 20 to 65° South).	Several 100,000 [3]—Worldwide 18,125 [5]—Scotia Sea and Antarctica Peninsula.	NL	NC
Sei whale (*Balaenoptera borealis*).	Primarily off-shore, pelagic.	Uncommon.	Migratory, Feeding Concentration 40 to 50° South.	80,000 [3]—Worldwide	EN	D
Fin whale (*Balaenoptera physalus*).	Continental slope, pelagic.	Common	Cosmopolitan, Migratory	140,000 [3]—Worldwide 4,672 [5]—Scotia Sea and Antarctica Peninsula.	EN	D
Blue whale (*Balaenoptera musculus;* including pygmy blue whale [*Balaenoptera musculus brevicauda*]).	Pelagic, shelf, coastal.	Uncommon.	Migratory Pygmy blue whale—North of Antarctic Convergence 55° South.	8,000 to 9,000 [3]—Worldwide 1,700 [6]—Southern Ocean	EN	D
Odontocetes:						
Sperm whale (*Physeter macrocephalus*).	Pelagic, deep sea	Common	Cosmopolitan, Migratory	360,000 [3]—Worldwide 9,500 [3]—Antarctic	EN	D
Arnoux's beaked whale (*Berardius arnuxii*).	Pelagic	Common	Circumpolar in Southern Hemisphere, 24 to 78° South.	NA	NL	NC
Cuvier's beaked whale (*Ziphius cavirostris*).	Pelagic	Rare	Cosmopolitan	NA	NL	NC
Southern bottlenose whale (*Hyperoodon planifrons*).	Pelagic	Common	Circumpolar—30° South to ice edge.	500,000 [3]—South of Antarctic Convergence.	NL	NC
Gray's beaked whale (*Mesoplodon grayi*).	Pelagic	Rare	30° South to Antarctic waters	NA	NL	NC
Hector's beaked whale (*Mesoplodon hectori*).	Pelagic	Rare	Circumpolar—cool temperate waters of Southern Hemisphere.	NA	NL	NC
Spade-toothed beaked whale (*Mesoplodon traversii*).	Pelagic	Rare	Circumantarctic	NA	NL	NC
Strap-toothed beaked whale (*Mesoplodon layardii*).	Pelagic	Common	30° South to Antarctic Convergence.	NA	NL	NC
Killer whale (*Orcinus orca*)	Pelagic, shelf, coastal, pack ice.	Common	Cosmopolitan	80,000 [3]—South of Antarctic Convergence. 25,000 [7]—Southern Ocean	NL	NC
Long-finned pilot whale (*Globicephala melas*).	Pelagic, shelf, coastal.	Common	Circumpolar—19 to 68° South in Southern Hemisphere.	200,000 [3,8]—South of Antarctic Convergence.	NL	NC

TABLE 4—THE HABITAT, OCCURRENCE, RANGE, REGIONAL ABUNDANCE, AND CONSERVATION STATUS OF MARINE MAMMALS THAT MAY OCCUR IN OR NEAR THE PROPOSED LOW-ENERGY SEISMIC SURVEY AREA IN THE ROSS SEA—Continued

[See text and Tables 6 and 7 in NSF and ASC's IHA application for further details]

Species	Habitat	Occurrence	Range	Population estimate	ESA [1]	MMPA [2]
Southern right whale dolphin (*Lissodelphis peronii*).	Pelagic	Rare	12 to 65° South	NA	NL	NC
Hourglass dolphin (*Lagenorhynchus cruciger*).	Pelagic, ice edge	Common	33° South to pack ice	144,000 [3]—South of Antarctic Convergence.	NL	NC
Spectacled porpoise (*Phocoena dioptrica*).	Coastal, pelagic	Rare	Circumpolar—Southern Hemisphere.	NA	NL	NC
Pinnipeds:						
Crabeater seal (*Lobodon carcinophaga*).	Coastal, pack ice	Common	Circumpolar—Antarctic	5,000,000 to 15,000,000 [3 9]—Worldwide.	NL	NC
Leopard seal (*Hydrurga leptonyx*).	Pack ice, sub-Antarctic islands.	Common	Sub-Antarctic islands to pack ice	220,000 to 440,000 [3 10]—Worldwide	NL	NC
Ross seal (*Ommatophoca rossii*).	Pack ice, smooth ice floes, pelagic.	Common	Circumpolar—Antarctic	130,000 [3] 20,000 to 220,000 [14]—Worldwide	NL	NC
Weddell seal (*Leptonychotes weddellii*).	Fast ice, pack ice, sub-Antarctic islands.	Common	Circumpolar—Southern Hemisphere.	500,000 to 1,000,000 [3 11]—Worldwide.	NL	NC
Southern elephant seal (*Mirounga leonina*).	Coastal, pelagic, sub-Antarctic waters.	Uncommon.	Circumpolar—Antarctic Convergence to pack ice.	640,000 [12] to 650,000 [3]—Worldwide 470,000—South Georgia Island [14]	NL	NC
Antarctic fur seal (*Arctocephalus gazella*).	Shelf, rocky habitats.	Rare	Sub-Antarctic islands to pack ice edge.	1,600,000 [13] to 3,000,000 [3]—Worldwide.	NL	NC
Subantarctic fur seal (*Arctocephalus tropicalis*).	Shelf, rocky habitats.	Rare	Subtropical front to sub-Antarctic islands and Antarctica.	Greater than 310,000 [3]—Worldwide	NL	NC

NA = Not available or not assessed.
[1] U.S. Endangered Species Act: EN = Endangered, T = Threatened, DL = Delisted, NL = Not listed.
[2] U.S. Marine Mammal Protection Act: D = Depleted, S = Strategic, NC = Not Classified.
[3] Jefferson *et al.,* 2008.
[4] Kenney, 2009.
[5] Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) survey area (Reilly *et al.,* 2004).
[6] Sears and Perrin, 2009.
[7] Ford, 2009.
[8] Olson, 2009.
[9] Bengston, 2009.
[10] Rogers, 2009.
[11] Thomas and Terhune, 2009.
[12] Hindell and Perrin, 2009.
[13] Arnould, 2009.
[14] Academic Press, 2009.

Refer to sections 3 and 4 of NSF and ASC's IHA application for detailed information regarding the abundance and distribution, population status, and life history and behavior of these other marine mammal species and their occurrence in the proposed action area. The IHA application also presents how NSF and ASC calculated the estimated densities for the marine mammals in the proposed study area. NMFS has reviewed these data and determined them to be the best available scientific information for the purposes of the proposed IHA.

Potential Effects of the Proposed Specified Activity on Marine Mammals

This section includes a summary and discussion of the ways that the types of stressors associated with the specified activity (e.g., seismic airgun operation, vessel movement, gear deployment, and icebreaking) have been observed to impact marine mammals. This discussion may also include reactions that we consider to rise to the level of a take and those that we do not consider to rise to the level of take (for example, with acoustics, we may include a discussion of studies that showed animals not reacting at all to sound or exhibiting barely measureable avoidance). This section is intended as a background of potential effects and does not consider either the specific manner in which this activity would be carried out or the mitigation that would be implemented, and how either of those would shape the anticipated impacts from this specific activity. The ''Estimated Take by Incidental Harassment'' section later in this document would include a quantitative analysis of the number of individuals that are expected to be taken by this activity. The ''Negligible Impact Analysis'' section will include the analysis of how this specific activity will impact marine mammals and will consider the content of this section, the ''Estimated Take by Incidental Harassment'' section, the ''Proposed Mitigation'' section, and the ''Anticipated Effects on Marine Mammal Habitat'' section to draw conclusions regarding the likely impacts of this activity on the reproductive success or survivorship of individuals and from that on the affected marine mammal populations or stocks.

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms have been derived using auditory evoked potentials, anatomical modeling, and other data, Southall *et al.* (2007) designate ''functional hearing groups'' for marine mammals and estimate the lower and upper frequencies of functional hearing of the groups. The functional groups and the associated frequencies are indicated below (though animals are less sensitive to sounds at the outer edge of their functional range and most sensitive to sounds of frequencies within a smaller range somewhere in the middle of their functional hearing range):

• Low-frequency cetaceans (13 species of mysticetes): Functional hearing is estimated to occur between approximately 7 Hz and 30 kHz;
• Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): Functional hearing is estimated to occur between approximately 150 Hz and 160 kHz;
• High-frequency cetaceans (eight species of true porpoises, six species of river dolphins, *Kogia* spp., the franciscana [*Pontoporia blainvillei*], and four species of cephalorhynchids): Functional hearing is estimated to occur between approximately 200 Hz and 180 kHz; and
• Phocid pinnipeds in water: Functional hearing is estimated to occur between approximately 75 Hz and 100 kHz;
• Otariid pinnipeds in water: Functional hearing is estimated to occur between approximately 100 Hz and 40 kHz.

As mentioned previously in this document, 18 marine mammal species (13 cetacean and 5 pinniped species) are likely to occur in the proposed low-energy seismic survey area. Of the 13 cetacean species likely to occur in NSF and ASC's proposed action area, 6 are classified as low-frequency cetaceans (humpback, minke, Antarctic minke, sei, fin, and blue whale), and 7 are classified as mid-frequency cetaceans (sperm, Arnoux's beaked, southern bottlenose, strap-toothed beaked, killer, and long-finned pilot whale, and hourglass dolphin) (Southall *et al.,* 2007). Of the 5 pinniped species likely to occur in NSF and ASC's proposed action area, all are classified as phocid pinnipeds (crabeater, leopard, Ross, Weddell, and southern elephant seal) (Southall *et al.,* 2007). A species functional hearing group is a consideration when we analyze the effects of exposure to sound on marine mammals.

Acoustic stimuli generated by the operation of the airguns, which introduce sound into the marine environment, may have the potential to cause Level B harassment of marine mammals in the proposed study area. The effects of sounds from airgun operations might include one or more of the following: Tolerance, masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson *et al.,* 1995; Gordon *et al.,* 2004; Nowacek *et al.,* 2007; Southall *et al.,* 2007). Permanent hearing impairment, in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not an injury (Southall *et al.,* 2007). Although the possibility cannot be entirely excluded, it is unlikely that the proposed project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. Based on the available data and studies described here, some behavioral disturbance is expected. A more comprehensive review of these issues can be found in the ''Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement prepared for Marine Seismic Research that is funded by the National Science Foundation and conducted by the U.S. Geological Survey'' (NSF/USGS, 2011) and L–DEO's ''Environmental Assessment of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras, September to October 2014.''

Tolerance

Richardson *et al.* (1995) defines tolerance as the occurrence of marine mammals in areas where they are exposed to human activities or man-made noise. In many cases, tolerance develops by the animal habituating to the stimulus (i.e., the gradual waning of responses to a repeated or ongoing stimulus) (Richardson, *et al.,* 1995; Thorpe, 1963), but because of ecological or physiological requirements, many marine animals may need to remain in areas where they are exposed to chronic stimuli (Richardson, *et al.,* 1995).

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Several studies have shown that marine mammals at distances more than a few kilometers from operating seismic vessels often show no apparent response. That is often true even in cases when the pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of the marine mammal group. Although various baleen whales and toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times marine mammals of all three types have shown no overt reactions. The relative responsiveness of baleen and toothed whales are quite variable.

Masking

The term masking refers to the inability of a subject to recognize the occurrence of an acoustic stimulus as a result of the interference of another acoustic stimulus (Clark *et al.,* 2009). Introduced underwater sound may, through masking, reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant fraction of the time (Richardson *et al.,* 1995).

The airguns for the proposed low-energy seismic survey have dominant frequency components of 2 to 188 Hz. This frequency range fully overlaps the lower part of the frequency range of odontocete calls and/or functional hearing (full range about 150 Hz to 180 kHz). Airguns also produce a small portion of their sound at mid and high frequencies that overlap most, if not all, frequencies produced by odontocetes. While it is assumed that mysticetes can detect acoustic impulses from airguns and vessel sounds (Richardson *et al.,* 1995a), sub-bottom profilers, and most of the multi-beam echosounders would likely be detectable by some mysticetes based on presumed mysticete hearing sensitivity. Odontocetes are presumably more sensitive to mid to high frequencies produced by the multi-beam echosounders and sub-bottom profilers than to the dominant low frequencies produced by the airguns and vessel. A more comprehensive review of the relevant background information for odontocetes appears in Section 3.6.4.3, Section 3.7.4.3 and Appendix E of the NSF/USGS PEIS (2011).

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited. Because of the intermittent nature and low duty cycle of seismic airgun pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in some situations, reverberation occurs for much or the entire interval between pulses (e.g., Simard *et al.,* 2005; Clark and Gagnon, 2006) which could mask calls. Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls can usually be heard between the seismic pulses (e.g., Richardson *et al.,* 1986; McDonald *et al.,* 1995; Greene *et al.,* 1999; Nieukirk *et al.,* 2004; Smultea *et al.,* 2004; Holst *et al.,* 2005a,b, 2006; and Dunn and Hernandez, 2009). However, Clark and Gagnon (2006) reported that fin whales in the North Atlantic Ocean went silent for an extended period starting soon after the onset of a seismic survey in the area. Similarly, there has been one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles *et al.,* 1994). However, more recent studies found that they continued calling in the presence of seismic pulses (Madsen *et al.,* 2002; Tyack *et al.,* 2003; Smultea *et al.,* 2004; Holst *et al.,* 2006; and Jochens *et al.,* 2008). Dilorio and Clark (2009) found evidence of increased calling by blue whales during operations by a lower-energy seismic source (i.e., sparker). Dolphins and porpoises commonly are heard calling while airguns are operating (e.g., Gordon *et al.,* 2004; Smultea *et al.,* 2004; Holst *et al.,* 2005a, b; and Potter *et al.,* 2007). 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.

Pinnipeds have the most sensitive hearing and/or produce most of their sounds in frequencies higher than the dominant components of airgun sound, but there is some overlap in the frequencies of the airgun pulses and the calls. However, the intermittent nature of airgun pules presumably reduces the potential for masking.

Marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior through shifting call frequencies, increasing call volume, and increasing vocalization rates. For example blue whales are found to increase call rates when exposed to noise from seismic surveys in the St. Lawrence Estuary (Dilorio and Clark, 2009). The North Atlantic right whales (*Eubalaena glacialis*) exposed to high shipping noise increased call frequency (Parks *et al.,* 2007), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller *et al.,* 2000). In general, NMFS expects the masking effects of seismic pulses to be minor, given the normally intermittent nature of seismic pulses.

Behavioral Disturbance

Marine mammals may behaviorally react to sound when exposed to anthropogenic noise. Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson *et al.,* 1995; Wartzok *et al.,* 2004; Southall *et al.,* 2007; Weilgart, 2007). These behavioral reactions are often shown as: Changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (e.g., pinnipeds flushing into the water from haul-outs or rookeries). 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).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification could be expected to be biologically significant if the change affects growth, survival, and/or reproduction. Some of these significant behavioral modifications include:

- Change in diving/surfacing patterns (such as those thought to be causing beaked whale stranding due to exposure to military mid-frequency tactical sonar);
- Habitat abandonment due to loss of desirable acoustic environment; and
- Cessation of feeding or social interaction.

The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Richardson *et al.,* 1995; Southall *et al.,* 2007). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many mammals would be present within a particular distance of industrial activities and/or exposed to a particular level of sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically-important manner.

Baleen Whales—Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable (reviewed in Richardson *et al.,* 1995; Gordon *et al.,* 2004). Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the cases of migrating gray (*Eschrichtius robustus*) and bowhead (*Balaena mysticetus*) whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals (Richardson, *et al.,* 1995). They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Studies of gray, bowhead, and humpback whales have shown that seismic pulses with received levels of 160 to 170 dB re 1 μPa (rms) seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed (Malme *et al.,* 1986, 1988; Richardson *et al.,* 1995). In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from 4 to 15 km (2.2 to 8.1 nmi) from the source. A substantial proportion of the baleen whales within those distances may show avoidance or other strong behavioral reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and studies have shown that some species of baleen whales, notably bowhead, gray, and humpback whales, at times, show strong avoidance at received levels lower than 160 to 170 dB re 1 μPa (rms).

Researchers have studied the responses of humpback whales to seismic surveys during migration, feeding during the summer months, breeding while offshore from Angola, and wintering offshore from Brazil. McCauley *et al.* (1998, 2000a) studied the responses of humpback whales off western Australia to a full-scale seismic survey with a 16 airgun array (2,678 in^3) and to a single airgun (20 in^3) with source level of 227 dB re 1 μPa (p-p). In the 1998 study, they documented that avoidance reactions began at 5 to 8 km (2.7 to 4.3 nmi) from the array, and that those reactions kept most pods approximately 3 to 4 km (1.6 to 2.2 nmi) from the operating seismic boat. In the 2000 study, they noted localized displacement during migration of 4 to 5 km (2.2 to 2.7 nmi) by traveling pods and 7 to 12 km (3.8 to 6.5 nmi) by more sensitive resting pods of cow-calf pairs. Avoidance distances with respect to the single airgun were smaller but consistent with the results from the full array in terms of the received sound levels. The mean received level for initial avoidance of an approaching airgun was 140 dB re 1 μPa (rms) for humpback pods containing females, and at the mean closest point of approach distance the received level was 143 dB re 1 μPa (rms). The initial avoidance response generally occurred at distances of 5 to 8 km (2.7 to 4.3 nmi) from the airgun array and 2 km (1.1 nmi) from the single airgun. However, some individual humpback whales, especially males, approached within distances of 100 to 400 m (328 to 1,312 ft), where the maximum received level was 179 dB re 1 μPa (rms).

Data collected by observers during several seismic surveys in the Northwest Atlantic showed that sighting rates of humpback whales were significantly greater during non-seismic periods compared with periods when a full array was operating (Moulton and Holst, 2010). In addition, humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic vs. non-seismic periods (Moulton and Holst, 2010).

Humpback whales on their summer feeding grounds in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64–L (100 in^3) airgun (Malme *et al.,* 1985). Some humpbacks seemed ''startled'' at received levels of 150 to 169 dB re 1 μPa. Malme *et al.* (1985) concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 dB re 1 μPa (rms). However, Moulton and Holst (2010) reported that humpback whales monitored during seismic surveys in the Northwest Atlantic had lower sighting rates and were most often seen swimming away from the vessel during seismic periods compared with periods when airguns were silent.

Studies have suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel *et al.,* 2004). The evidence for this was circumstantial and subject to alternative explanations (IAGC, 2004). Also, the evidence was not consistent with subsequent results from the same area of Brazil (Parente *et al.,* 2006), or with direct studies of humpbacks exposed to seismic surveys in other areas and seasons. After allowance for data from subsequent years, there was ''no observable direct correlation'' between strandings and seismic surveys (IWC, 2007: 236).

Reactions of migrating and feeding (but not wintering) gray whales to seismic surveys have been studied. Malme *et al.* (1986, 1988) studied the responses of feeding eastern Pacific gray whales to pulses from a single 100 in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50 percent of feeding gray whales stopped feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10 percent of feeding whales interrupted feeding at received levels of 163 dB re 1 μPa (rms). Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast (Malme *et al.,* 1984; Malme and Miles, 1985), and western Pacific gray whales feeding off Sakhalin Island, Russia (Wursig *et al.,* 1999; Gailey *et al.,* 2007; Johnson *et al.,* 2007; Yazvenko *et al.,* 2007a, b), along with data on gray whales off British Columbia (Bain and Williams, 2006).

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses (Stone, 2003; MacLean and Haley, 2004; Stone and Tasker, 2006), and calls from blue and fin whales have been localized in areas with airgun operations (e.g., McDonald *et al.,* 1995; Dunn and Hernandez, 2009; Castellote *et al.,* 2010). Sightings by observers on seismic vessels off the United Kingdom from 1997 to 2000 suggest that, during times of good sightability, sighting rates for mysticetes (mainly fin and sei whales) were similar when large arrays of airguns were shooting versus silent (Stone, 2003; Stone and Tasker, 2006). However, these whales tended to exhibit localized avoidance, remaining significantly further (on average) from the airgun array during seismic operations compared with non-seismic periods (Stone and Tasker, 2006). Castellote *et al.* (2010) reported that singing fin whales in the Mediterranean moved away from an operating airgun array.

Ship-based monitoring studies of baleen whales (including blue, fin, sei, minke, and humpback whales) in the Northwest Atlantic found that overall, this group had lower sighting rates during seismic vs. non-seismic periods (Moulton and Holst, 2010). Baleen whales as a group were also seen significantly farther from the vessel during seismic compared with non-seismic periods, and they were more often seen to be swimming away from the operating seismic vessel (Moulton and Holst, 2010). Blue and minke whales were initially sighted significantly farther from the vessel during seismic operations compared to non-seismic periods; the same trend was observed for fin whales (Moulton and Holst, 2010). Minke whales were most often observed to be swimming away from the vessel when seismic operations were underway (Moulton and Holst, 2010).

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades (Appendix A in Malme *et al.,* 1984; Richardson *et al.,* 1995; Allen and Angliss, 2010). The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year (Johnson *et al.,* 2007). Similarly, bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years (Richardson *et al.,* 1987; Allen and Angliss, 2010). The history of coexistence between seismic surveys and baleen whales suggests that brief exposures to sound pulses from any single seismic survey are unlikely to result in prolonged effects.

Toothed Whales—Little systematic information is available about reactions of toothed whales to noise pulses. Few studies similar to the more extensive baleen whale/seismic pulse work summarized above have been reported for toothed whales. However, there are recent systematic studies on sperm whales (e.g., Gordon *et al.,* 2006; Madsen *et al.,* 2006; Winsor and Mate, 2006; Jochens *et al.,* 2008; Miller *et al.,* 2009). There is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (e.g., Stone, 2003; Smultea *et al.,* 2004; Moulton and Miller, 2005; Bain and Williams, 2006; Holst *et al.,* 2006; Stone and Tasker, 2006; Potter *et al.,* 2007; Hauser *et al.,* 2008; Holst and Smultea, 2008; Weir, 2008; Barkaszi *et al.,* 2009; Richardson *et al.,* 2009; Moulton and Holst, 2010).

Seismic operators and PSOs on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels (e.g., Goold, 1996a,b,c; Calambokidis and Osmek, 1998; Stone, 2003; Moulton and Miller, 2005; Holst *et al.,* 2006; Stone and Tasker, 2006; Weir, 2008; Richardson *et al.,* 2009; Barkaszi *et al.,* 2009; Moulton and Holst, 2010). Some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when large arrays of airguns are firing (e.g., Moulton and Miller, 2005). Nonetheless, small toothed whales more often tend to head away, or to maintain a somewhat greater distance from the vessel, when a large array of airguns is operating than when it is silent (e.g., Stone and Tasker, 2006; Weir, 2008; Barry *et al.,* 2010; Moulton and Holst, 2010). In most cases, the avoidance radii for delphinids appear to be small, on the order of one km or less, and some individuals show no apparent avoidance. Captive bottlenose dolphins (*Tursiops truncatus*) and beluga whales (*Delphinapterus leucas*) exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran *et al.,* 2000, 2002, 2005). However, the animals tolerated high received levels of sound before exhibiting aversive behaviors.

Results of porpoises depend on species. The limited available data suggest that harbor porpoises (*Phocoena phocoena*) show stronger avoidance of seismic operations than do Dall's porpoises (*Phocoenoides dalli*) (Stone, 2003; MacLean and Koski, 2005; Bain and Williams, 2006; Stone and Tasker, 2006). Dall's porpoises seem relatively tolerant of airgun operations (MacLean and Koski, 2005; Bain and Williams, 2006), although they too have been observed to avoid large arrays of operating airguns (Calambokidis and Osmek, 1998; Bain and Williams, 2006). This apparent difference in responsiveness of these two porpoise species is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson *et al.,* 1995; Southall *et al.,* 2007).

Most studies of sperm whales exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses (e.g., Stone, 2003; Moulton *et al.,* 2005, 2006a; Stone and Tasker, 2006; Weir, 2008). In most cases the whales do not show strong avoidance, and they continue to call. However, controlled exposure experiments in the Gulf of Mexico indicate that foraging behavior was altered upon exposure to airgun sound (Jochens *et al.,* 2008; Miller *et al.,* 2009; Tyack, 2009). There are almost no specific data on the behavioral reactions of beaked whales to seismic surveys. However, some northern bottlenose whales (*Hyperoodon ampullatus*) remained in the general area and continued to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys (Gosselin and Lawson, 2004; Laurinolli and Cochrane, 2005; Simard *et al.,* 2005). Most beaked whales tend to avoid approaching vessels of other types (e.g., Wursig *et al.,* 1998). They may also dive for an extended period when approached by a vessel (e.g., Kasuya, 1986), although it is uncertain how much longer such dives may be as compared to dives by undisturbed beaked whales, which also are often quite long (Baird *et al.,* 2006; Tyack *et al.,* 2006). Based on a single observation, Aguilar-Soto *et al.* (2006) suggested that foraging efficiency of Cuvier's beaked whales may be reduced by close approach of vessels. In any event, it is likely that most beaked whales would also show strong avoidance of an approaching seismic vessel, although this has not been documented explicitly. In fact, Moulton and Holst (2010) reported 15 sightings of beaked whales during seismic studies in the Northwest Atlantic; seven of those sightings were made at times when at least one airgun was operating. There was little evidence to indicate that beaked whale behavior was affected by airgun operations; sighting rates and distances were similar during seismic and non-seismic periods (Moulton and Holst, 2010).

There are increasing indications that some beaked whales tend to strand when naval exercises involving mid-frequency sonar operation are ongoing nearby (e.g., Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; NOAA and USN, 2001; Jepson *et al.,* 2003; Hildebrand, 2005; Barlow and Gisiner, 2006; see also the ''Stranding and Mortality'' section in this notice). These strandings are apparently a disturbance response, although auditory or other injuries or other physiological effects may also be involved. Whether beaked whales would ever react similarly to seismic surveys is unknown. Seismic survey sounds are quite different from those of the sonar in operation during the above-cited incidents.

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive of some mysticetes. However, other data suggest that some odontocete species, including harbor porpoises, may be more responsive than might be expected given their poor low-frequency hearing. Reactions at longer distances may be particularly likely when sound propagation conditions are conducive to transmission of the higher frequency components of airgun sound to the animals' location (DeRuiter *et al.,* 2006; Goold and Coates, 2006; Tyack *et al.,* 2006; Potter *et al.,* 2007).

Pinnipeds—Pinnipeds are not likely to show a strong avoidance reaction to the airgun array. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behavior. In the Beaufort Sea, some ringed seals avoided an area of 100 m to (at most) a few hundred meters around seismic vessels, but many seals remained within 100 to 200 m (328 to 656 ft) of the trackline as the operating airgun array passed by (e.g., Harris *et al.,* 2001; Moulton and Lawson, 2002; Miller *et al.,* 2005.). Ringed seal (*Pusa hispida*) sightings averaged somewhat farther away from the seismic vessel when the airguns were operating than when they were not, but the difference was small (Moulton and Lawson, 2002). Similarly, in Puget Sound, sighting distances for harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*) tended to be larger when airguns were operating (Calambokidis and Osmek, 1998). Previous telemetry work suggests that avoidance and other behavioral reactions may be stronger than evident to date from visual studies (Thompson *et al.,* 1998).

During seismic exploration off Nova Scotia, gray seals (*Halichoerus grypus*) exposed to noise from airguns and linear explosive charges did not react strongly (J. Parsons in Greene *et al.,* 1985). Pinnipeds in both water and air, sometimes tolerate strong noise pulses from non-explosive and explosive scaring devices, especially if attracted to the area for feeding and reproduction (Mate and Harvey, 1987; Reeves *et al.,* 1996). Thus pinnipeds are expected to be rather tolerant of, or habituate to, repeated underwater sounds from distant seismic sources, at least when the animals are strongly attracted to the area.

Hearing Impairment and Other Physical Effects

Exposure to high intensity sound for a sufficient duration may result in auditory effects such as a noise-induced threshold shift—an increase in the auditory threshold after exposure to noise (Finneran, Carder, Schlundt, and Ridgway, 2005). Factors that influence the amount of threshold shift include the amplitude, duration, frequency content, temporal pattern, and energy distribution of noise exposure. The magnitude of hearing threshold shift normally decreases over time following cessation of the noise exposure. The amount of threshold shift just after exposure is called the initial threshold shift. If the threshold shift eventually returns to zero (i.e., the threshold returns to the pre-exposure value), it is called temporary threshold shift (TTS) (Southall *et al.,* 2007). Researchers have studied TTS in certain captive odontocetes and pinnipeds exposed to strong sounds (reviewed in Southall *et al.,* 2007). However, there has been no specific documentation of TTS let alone permanent hearing damage, i.e., permanent threshold shift (PTS), in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions.

Temporary Threshold Shift—TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. At least in terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the noise ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound. Available data on TTS in marine mammals are summarized in Southall *et al.* (2007). Table 2 (above) presents the estimated distances from the *Palmer'*s airguns at which the received energy level (per pulse, flat-weighted) would be expected to be greater than or equal to 180 and 190 dB re 1 μPa (rms).

To avoid the potential for injury, NMFS (1995, 2000) concluded that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding 180 and 190 dB re 1 μPa (rms). NMFS believes that to avoid the potential for Level A harassment, cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding 180 and 190 dB re 1 μPa (rms), respectively. The established 180 and 190 dB (rms) criteria are not considered to be the levels above which TTS might occur. Rather, they are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements for marine mammals started to become available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. NMFS also assumes that cetaceans and pinnipeds exposed to levels exceeding 160 dB re 1 μPa (rms) may experience Level B harassment.

For toothed whales, researchers have derived TTS information for odontocetes from studies on the bottlenose dolphin and beluga. The experiments show that exposure to a single impulse at a received level of 207 kPa (or 30 psi, p-p), which is equivalent to 228 dB re 1 Pa (p-p), resulted in a 7 and 6 dB TTS in the beluga whale at 0.4 and 30 kHz, respectively. Thresholds returned to within 2 dB of the pre-exposure level within 4 minutes of the exposure (Finneran *et al.,* 2002). For the one harbor porpoise tested, the received level of airgun sound that elicited onset of TTS was lower (Lucke *et al.,* 2009). If these results from a single animal are representative, it is inappropriate to assume that onset of TTS occurs at similar received levels in all odontocetes (*cf.* Southall *et al.,* 2007). Some cetaceans apparently can incur TTS at considerably lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin.

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. The frequencies to which baleen whales are most sensitive are assumed to be lower than those to which odontocetes are most sensitive, and natural background noise levels at those low frequencies tend to be higher. As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison, 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales than those of odontocetes (Southall *et al.,* 2007).

In pinnipeds, researchers have not measured TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound. Initial evidence from more prolonged (non-pulse) exposures suggested that some pinnipeds (harbor seals in particular) incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak *et al.,* 1999, 2005; Ketten *et al.,* 2001). The TTS threshold for pulsed sounds has been indirectly estimated as being an SEL of approximately 171 dB re 1 $\mu Pa^2 \cdot s$ (Southall *et al.,* 2007) which would be equivalent to a single pulse with a received level of approximately 181 to 186 dB re 1 μPa (rms), or a series of pulses for which the highest rms values are a few dB lower. Corresponding values for California sea lions and northern elephant seals (*Mirounga angustirostris*) are likely to be higher (Kastak *et al.,* 2005).

Permanent Threshold Shift—When PTS occurs, there is physical damage to the sound receptors in the ear. In severe cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985). There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the possibility that mammals close to an airgun array might incur at least mild TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson *et al.,* 1995, p. 372*ff;* Gedamke *et al.,* 2008). Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS.

Relationships between TTS and PTS thresholds have not been studied in marine mammals but are assumed to be similar to those in humans and other terrestrial mammals (Southall *et al.,* 2007). PTS might occur at a received sound level at least several dBs above that inducing mild TTS if the animal were exposed to strong sound pulses with rapid rise times. Based on data from terrestrial mammals, a precautionary assumption is that the PTS threshold for impulse sounds (such as airgun pulses as received close to the source) is at least 6 dB higher than the TTS threshold on a peak-pressure basis, and probably greater than 6 dB (Southall *et al.,* 2007). Given the higher level of sound necessary to cause PTS as compared with TTS, it is considerably less likely that PTS would occur. Baleen whales generally avoid the immediate area around operating seismic vessels, as do some other marine mammals.

Non-auditory Physiological Effects—Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007). Studies examining such effects are limited. However, resonance effects (Gentry, 2002) and direct noise-induced bubble formations (Crum *et al.,* 2005) are implausible in the case of exposure to an impulsive broadband source like an airgun array. If seismic surveys disrupt diving patterns of deep-diving species, this might perhaps result in bubble formation and a form of the bends, as speculated to occur in beaked whales exposed to sonar. However, there is no specific evidence of this upon exposure to airgun pulses.

In general, very little is known about the potential for seismic survey sounds (or other types of strong underwater sounds) to cause non-auditory physical effects in marine mammals. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall *et al.,* 2007), or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, are especially unlikely to incur non-auditory physical effects.

Stranding and Mortality—When a living or dead marine mammal swims or floats onto shore and becomes ''beached'' or incapable of returning to sea, the event is termed 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 are known to 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).

Strandings Associated with Military Active Sonar—Several sources have published lists of mass stranding events of cetaceans in an attempt to identify relationships between those stranding events and military active sonar (Hildebrand, 2004; IWC, 2005; Taylor *et al.,* 2004). For example, based on a review of stranding records between 1960 and 1995, the International Whaling Commission (2005) identified ten mass stranding events and concluded that, out of eight stranding events reported from the mid-1980s to the summer of 2003, seven had been coincident with the use of mid-frequency active sonar and most involved beaked whales.

Over the past 12 years, there have been five stranding events coincident with military mid-frequency active sonar use in which exposure to sonar is believed to have been a contributing factor to strandings: Greece (1996); the Bahamas (2000); Madeira (2000); Canary Islands (2002); and Spain (2006). Refer to Cox *et al.* (2006) for a summary of common features shared by the strandings events in Greece (1996), Bahamas (2000), Madeira (2000), and Canary Islands (2002); and Fernandez *et al.,* (2005) for an additional summary of the Canary Islands 2002 stranding event.

Potential for Stranding from Seismic Surveys—Marine mammals close to underwater detonations of high explosives can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten *et al.,* 1993; Ketten, 1995). However, explosives are no longer used in marine waters for commercial seismic surveys or (with rare exceptions) for seismic research. These methods have been replaced entirely by airguns or related non-explosive pulse generators. Airgun pulses are less energetic and have slower rise times, and there is no specific evidence that they can cause serious injury, death, or stranding even in the case of large airgun arrays. However, the association of strandings of beaked whales with naval exercises involving mid-frequency active sonar (non-pulse sound) and, in one case, the regional co-occurrence of an L–DEO seismic survey (Malakoff, 2002; Cox *et al.,* 2006), has raised the possibility that beaked whales exposed to strong ''pulsed'' sounds could also be susceptible to injury and/or behavioral reactions that can lead to stranding (e.g., Hildebrand, 2005; Southall *et al.,* 2007).

Specific sound-related processes that lead to strandings and mortality are not well documented, but may include:

(1) Swimming in avoidance of a sound into shallow water;

(2) A change in behavior (such as a change in diving behavior) that might contribute to tissue damage, gas bubble formation, hypoxia, cardiac arrhythmia, hypertensive hemorrhage or other forms of trauma;

(3) A physiological change such as a vestibular response leading to a behavioral change or stress-induced hemorrhagic diathesis, leading in turn to tissue damage; and

(4) Tissue damage directly from sound exposure, such as through acoustically-mediated bubble formation and growth or acoustic resonance of tissues.

Some of these mechanisms are unlikely to apply in the case of impulse sounds. However, there are indications that gas-bubble disease (analogous to ''the bends''), induced in supersaturated tissue by a behavioral response to acoustic exposure, could be a pathologic mechanism for the strandings and mortality of some deep-diving cetaceans exposed to sonar. The evidence for this remains circumstantial and associated with exposure to naval mid-frequency sonar, not seismic surveys (Cox *et al.,* 2006; Southall *et al.,* 2007).

Seismic pulses and mid-frequency sonar signals are quite different, and some mechanisms by which sonar sounds have been hypothesized to affect beaked whales are unlikely to apply to airgun pulses. Sounds produced by airgun arrays are broadband impulses with most of the energy below one kHz. Typical military mid-frequency sonar emits non-impulse sounds at frequencies of 2 to 10 kHz, generally with a relatively narrow bandwidth at any one time. A further difference between seismic surveys and naval exercises is that naval exercises can involve sound sources on more than one vessel. Thus, it is not appropriate to expect that the same effects to marine mammals would result from military sonar and seismic surveys. However, evidence that sonar signals can, in special circumstances, lead (at least indirectly) to physical damage and mortality (e.g., Balcomb and Claridge, 2001; NOAA and USN, 2001; Jepson *et al.,* 2003; Fernández *et al.,* 2004, 2005; Hildebrand 2005; Cox *et al.,* 2006) suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity sound.

There is no conclusive evidence of cetacean strandings or deaths at sea as a result of exposure to seismic surveys, but a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings. Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel *et al.,* 2004) were not well founded (IAGC, 2004; IWC, 2007). In September 2002, there was a stranding of two Cuvier's beaked whales in the Gulf of California, Mexico, when the L–DEO vessel R/V *Maurice Ewing* was operating a 20 airgun (8,490 in^3) array in the general region. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence (Hogarth, 2002; Yoder, 2002). Nonetheless, the Gulf of California incident plus the beaked whale strandings near naval exercises involving use of mid-frequency sonar suggests a need for caution in conducting seismic surveys in areas occupied by beaked whales until more is known about effects of seismic surveys on those species (Hildebrand, 2005). No injuries of beaked whales are anticipated during the proposed study because of:

(1) The high likelihood that any beaked whales nearby would avoid the approaching vessel before being exposed to high sound levels, and

(2) Differences between the sound sources to be used in the proposed study and operated by NSF and ASC and those involved in the naval exercises associated with strandings.

Potential Effects of Other Acoustic Devices and Sources

Multi-Beam Echosounder

NSF and ASC would operate the Simrad EM120 multi-beam echosounder from the source vessel during the planned study. Sounds from the multi-beam echosounder are very short pulses, occurring for approximately 15 ms, depending on water depth. Most of the energy in the sound pulses emitted by the multi-beam echosounder is at frequencies near 12 kHz, and the maximum source level is 242 dB re 1 μPa (rms). The beam is narrow (1 to 2°) in fore-aft extent and wide (150°) in the cross-track extent. Each ping consists of nine (in water greater than 1,000 m deep) consecutive successive fan-shaped transmissions (segments) at different cross-track angles. Any given mammal at depth near the trackline would be in the main beam for only one or two of the nine segments. Also, marine mammals that encounter the Simrad EM120 are unlikely to be subjected to repeated pulses because of the narrow fore–aft width of the beam and would receive only limited amounts of pulse energy because of the short pulses. Animals close to the ship (where the beam is narrowest) are especially unlikely to be ensonified for more than one 15 ms pulse (or two pulses if in the overlap area). Similarly, Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when a multi-beam echosounder emits a pulse is small. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to receive the multiple pulses that might result in sufficient exposure to cause TTS.

Navy sonars that have been linked to avoidance reactions and stranding of cetaceans: (1) Generally have longer pulse duration than the Simrad EM120; and (2) are often directed close to horizontally, as well as omnidirectional, versus more downward and narrowly for the multi-beam echosounder. The area of possible influence of the multi-beam echosounder is much smaller—a narrow band below the source vessel. Also, the duration of exposure for a given marine mammal can be much longer for naval sonar. During NSF and ASC's operations, the individual pulses would be very short, and a given mammal would not receive many of the downward-directed pulses as the vessel passes by. Possible effects of a multi-beam echosounder on marine mammals are described below.

Stranding—In 2013, an International Scientific Review Panel investigated a 2008 mass stranding of approximately 100 melon-headed whales in a Madagascar lagoon system (Southall *et al.,* 2013) associated with the use of a high-frequency mapping system. The report indicated that the use of a 12 kHz multi-beam echosounder was the most plausible and likely initial behavioral trigger of the mass stranding event. This was the first time that a relatively high-frequency mapping sonar system has been associated with a stranding event. However, the report also notes that there were several site- and situation-specific secondary factors that may have contributed to the avoidance responses that lead to the eventual entrapment and mortality of the whales within the Loza Lagoon system (e.g., the survey vessel transiting in a north-south direction on the shelf break parallel to the shore may have trapped the animals between the sound source and the shore driving them towards the Loza Lagoon). The report concluded that for odontocete cetaceans that hear well in the 10 to 50 kHz range, where ambient noise is typically quite low, high-power active sonars operating in this range may be more easily audible and have potential effects over larger areas than low-frequency systems that have more typically been considered in terms of anthropogenic noise impacts (Southall *et al.,* 2013). However, the risk may be very low given the extensive use of these systems worldwide on a daily basis and the lack of direct evidence of such responses previously (Southall *et al.,* 2013).

Masking—Marine mammal communications would not be masked appreciably by the multi-beam echosounder signals, given the low duty cycle of the echosounder and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of baleen whales, the multi-beam echosounder signals (12 kHz) generally do not overlap with the predominant frequencies in the calls (16 Hz to less than 12 kHz), which would avoid any significant masking (Richardson *et al.,* 1995).

Behavioral Responses—Behavioral reactions of free-ranging marine mammals to sonars, echosounders, and other sound sources appear to vary by species and circumstance. Observed reactions have included silencing and dispersal by sperm whales (Watkins *et al.,* 1985), increased vocalizations and no dispersal by pilot whales (Rendell and Gordon, 1999), and the previously-mentioned beachings by beaked whales. During exposure to a 21 to 25 kHz ''whale-finding'' sonar with a source level of 215 dB re 1 μPa, gray whales reacted by orienting slightly away from the source and being deflected from their course by approximately 200 m (656.2 ft) (Frankel, 2005). When a 38 kHz echosounder and a 150 kHz ADCP were transmitting during studies in the Eastern Tropical Pacific, baleen whales showed no significant responses, while spotted and spinner dolphins were detected slightly more often and beaked whales less often during visual surveys (Gerrodette and Pettis, 2005).

Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1 second tonal signals at frequencies similar to those that would be emitted by the multi-beam echosounder used by NSF and ASC, and to shorter broadband pulsed signals. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure (Schlundt *et al.,* 2000; Finneran *et al.,* 2002; Finneran and Schlundt, 2004). The relevance of those data to free-ranging odontocetes is uncertain, and in any case, the test sounds were quite different in duration as compared with those from a multi-beam echosounder.

Hearing Impairment and Other Physical Effects—Given several stranding events that have been associated with the operation of naval sonar in specific circumstances, there is concern that mid-frequency sonar sounds can cause serious impacts to marine mammals (see above). However, the multi-beam echosounder proposed for use by NSF and ASC is quite different than sonar used for Navy operations. Pulse duration of the multi-beam echosounder is very short relative to the naval sonar. Also, at any given location, an individual marine mammal would be in the beam of the multi-beam echosounder for much less time, given the generally downward orientation of the beam and its narrow fore-aft beamwidth; Navy sonar often uses near-horizontally-directed sound. Those factors would all reduce the sound energy received from the multi-beam echosounder rather drastically relative to that from naval sonar. NMFS believes that the brief exposure of marine mammals to one pulse, or small numbers of signals, from the multi-beam echosounder in this particular case is not likely to result in the harassment of marine mammals.

Single-Beam Echosounder

NSF and ASC would operate the Knudsen 3260 and Bathy 2000 single-beam echosounders from the source vessel during the planned study. Sounds from the single-beam echosounder are very short pulses, depending on water depth. Most of the energy in the sound pulses emitted by the singlebeam echosounder is at frequencies near 12 kHz for bottom-tracking purposes or at 3.5 kHz in the sub-bottom profiling mode. The sonar emits energy in a 30° beam from the bottom of the ship. Marine mammals that encounter the Knudsen 3260 or Bathy 2000 are unlikely to be subjected to repeated pulses because of the relatively narrow fore–aft width of the beam and would receive only limited amounts of pulse energy because of the short pulses. Animals close to the ship (where the beam is narrowest) are especially unlikely to be ensonified for more than one pulse (or two pulses if in the overlap area). Similarly, Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when a single-beam echosounder emits a pulse is small. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to receive the multiple pulses that might result in sufficient exposure to cause TTS.

Navy sonars that have been linked to avoidance reactions and stranding of cetaceans: (1) Generally have longer pulse duration than the Knudsen 3260 or Bathy 2000; and (2) are often directed close to horizontally versus more downward for the echosounder. The area of possible influence of the single-beam echosounder is much smaller—a narrow band below the source vessel. Also, the duration of exposure for a given marine mammal can be much longer for naval sonar. During NSF and ASC's operations, the individual pulses would be very short, and a given mammal would not receive many of the downward-directed pulses as the vessel passes by. Possible effects of a single-beam echosounder on marine mammals are described below.

Masking—Marine mammal communications would not be masked appreciably by the single-beam echosounder signals given the low duty cycle of the echosounder and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of baleen whales, the single-beam echosounder signals (12 or 3.5 kHz) do not overlap with the predominant frequencies in the calls (16 Hz to less than 12 kHz), which would avoid any significant masking (Richardson *et al.,* 1995).

Behavioral Responses—Behavioral reactions of free-ranging marine mammals to sonars, echosounders, and other sound sources appear to vary by species and circumstance. Observed reactions have included silencing and dispersal by sperm whales (Watkins *et al.,* 1985), increased vocalizations and no dispersal by pilot whales (Rendell and Gordon, 1999), and the previously-mentioned beachings by beaked whales. During exposure to a 21 to 25 kHz ''whale-finding'' sonar with a source level of 215 dB re 1 μPa, gray whales reacted by orienting slightly away from the source and being deflected from their course by approximately 200 m (656.2 ft) (Frankel, 2005). When a 38 kHz echosounder and a 150 kHz ADCP were transmitting during studies in the Eastern Tropical Pacific, baleen whales showed no significant responses, while spotted and spinner dolphins were detected slightly more often and beaked whales less often during visual surveys (Gerrodette and Pettis, 2005).

Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1 second tonal signals at frequencies similar to those that would be emitted by the single-beam echosounder used by NSF and ASC, and to shorter broadband pulsed signals. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure (Schlundt *et al.,* 2000; Finneran *et al.,* 2002; Finneran and Schlundt, 2004). The relevance of those data to free-ranging odontocetes is uncertain, and in any case, the test sounds were quite different in duration as compared with those from a single-beam echosounder.

Hearing Impairment and Other Physical Effects—Given recent stranding events that have been associated with the operation of naval sonar, there is concern that mid-frequency sonar sounds can cause serious impacts to marine mammals (see above). However, the single-beam echosounder proposed for use by NSF and ASC is quite different than sonar used for Navy operations. Pulse duration of the single-beam echosounder is very short relative to the naval sonar. Also, at any given location, an individual marine mammal would be in the beam of the single-beam echosounder for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; Navy sonar often uses near-horizontally-directed sound. Those factors would all reduce the sound energy received from the single-beam echosounder rather drastically relative to that from naval sonar. NMFS believes that the brief exposure of marine mammals to one pulse, or small numbers of signals, from the single-beam echosounder in this particular case is not likely to result in the harassment of marine mammals.

Acoustic Doppler Current Profilers

NSF and ASC would operate the ADCP Teledyne RDI VM–150 and ADCP Ocean Surveyor OS–38 from the source vessel during the planned study. Most of the energy in the sound pulses emitted by the ADCPs operate at frequencies near 150 kHz, and the maximum source level is 223.6 dB re 1 μPa (rms). Sound energy from the ADCP is emitted as a 30° conically-shaped beam. Marine mammals that encounter the ADCPs are unlikely to be subjected to repeated pulses because of the relatively narrow fore–aft width of the beam and would receive only limited amounts of pulse energy because of the short pulses. Animals close to the ship (where the beam is narrowest) are especially unlikely to be ensonified for more than one 15 ms pulse (or two pulses if in the overlap area). Similarly, Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when the ADCPs emit a pulse is small. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to receive the multiple pulses that might result in sufficient exposure to cause TTS.

Navy sonars that have been linked to avoidance reactions and stranding of cetaceans: (1) Generally have longer pulse duration than the ADCPs; and (2) are often directed close to horizontally versus more downward for the ADCPs. The area of possible influence of the ADCPs is much smaller—a narrow band below the source vessel. Also, the duration of exposure for a given marine mammal can be much longer for naval sonar. During NSF and ASC's operations, the individual pulses would be very short, and a given mammal would not receive many of the downward-directed pulses as the vessel passes by. Possible effects of the ADCPs on marine mammals are described below.

Masking—Marine mammal communications would not be masked appreciably by the ADCP signals, given the low duty cycle of the ADCPs and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of baleen whales, the ADCP signals (150 kHz) do not overlap with the predominant frequencies in the calls (16 Hz to less than 12 kHz), which would avoid any significant masking (Richardson *et al.,* 1995).

Behavioral Responses—Behavioral reactions of free-ranging marine mammals to sonars, echosounders, and other sound sources appear to vary by species and circumstance. Observed reactions have included silencing and dispersal by sperm whales (Watkins *et al.,* 1985), increased vocalizations and no dispersal by pilot whales (Rendell and Gordon, 1999), and the previously-mentioned beachings by beaked whales. During exposure to a 21 to 25 kHz ''whale-finding'' sonar with a source level of 215 dB re 1 µPa, gray whales reacted by orienting slightly away from the source and being deflected from their course by approximately 200 m (656.2 ft) (Frankel, 2005). When a 38 kHz echosounder and a 150 kHz ADCP were transmitting during studies in the Eastern Tropical Pacific, baleen whales showed no significant responses, while spotted and spinner dolphins were detected slightly more often and beaked whales less often during visual surveys (Gerrodette and Pettis, 2005).

Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1 second tonal signals at frequencies similar to those that would be emitted by the ADCPs used by NSF and ASC, and to shorter broadband pulsed signals. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure (Schlundt *et al.,* 2000; Finneran *et al.,* 2002; Finneran and Schlundt, 2004). The relevance of those data to free-ranging odontocetes is uncertain, and in any case, the test sounds were quite different in duration as compared with those from an ADCP.

Hearing Impairment and Other Physical Effects—Given recent stranding events that have been associated with the operation of naval sonar, there is concern that mid-frequency sonar sounds can cause serious impacts to marine mammals (see above). However, the ADCPs proposed for use by NSF and ASC is quite different than sonar used for Navy operations. Pulse duration of the ADCPs is very short relative to the naval sonar. Also, at any given location, an individual marine mammal would be in the beam of the ADCPs for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; Navy sonar often uses near-horizontally-directed sound. Those factors would all reduce the sound energy received from the ADCPs rather drastically relative to that from naval sonar. NMFS believes that the brief exposure of marine mammals to one pulse, or small numbers of signals, from the ADCPs in this particular case is not likely to result in the harassment of marine mammals.

Coring Activities

During coring, the noise created by the mechanical action of the devices on the seafloor is expected to be perceived by nearby fish and other marine organisms and deter them from swimming toward the source. Coring activities would be highly localized and short-term in duration and would not be expected to significantly interfere with marine mammal behavior. The potential direct effects include temporary localized disturbance or displacement from associated sounds and/or physical movement/actions of the operations. Additionally, the potential indirect effects may consist of very localized and transitory/short-term disturbance of bottom habitat and associated prey in shallow-water areas as a result of coring and sediment sampling (NSF/USGS PEIS, 2011). NMFS believes that the brief exposure of marine mammals to noise created from the mechanical action of the devices for coring is not likely to result in the harassment of marine mammals.

A maximum total of 32 coring samples would be obtained using these devices and ranging from 1.5 to 3 hours per sample and it is estimated that the pinger would operate a total of 96 hours. The vessel would be stationary during core sampling deployment and recovery, so the likelihood of a collision or entanglement with a marine mammal is very low.

Vessel Movement and Collisions

Vessel movement in the vicinity of marine mammals has the potential to result in either a behavioral response or a direct physical interaction. Both scenarios are discussed below in this section.

Behavioral Responses to Vessel Movement—There are limited data concerning marine mammal behavioral responses to vessel traffic and vessel noise, and a lack of consensus among scientists with respect to what these responses mean or whether they result in short-term or long-term adverse effects. In those cases where there is a busy shipping lane or where there is a large amount of vessel traffic, marine mammals (especially low frequency specialists) may experience acoustic masking (Hildebrand, 2005) if they are present in the area (e.g., killer whales in Puget Sound; Foote *et al.,* 2004; Holt *et al.,* 2008). In cases where vessels actively approach marine mammals (e.g., whale watching or dolphin watching boats), scientists have documented that animals exhibit altered behavior such as increased swimming speed, erratic movement, and active avoidance behavior (Bursk, 1983; Acevedo, 1991; Baker and MacGibbon, 1991; Trites and Bain, 2000; Williams *et al.,* 2002; Constantine *et al.,* 2003), reduced blow interval (Ritcher *et al.,* 2003), disruption of normal social behaviors (Lusseau, 2003, 2006), and the shift of behavioral activities which may increase energetic costs (Constantine *et al.,* 2003, 2004). A detailed review of marine mammal reactions to ships and boats is available in Richardson *et al.,* (1995). For each of the marine mammal taxonomy groups, Richardson *et al.,* (1995) provides the following assessment regarding reactions to vessel traffic:

Toothed whales—''In summary, toothed whales sometimes show no avoidance reaction to vessels, or even approach them. However, avoidance can occur, especially in response to vessels of types used to chase or hunt the animals. This may cause temporary displacement, but we know of no clear evidence that toothed whales have abandoned significant parts of their range because of vessel traffic.''

Baleen whales—''When baleen whales receive low-level sounds from distant or stationary vessels, the sounds often seem to be ignored. Some whales approach the sources of these sounds. When vessels approach whales slowly and non-aggressively, whales often exhibit slow and inconspicuous avoidance maneuvers. In response to strong or rapidly changing vessel noise, baleen whales often interrupt their normal behavior and swim rapidly away. Avoidance is especially strong when a boat heads directly toward the whale.''

Behavioral responses to stimuli are complex and influenced to varying degrees by a number of factors, such as species, behavioral contexts, geographical regions, source characteristics (moving or stationary, speed, direction, etc.), prior experience of the animal and physical status of the animal. For example, studies have shown that beluga whales' reaction varied when exposed to vessel noise and traffic. In some cases, beluga whales exhibited rapid swimming from ice-breaking vessels up to 80 km (43.2 nmi) away and showed changes in surfacing, breathing, diving, and group composition in the Canadian high Arctic where vessel traffic is rare (Finley *et al.,* 1990). In other cases, beluga whales were more tolerant of vessels, but responded differentially to certain vessels and operating characteristics by reducing their calling rates (especially older animals) in the St. Lawrence River where vessel traffic is common (Blane and Jaakson, 1994). In Bristol Bay, Alaska, beluga whales continued to feed when surrounded by fishing vessels and resisted dispersal even when purposefully harassed (Fish and Vania, 1971).

In reviewing more than 25 years of whale observation data, Watkins (1986) concluded that whale reactions to vessel traffic were ''modified by their previous experience and current activity: Habituation often occurred rapidly, attention to other stimuli or preoccupation with other activities sometimes overcame their interest or wariness of stimuli.'' Watkins noticed that over the years of exposure to ships in the Cape Cod area, minke whales changed from frequent positive interest (e.g., approaching vessels) to generally uninterested reactions; fin whales changed from mostly negative (e.g., avoidance) to uninterested reactions; fin whales changed from mostly negative (e.g., avoidance) to uninterested reactions; right whales apparently continued the same variety of responses (negative, uninterested, and positive responses) with little change; and humpbacks dramatically changed from mixed responses that were often negative to reactions that were often strongly positive. Watkins (1986) summarized that ''whales near shore, even in regions with low vessel traffic, generally have become less wary of boats and their noises, and they have appeared to be less easily disturbed than previously. In particular locations with intense shipping and repeated approaches by boats (such as the whale-watching areas of Stellwagen Bank), more and more whales had positive reactions to familiar vessels, and they also occasionally approached other boats and yachts in the same ways.''

Although the radiated sound from the *Palmer* would be audible to marine mammals over a large distance, it is unlikely that marine mammals would respond behaviorally (in a manner that NMFS would consider harassment under the MMPA) to low-level distant shipping noise as the animals in the area are likely to be habituated to such noises (Nowacek *et al.,* 2004). In light of these facts, NMFS does not expect the *Palmer's* movements to result in Level B harassment.

Vessel Strike—Ship strikes of cetaceans can cause major wounds, which may lead to the death of the animal. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Vanderlaan and Taggart, 2007).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., the sperm whale). In addition, some baleen whales, such as the North Atlantic right whale, seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek *et al.,* 2004). These species are primarily large, slow moving whales. Smaller marine mammals (e.g., bottlenose dolphins) move quickly through the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Jensen and Silber, 2003; Vanderlaan and Taggart, 2007). In assessing records in which vessel speed was known, Laist *et al.* (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 kts (24.1 km/hr, 14.9 mph).

NSF and ASC's proposed operation of one source vessel for the proposed low-energy seismic survey is relatively small in scale (i.e., a one vessel operation) compared to the number of other ships (e.g., fishing, tourist, and other vessels supporting McMurdo Station operations) transiting at higher speeds in the same areas on an annual basis. The probability of vessel and marine mammal interactions occurring during the proposed low-energy seismic survey is unlikely due to the *Palmer's* slow operational speed, which is typically 5 kts. Outside of seismic operations, the *Palmer's* cruising speed would be approximately 10.1 to 14.5 kts, which is generally below the speed at which studies have noted reported increases of marine mammal injury or death (Laist *et al.,* 2001).

As a final point, the *Palmer* has a number of other advantages for avoiding ship strikes as compared to most commercial merchant vessels, including the following: The *Palmer's* bridge and aloft observation tower offers good visibility to visually monitor for marine mammal presence; PSOs posted during operations scan the ocean for marine mammals and must report visual alerts of marine mammal presence to crew; and the PSOs receive extensive training that covers the fundamentals of visual observing for marine mammals and information about marine mammals and their identification at sea.

Entanglement

Entanglement can occur if wildlife becomes immobilized in survey lines, cables, nets, or other equipment that is moving through the water column. The proposed low-energy seismic survey would require towing approximately one or two 100 m cable streamers. While towing this size of an array carries some level of risk of entanglement for marine mammals due to the operational nature of the activity, entanglement is unlikely. Wildlife, especially slow moving individuals, such as large whales, have a low probability of becoming entangled due to slow speed of the survey vessel and onboard monitoring efforts. In May 2011, there was one recorded entrapment of an olive ridley sea turtle (*Lepidochelys olivacea*) in the R/V

Marcus G. Langseth's barovanes after the conclusion of a seismic survey off Costa Rica. There have been cases of baleen whales, mostly gray whales (Heyning, 1990), becoming entangled in fishing lines. The probability for entanglement of marine mammals is considered very low because of the vessel speed and the monitoring efforts onboard the survey vessel. Furthermore, there has been no history of marine mammal entanglement with seismic equipment used by the U.S. academic research fleet.

Icebreaking Activities

Icebreakers produce more noise while breaking ice than ships of comparable size due, primarily, to the sounds of propeller cavitating (Richardson *et al.,* 1995). Multi-year ice is expected to be encountered in the proposed action area. Icebreakers commonly back and ram into heavy ice until losing momentum to make way. The highest noise levels usually occur while backing full astern in preparation to ram forward through the ice. Overall the noise generated by an icebreaker pushing ice was 10 to 15 dB greater than the noise produced by the ship underway in open water (Richardson *et al.,* 1995). In general, the Antarctic and Southern Ocean is a noisy environment. Calving and grounding icebergs as well as the break-up of ice sheets, can produce a large amount of underwater noise. Little information is available about the increased sound levels due to icebreaking.

Cetaceans—Few studies have been conducted to evaluate the potential interference of icebreaking noise with marine mammal vocalizations. Erbe and Farmer (1998) measured masked hearing thresholds of a captive beluga whale. They reported that the recording of a Canadian Coast Guard Ship (CCGS) *Henry Larsen,* ramming ice in the Beaufort Sea, masked recordings of beluga vocalizations at a noise to signal pressure ratio of 18 dB, when the noise pressure level was eight times as high as the call pressure. Erbe and Farmer (2000) also predicted when icebreaker noise would affect beluga whales through software that combined a sound propagation model and beluga whale impact threshold models. They again used the data from the recording of the *Henry Larsen* in the Beaufort Sea and predicted that masking of beluga whale vocalizations could extend between 40 and 71 km (21.6 and 38.3 nmi) near the surface. Lesage *et al.* (1999) report that beluga whales changed their call type and call frequency when exposed to boat noise. It is possible that the whales adapt to the ambient noise levels and are able to communicate despite the sound. Given the documented reaction of belugas to ships and icebreakers it is highly unlikely that beluga whales would remain in the proximity of vessels where vocalizations would be masked.

Beluga whales have been documented swimming rapidly away from ships and icebreakers in the Canadian high Arctic when a ship approaches to within 35 to 50 km (18.9 to 27 nmi), and they may travel up to 80 km (43.2 nmi) from the vessel's track (Richardson *et al.,* 1995). It is expected that belugas avoid icebreakers as soon as they detect the ships (Cosens and Dueck, 1993). However, the reactions of beluga whales to ships vary greatly and some animals may become habituated to high levels of ambient noise (Erbe and Darmber, 2000).

There is little information about the effects of icebreaking ships on baleen whales. Migrating bowhead whales appeared to avoid an area around a drill site by greater than 25 km (13.5 mi) where an icebreaker was working in the Beaufort Sea. There was intensive icebreaking daily in support of the drilling activities (Brewer *et al.,* 1993). Migrating bowheads also avoided a nearby drill site at the same time of year where little icebreaking was being conducted (LGL and Greeneridge, 1987). It is unclear as to whether the drilling activities, icebreaking operations, or the ice itself might have been the cause for the whale's diversion. Bowhead whales are not expected to occur in the proximity of the proposed action area.

Pinnipeds—Brueggeman *et al.* (1992) reported on the reactions of seals to an icebreaker during activities at two prospects in the Chukchi Sea. Reactions of seals to the icebreakers varied between the two prospects. Most (67%) seals did not react to the icebreaker at either prospect. Reaction at one prospect was greatest during icebreaking activity (running/maneuvering/jogging) and was 0.23 km (0.12 nmi) of the vessel and lowest for animals beyond 0.93 km (0.5 nmi). At the second prospect however, seal reaction was lowest during icebreaking activity with higher and similar levels of response during general (non-icebreaking) vessel operations and when the vessel was at anchor or drifting. The frequency of seal reaction generally declined with increasing distance from the vessel except during general vessel activity where it remained consistently high to about 0.46 km (0.25 nmi) from the vessel before declining.

Similarly, Kanik *et al.* (1980) found that ringed (*Pusa hispida*) and harp seals (*Pagophilus groenlandicus*) often dove into the water when an icebreaker was breaking ice within 1 km (0.5 nmi) of the animals. Most seals remained on the ice when the ship was breaking ice 1 to 2 km (0.5 to 1.1 nmi) away.

The potential effects to marine mammals described in this section of the document do not take into consideration the proposed monitoring and mitigation measures described later in this document (see the ''Proposed Mitigation'' and ''Proposed Monitoring and Reporting'' sections) which, as noted are designed to effect the least practicable impact on affected marine mammal species and stocks.

Anticipated Effects on Marine Mammal Habitat

The proposed low-energy seismic survey is not anticipated to have any permanent impact on habitats used by the marine mammals in the proposed study area, including the food sources they use (i.e. fish and invertebrates). Additionally, no physical damage to any habitat is anticipated as a result of conducting airgun operations during the proposed low-energy seismic survey. While it is anticipated that the specified activity may result in marine mammals avoiding certain areas due to temporary ensonification, this impact to habitat is temporary and was considered in further detail earlier in this document, as behavioral modification. The main impact associated with the proposed activity would be temporarily elevated noise levels and the associated direct effects on marine mammals in any particular area of the approximately 3,882 km^2 proposed study area, previously discussed in this notice.

The *Palmer* is designed for continuous passage at 3 kts through ice 1 m thick. During the proposed project the *Palmer* would typically encounter first- or second-year ice while avoiding thicker ice floes, particularly large intact multi-year ice, whenever possible. In addition, the vessel would follow leads when possible while following the survey route. As the vessel passes through the ice, the ship causes the ice to part and travel alongside the hull. This ice typically returns to fill the wake as the ship passes. The effects are transitory (i.e., hours at most) and localized (i.e., constrained to a relatively narrow swath perhaps 10 m [32.1 ft] to each side of the vessel). The *Palmer's* maximum beam is 18.3 m (60 ft). Applying the maximum estimated amount of icebreaking (500 km), to the corridor opened by the ship, NSF and ASC anticipate that a maximum of approximately 18 km^2 (5.3 nmi^2) of ice may be disturbed. This represents an inconsequential amount of the total ice present in the Southern Ocean.

Sea ice is important for pinniped life functions such as resting, breeding, and molting. Icebreaking activities may damage seal breathing holes and would also reduce the haul-out area in the immediate vicinity of the ship's track. Icebreaking along a maximum of 500 km of tracklines would alter local ice conditions in the immediate vicinity of the vessel. This has the potential to temporarily lead to a reduction of suitable seal haul-out habitat. However, the dynamic sea-ice environment requires that seals be able to adapt to changes in sea, ice, and snow conditions, and they therefore create new breathing holes and lairs throughout the winter and spring (Hammill and Smith, 1989). In addition, seals often use open leads and cracks in the ice to surface and breathe (Smith and Stirling, 1975). Disturbance of the ice would occur in a very small area relative to the Southern Ocean ice-pack and no significant impact on marine mammals is anticipated by icebreaking during the proposed low-energy seismic survey. The next section discusses the potential impacts of anthropogenic sound sources on common marine mammal prey in the proposed study area (i.e., fish and invertebrates).

Anticipated Effects on Fish

One reason for the adoption of airguns as the standard energy source for marine seismic surveys is that, unlike explosives, they have not been associated with large-scale fish kills. However, existing information on the impacts of seismic surveys on marine fish and invertebrate populations is limited. There are three types of potential effects of exposure to seismic surveys: (1) Pathological, (2) physiological, and (3) behavioral. Pathological effects involve lethal and temporary or permanent sub-lethal injury. Physiological effects involve temporary and permanent primary and secondary stress responses, such as changes in levels of enzymes and proteins. Behavioral effects refer to temporary and (if they occur) permanent changes in exhibited behavior (e.g., startle and avoidance behavior). The three categories are interrelated in complex ways. For example, it is possible that certain physiological and behavioral changes could potentially lead to an ultimate pathological effect on individuals (i.e., mortality).

The specific received sound levels at which permanent adverse effects to fish potentially could occur are little studied and largely unknown. Furthermore, the available information on the impacts of seismic surveys on marine fish is from studies of individuals or portions of a population; there have been no studies at the population scale. The studies of individual fish have often been on caged fish that were exposed to airgun pulses in situations not representative of an actual seismic survey. Thus, available information provides limited insight on possible real-world effects at the ocean or population scale. This makes drawing conclusions about impacts on fish problematic because, ultimately, the most important issues concern effects on marine fish populations, their viability, and their availability to fisheries.

Hastings and Popper (2005), Popper (2009), and Popper and Hastings (2009a,b) provided recent critical reviews of the known effects of sound on fish. The following sections provide a general synopsis of the available information on the effects of exposure to seismic and other anthropogenic sound as relevant to fish. The information comprises results from scientific studies of varying degrees of rigor plus some anecdotal information. Some of the data sources may have serious shortcomings in methods, analysis, interpretation, and reproducibility that must be considered when interpreting their results (see Hastings and Popper, 2005). Potential adverse effects of the program's sound sources on marine fish are noted.

Pathological Effects—The potential for pathological damage to hearing structures in fish depends on the energy level of the received sound and the physiology and hearing capability of the species in question. For a given sound to result in hearing loss, the sound must exceed, by some substantial amount, the hearing threshold of the fish for that sound (Popper, 2005). The consequences of temporary or permanent hearing loss in individual fish on a fish population are unknown; however, they likely depend on the number of individuals affected and whether critical behaviors involving sound (e.g., predator avoidance, prey capture, orientation and navigation, reproduction, etc.) are adversely affected.

Little is known about the mechanisms and characteristics of damage to fish that may be inflicted by exposure to seismic survey sounds. Few data have been presented in the peer-reviewed scientific literature. As far as NSF, ASC, and NMFS know, there are only two papers with proper experimental methods, controls, and careful pathological investigation implicating sounds produced by actual seismic survey airguns in causing adverse anatomical effects. One such study indicated anatomical damage, and the second indicated TTS in fish hearing. The anatomical case is McCauley *et al.* (2003), who found that exposure to airgun sound caused observable anatomical damage to the auditory maculae of pink snapper (*Pagrus auratus*). This damage in the ears had not been repaired in fish sacrificed and examined almost two months after exposure. On the other hand, Popper *et al.* (2005) documented only TTS (as determined by auditory brainstem response) in two of three fish species from the Mackenzie River Delta. This study found that broad whitefish (*Coregonus nasus*) exposed to five airgun shots were not significantly different from those of controls. During both studies, the repetitive exposure to sound was greater than would have occurred during a typical seismic survey. However, the substantial low-frequency energy produced by the airguns (less than 400 Hz in the study by McCauley *et al.* [2003] and less than approximately 200 Hz in Popper *et al.* [2005]) likely did not propagate to the fish because the water in the study areas was very shallow (approximately nine m in the former case and less than two m in the latter). Water depth sets a lower limit on the lowest sound frequency that would propagate (the ''cutoff frequency'') at about one-quarter wavelength (Urick, 1983; Rogers and Cox, 1988).

Wardle *et al.* (2001) suggested that in water, acute injury and death of organisms exposed to seismic energy depends primarily on two features of the sound source: (1) The received peak pressure, and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. According to Buchanan *et al.* (2004), for the types of seismic airguns and arrays involved with the proposed program, the pathological (mortality) zone for fish would be expected to be within a few meters of the seismic source. Numerous other studies provide examples of no fish mortality upon exposure to seismic sources (Falk and Lawrence, 1973; Holliday *et al.,* 1987; La Bella *et al.,* 1996; Santulli *et al.,* 1999; McCauley *et al.,* 2000a,b, 2003; Bjarti, 2002; Thomsen, 2002; Hassel *et al.,* 2003; Popper *et al.,* 2005; Boeger *et al.,* 2006).

An experiment of the effects of a single 700 in^3 airgun was conducted in Lake Meade, Nevada (USGS, 1999). The data were used in an Environmental Assessment of the effects of a marine reflection survey of the Lake Meade fault system by the National Park Service (Paulson *et al.,* 1993, in USGS, 1999). The airgun was suspended 3.5 m (11.5 ft) above a school of threadfin shad in Lake Meade and was fired three successive times at a 30 second interval. Neither surface inspection nor diver observations of the water column and bottom found any dead fish.

For a proposed seismic survey in Southern California, USGS (1999) conducted a review of the literature on the effects of airguns on fish and fisheries. They reported a 1991 study of the Bay Area Fault system from the continental shelf to the Sacramento River, using a 10 airgun (5,828 in ^{3}) array. Brezzina and Associates were hired by USGS to monitor the effects of the surveys and concluded that airgun operations were not responsible for the death of any of the fish carcasses observed. They also concluded that the airgun profiling did not appear to alter the feeding behavior of sea lions, seals, or pelicans observed feeding during the seismic surveys.

Some studies have reported, some equivocally, that mortality of fish, fish eggs, or larvae can occur close to seismic sources (Kostyuchenko, 1973; Dalen and Knutsen, 1986; Booman *et al.,* 1996; Dalen *et al.,* 1996). Some of the reports claimed seismic effects from treatments quite different from actual seismic survey sounds or even reasonable surrogates. However, Payne *et al.* (2009) reported no statistical differences in mortality/morbidity between control and exposed groups of capelin eggs or monkfish larvae. Saetre and Ona (1996) applied a 'worst-case scenario' mathematical model to investigate the effects of seismic energy on fish eggs and larvae. They concluded that mortality rates caused by exposure to seismic surveys are so low, as compared to natural mortality rates, that the impact of seismic surveying on recruitment to a fish stock must be regarded as insignificant.

Physiological Effects—Physiological effects refer to cellular and/or biochemical responses of fish to acoustic stress. Such stress potentially could affect fish populations by increasing mortality or reducing reproductive success. Primary and secondary stress responses of fish after exposure to seismic survey sound appear to be temporary in all studies done to date (Sverdrup *et al.,* 1994; Santulli *et al.,* 1999; McCauley *et al.,* 2000a,b). The periods necessary for the biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus.

Behavioral Effects—Behavioral effects include changes in the distribution, migration, mating, and catchability of fish populations. Studies investigating the possible effects of sound (including seismic survey sound) on fish behavior have been conducted on both uncaged and caged individuals (e.g., Chapman and Hawkins, 1969; Pearson *et al.,* 1992; Santulli *et al.,* 1999; Wardle *et al.,* 2001; Hassel *et al.,* 2003). Typically, in these studies fish exhibited a sharp startle response at the onset of a sound followed by habituation and a return to normal behavior after the sound ceased.

The Minerals Management Service (MMS, 2005) assessed the effects of a proposed seismic survey in Cook Inlet. The seismic survey proposed using three vessels, each towing two four-airgun arrays ranging from 24,580.6 to 40,967.7 cm ^{3} (1,500 to 2,500 in ^{3}). MMS noted that the impact to fish populations in the survey area and adjacent waters would likely be very low and temporary. MMS also concluded that seismic surveys may displace the pelagic fishes from the area temporarily when airguns are in use. However, fishes displaced and avoiding the airgun noise are likely to backfill the survey area in minutes to hours after cessation of seismic testing. Fishes not dispersing from the airgun noise (e.g., demersal species) may startle and move short distances to avoid airgun emissions.

In general, any adverse effects on fish behavior or fisheries attributable to seismic testing may depend on the species in question and the nature of the fishery (season, duration, fishing method). They may also depend on the age of the fish, its motivational state, its size, and numerous other factors that are difficult, if not impossible, to quantify at this point, given such limited data on effects of airguns on fish, particularly under realistic at-sea conditions.

Anticipated Effects on Invertebrates

The existing body of information on the impacts of seismic survey sound on marine invertebrates is very limited. However, there is some unpublished and very limited evidence of the potential for adverse effects on invertebrates, thereby justifying further discussion and analysis of this issue. The three types of potential effects of exposure to seismic surveys on marine invertebrates are pathological, physiological, and behavioral. Based on the physical structure of their sensory organs, marine invertebrates appear to be specialized to respond to particle displacement components of an impinging sound field and not to the pressure component (Popper *et al.,* 2001).

The only information available on the impacts of seismic surveys on marine invertebrates involves studies of individuals; there have been no studies at the population scale. Thus, available information provides limited insight on possible real-world effects at the regional or ocean scale. The most important aspect of potential impacts concerns how exposure to seismic survey sound ultimately affects invertebrate populations and their viability, including availability to fisheries.

Literature reviews of the effects of seismic and other underwater sound on invertebrates were provided by Moriyasu *et al.* (2004) and Payne *et al.* (2008). The following sections provide a synopsis of available information on the effects of exposure to seismic survey sound on species of decapod crustaceans and cephalopods, the two taxonomic groups of invertebrates on which most such studies have been conducted. The available information is from studies with variable degrees of scientific soundness and from anecdotal information. A more detailed review of the literature on the effects of seismic survey sound on invertebrates is provided in Appendix D of NSF/USGS's PEIS.

Pathological Effects—In water, lethal and sub-lethal injury to organisms exposed to seismic survey sound appears to depend on at least two features of the sound source: (1) The received peak pressure; and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. For the type of airgun array planned for the proposed program, the pathological (mortality) zone for crustaceans and cephalopods is expected to be within a few meters of the seismic source, at most; however, very few specific data are available on levels of seismic signals that might damage these animals. This premise is based on the peak pressure and rise/decay time characteristics of seismic airgun arrays currently in use around the world.

Some studies have suggested that seismic survey sound has a limited pathological impact on early developmental stages of crustaceans (Pearson *et al.,* 1994; Christian *et al.,* 2003; DFO, 2004). However, the impacts appear to be either temporary or insignificant compared to what occurs under natural conditions. Controlled field experiments on adult crustaceans

(Christian *et al.,* 2003, 2004; DFO, 2004) and adult cephalopods (McCauley *et al.,* 2000a,b) exposed to seismic survey sound have not resulted in any significant pathological impacts on the animals. It has been suggested that exposure to commercial seismic survey activities has injured giant squid (Guerra *et al.,* 2004), but the article provides little evidence to support this claim. Tenera Environmental (2011b) reported that Norris and Mohl (1983, summarized in Mariyasu *et al.,* 2004) observed lethal effects in squid (*Loligo vulgaris*) at levels of 246 to 252 dB after 3 to 11 minutes.

Andre *et al.* (2011) exposed four species of cephalopods (*Loligo vulgaris, Sepia officinalis, Octopus vulgaris,* and *Ilex coindetii*), primarily cuttlefish, to two hours of continuous 50 to 400 Hz sinusoidal wave sweeps at 157+/−5 dB re 1 μPa while captive in relatively small tanks. They reported morphological and ultrastructural evidence of massive acoustic trauma (i.e., permanent and substantial alterations [lesions] of statocyst sensory hair cells) to the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low frequency sound. The received SPL was reported as 157+/−5 dB re 1 μPa, with peak levels at 175 dB re 1 μPa. As in the McCauley *et al.* (2003) paper on sensory hair cell damage in pink snapper as a result of exposure to seismic sound, the cephalopods were subjected to higher sound levels than they would be under natural conditions, and they were unable to swim away from the sound source.

Physiological Effects—Physiological effects refer mainly to biochemical responses by marine invertebrates to acoustic stress. Such stress potentially could affect invertebrate populations by increasing mortality or reducing reproductive success. Primary and secondary stress responses (i.e., changes in haemolymph levels of enzymes, proteins, etc.) of crustaceans have been noted several days or months after exposure to seismic survey sounds (Payne *et al.,* 2007). It was noted however, than no behavioral impacts were exhibited by crustaceans (Christian *et al.,* 2003, 2004; DFO, 2004). The periods necessary for these biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus.

Behavioral Effects—There is increasing interest in assessing the possible direct and indirect effects of seismic and other sounds on invertebrate behavior, particularly in relation to the consequences for fisheries. Changes in behavior could potentially affect such aspects as reproductive success, distribution, susceptibility to predation, and catchability by fisheries. Studies investigating the possible behavioral effects of exposure to seismic survey sound on crustaceans and cephalopods have been conducted on both uncaged and caged animals. In some cases, invertebrates exhibited startle responses (e.g., squid in McCauley *et al.,* 2000a,b). In other cases, no behavioral impacts were noted (e.g., crustaceans in Christian *et al.,* 2003, 2004; DFO 2004). There have been anecdotal reports of reduced catch rates of shrimp shortly after exposure to seismic surveys; however, other studies have not observed any significant changes in shrimp catch rate (Andriguetto-Filho *et al.,* 2005). Similarly, Parry and Gason (2006) did not find any evidence that lobster catch rates were affected by seismic surveys. Any adverse effects on crustacean and cephalopod behavior or fisheries attributable to seismic survey sound depend on the species in question and the nature of the fishery (season, duration, fishing method). More information on the potential effects of airguns on fish and invertebrates are reviewed in section 3.2.4.3, section 3.3.4.3, and Appendix D of the NSF/USGS PEIS.

Proposed Mitigation

In order to issue an Incidental Take Authorization (ITA) 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 the availability of such species or stock for taking for certain subsistence uses (where relevant).

NSF and ASC reviewed the following source documents and have incorporated a suite of appropriate mitigation measures into their project description.

(1) Protocols used during previous NSF and USGS-funded seismic research cruises as approved by NMFS and detailed in the ''Final Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey;''

(2) Previous IHA applications and IHAs approved and authorized by NMFS; and

(3) Recommended best practices in Richardson *et al.* (1995), Pierson *et al.* (1998), and Weir and Dolman, (2007).

To reduce the potential for disturbance from acoustic stimuli associated with the activities, NSF, ASC, and their designees have proposed to implement the following mitigation measures for marine mammals:

(1) Proposed exclusion zones around the sound source;

(2) Speed and course alterations;

(3) Shut-down procedures; and

(4) Ramp-up procedures.

Proposed Exclusion Zones—During pre-planning of the cruise, the smallest airgun array was identified that could be used and still meet the geophysical scientific objectives. NSF and ASC use radii to designate exclusion and buffer zones and to estimate take for marine mammals. Table 2 (presented earlier in this document) shows the distances at which one would expect to receive three sound levels (160, 180, and 190 dB) from the two GI airgun array. The 180 and 190 dB level shut-down criteria are applicable to cetaceans and pinnipeds, respectively, as specified by NMFS (2000). NSF and ASC used these levels to establish the exclusion and buffer zones.

Received sound levels have been modeled by L–DEO for a number of airgun configurations, including two 45 in^3 Nucleus G airguns, in relation to distance and direction from the airguns (see Figure 2 of Appendix B of the IHA application). In addition, propagation measurements of pulses from two GI airguns have been reported for shallow water (approximately 30 m [98.4 ft] depth) in the GOM (Tolstoy *et al.,* 2004). However, measurements were not made for the two GI airguns in deep water. The model does not allow for bottom interactions, and is most directly applicable to deep water. Based on the modeling, estimates of the maximum distances from the GI airguns where sound levels are predicted to be 190, 180, and 160 dB re 1 μPa (rms) in intermediate water were determined (see Table 2 above).

Empirical data concerning the 190, 180, and 160 dB (rms) distances were acquired for various airgun arrays based on measurements during the acoustic verification studies conducted by L–DEO in the northern GOM in 2003 (Tolstoy *et al.,* 2004) and 2007 to 2008 (Tolstoy *et al.,* 2009). Results of the 18 and 36 airgun arrays are not relevant for the two GI airguns to be used in the proposed low-energy seismic survey because the airgun arrays are not the same size or volume. The empirical data for the 6, 10, 12, and 20 airgun arrays indicate that, for deep water, the L–DEO model tends to overestimate the received sound levels at a given distance (Tolstoy *et al.,* 2004). Measurements were not made for the two GI airgun array in deep water; however, NSF and ASC propose to use the safety radii predicted by L–DEO's model for the proposed GI airgun operations in intermediate water, although they are likely conservative given the empirical results for the other arrays.

Based on the modeling data, the outputs from the pair of 105 in^3 GI airguns proposed to be used during the low-energy seismic survey are considered a low-energy acoustic source in the NSF/USGS PEIS (2011) for marine seismic research. A low-energy seismic source was defined in the NSF/USGS PEIS as an acoustic source whose received level at 100 m is less than 180 dB. The NSF/USGS PEIS also established for these low-energy sources, a standard exclusion zone of 100 m for all low-energy sources in water depths greater than 100 m. This standard 100 m exclusion zone would be used during the proposed low-energy seismic survey. The 180 and 190 dB (rms) radii are shut-down criteria applicable to cetaceans and pinnipeds, respectively, as specified by NMFS (2000); these levels were used to establish exclusion zones. Therefore, the assumed 180 and 190 dB radii are 100 m for intermediate and deep water. If the PSO detects a marine mammal within or about to enter the appropriate exclusion zone, the airguns would be shut-down immediately.

Speed and Course Alterations—If a marine mammal is detected outside the exclusion zone and, based on its position and direction of travel (relative motion), is likely to enter the exclusion zone, changes of the vessel's speed and/or direct course would be considered if this does not compromise operational safety or damage the deployed equipment. This would be done if operationally practicable while minimizing the effect on the planned science objectives. For marine seismic surveys towing large streamer arrays, course alterations are not typically implemented due to the vessel's limited maneuverability. However, the *Palmer* would be towing a relatively short hydrophone streamer, so its maneuverability during operations with the hydrophone streamer would not be limited as vessels towing long streamers, thus increasing the potential to implement course alterations, if necessary. After any such speed and/or course alteration is begun, the marine mammal activities and movements relative to the seismic vessel would be closely monitored to ensure that the marine mammal does not approach within the exclusion zone. If the marine mammal appears likely to enter the exclusion zone, further mitigation actions would be taken, including further speed and/or course alterations, and/or shut-down of the airgun(s). Typically, during seismic operations, the source vessel is unable to change speed or course, and one or more alternative mitigation measures would need to be implemented.

Shut-down Procedures—If a marine mammal is detected outside the exclusion zone for the airgun(s) and the vessel's speed and/or course cannot be changed to avoid having the animal enter the exclusion zone, NSF and ASC would shut-down the operating airgun(s) before the animal is within the exclusion zone. Likewise, if a marine mammal is already within the exclusion zone when first detected, the seismic source would be shut-down immediately.

Following a shut-down, NSF and ASC would not resume airgun activity until the marine mammal has cleared the exclusion zone. NSF and ASC would consider the animal to have cleared the exclusion zone if:

- A PSO has visually observed the animal leave the exclusion zone, or
- A PSO has not sighted the animal within the exclusion zone for 15 minutes for species with shorter dive durations (i.e., small odontocetes and pinnipeds), or 30 minutes for species with longer dive durations (i.e., mysticetes and large odontocetes, including sperm, killer, and beaked whales).

Although power-down procedures are often standard operating practice for seismic surveys, they are not proposed to be used during this planned low-energy seismic survey because powering-down from two airguns to one airgun would make only a small difference in the exclusion zone(s) that probably would not be enough to allow continued one-airgun operations if a marine mammal came within the exclusion zone for two airguns.

Ramp-up Procedures—Ramp-up of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns firing until the full volume of the airgun array is achieved. The purpose of a ramp-up is to ''warn'' marine mammals in the vicinity of the airguns and to provide the time for them to leave the area, avoiding any potential injury or impairment of their hearing abilities. NSF and ASC would follow a ramp-up procedure when the airgun array begins operating after a specified period without airgun operations or when a shut-down has exceeded that period. NSF and ASC propose that, for the present cruise, this period would be approximately 15 minutes. SIO, L–DEO, and USGS have used similar periods (approximately 15 minutes) during previous low-energy seismic surveys.

Ramp-up would begin with a single GI airgun (105 in^3). The second GI airgun (105 in^3) would be added after 5 minutes. During ramp-up, the PSOs would monitor the exclusion zone, and if marine mammals are sighted, a shut-down would be implemented as though both GI airguns were operational.

If the complete exclusion zone has not been visible for at least 30 minutes prior to the start of operations in either daylight or nighttime, NSF and ASC would not commence the ramp-up. Given these provisions, it is likely that the airgun array would not be ramped-up from a complete shut-down during low light conditions, at night, or in thick fog, because the outer part of the exclusion zone for that array would not be visible during those conditions. If one airgun has been operating, ramp-up to full power would be permissible during low light, at night, or in poor visibility, on the assumption that marine mammals would be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away if they choose. NSF and ASC would not initiate a ramp-up of the airguns if a marine mammal is sighted within or near the applicable exclusion zones.

Proposed Mitigation Conclusions

NMFS has carefully evaluated the applicant's proposed mitigation measures and has considered a range of other measures in the context of ensuring that NMFS prescribes the means of effecting the least practicable impact on the affected marine mammal species and stocks and their habitat. NMFS's evaluation of potential measures included consideration of the following factors in relation to one another:

(1) The manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals;

(2) The proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and

(3) The practicability of the measure for applicant implementation.

Any mitigation measure(s) prescribed by NMFS should be able to accomplish, have a reasonable likelihood of accomplishing (based on current science), or contribute to the accomplishment of one or more of the general goals listed below:

(1) Avoidance of minimization of injury or death of marine mammals wherever possible (goals 2, 3, and 4 may contribute to this goal).

(2) A reduction in the numbers of marine mammals (total number or number at biologically important time or location) exposed to received levels of airguns, or other activities expected to result in the take of marine mammals (this goal may contribute to 1, above, or to reducing harassment takes only).

(3) A reduction in the number of time (total number or number at biologically important time or location) individuals would be exposed to received levels of airguns, or other activities expected to result in the take of marine mammals (this goal may contribute to 1, above, or to reducing harassment takes only).

(4) A reduction in the intensity of exposures (either total number or number at biologically important time or location) to received levels of airguns, or other activities, or other activities expected to result in the take of marine mammals (this goal may contribute to a, above, or to reducing the severity of harassment takes only).

(5) Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base, activities that block or limit passage to or from biologically important areas, permanent destruction of habitat, or temporary destruction/disturbance of habitat during a biologically important time.

(6) For monitoring directly related to mitigation—an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

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

Proposed Monitoring and Reporting

In order to issue an ITA 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 IHAs must include the suggested means of accomplishing the necessary monitoring and reporting that would 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. NSF and ASC submitted a marine mammal monitoring plan as part of the IHA application. It can be found in Section 13 of the IHA application. The plan may be modified or supplemented based on comments or new information received from the public during the public comment period.

Monitoring measures prescribed by NMFS should accomplish one or more of the following general goals:

(1) An increase in the probability of detecting marine mammals, both within the mitigation zone (thus allowing for more effective implementation of the mitigation) and in general to generate more data to contribute to the analyses mentioned below;

(2) An increase in our understanding of how many marine mammals are likely to be exposed to levels of sound (airguns) that we associate with specific adverse effects, such as behavioral harassment, TTS, or PTS;

(3) An increase in our understanding of how marine mammals respond to stimuli expected to result in take and how anticipated adverse effects on individuals (in different ways and to varying degrees) may impact the population, species, or stock (specifically through effects on annual rates of recruitment or survival) through any of the following methods:

- Behavioral observations in the presence of stimuli compared to observations in the absence of stimuli (need to be able to accurately predict received level, distance from source, and other pertinent information);
- Physiological measurements in the presence of stimuli compared to observations in the absence of stimuli (need to be able to accurately predict received level, distance from source, and other pertinent information); and
- Distribution and/or abundance comparisons in times or areas with concentrated stimuli versus times or areas without stimuli.

(4) An increased knowledge of the affected species; and

(5) An increase in our understanding of the effectiveness of certain mitigation and monitoring measures.

Proposed Monitoring

NSF and ASC propose to sponsor marine mammal monitoring during the proposed project, in order to implement the proposed mitigation measures that require real-time monitoring and to satisfy the anticipated monitoring requirements of the IHA. NSF and ASC's proposed ''Monitoring Plan'' is described below this section. NSF and ASC understand that this monitoring plan would be subject to review by NMFS and that refinements may be required. The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same regions. NSF and ASC is prepared to discuss coordination of their monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

Vessel-Based Visual Monitoring

PSOs would be based aboard the seismic source vessel and would watch for marine mammals near the vessel during icebreaking activities, daytime airgun operations and during any ramp-ups of the airguns at night. PSOs would also watch for marine mammals near the seismic vessel for at least 30 minutes prior to the start of airgun operations and after an extended shut-down (i.e., greater than approximately 15 minutes for this proposed low-energy seismic survey). When feasible, PSOs would conduct observations during daytime periods when the seismic system is not operating (such as during transits) for comparison of sighting rates and behavior with and without airgun operations and between acquisition periods. Based on PSO observations, the airguns would be shut-down when marine mammals are observed within or about to enter a designated exclusion zone. The exclusion zone is a region in which a possibility exists of adverse effects on animal hearing or other physical effects.

During seismic operations in the Ross Sea, at least three PSOs would be based aboard the *Palmer.* At least one PSO would stand watch at all times while the *Palmer* is operating airguns during the proposed low-energy seismic survey; this procedure would also be followed when the vessel is in transit and conducting icebreaking. NSF and ASC would appoint the PSOs with NMFS's concurrence. The lead PSO would be experienced with marine mammal species in the Ross Sea and/or Southern Ocean, the second and third PSOs would receive additional specialized training from the lead PSO to ensure that they can identify marine mammal species commonly found in the Ross Sea and Southern Ocean. Observations would take place during ongoing daytime operations and ramp-ups of the airguns. During the majority of seismic operations, at least one PSO would be on duty from observation platforms (i.e., the best available vantage point on the source vessel) to monitor marine mammals near the seismic vessel. PSO(s) would be on duty in shifts no longer than 4 hours in duration. Other crew would also be instructed to assist in detecting marine mammals and implementing mitigation requirements (if practical). Before the start of the low-energy seismic survey, the crew would be given additional instruction on how to do so.

The *Palmer* is a suitable platform for marine mammal observations and would serve as the platform from which PSOs would watch for marine mammals before and during seismic operations. Two locations are likely as observation stations onboard the *Palmer.* One observing station is located on the bridge level, with the PSO eye level at approximately 16.5 m (54.1 ft) above the waterline and the PSO would have a good view around the entire vessel. In addition, there is an aloft observation tower for the PSO approximately 24.4 m (80.1 ft) above the waterline that is protected from the weather, and affords PSOs an even greater view. The approximate view around the vessel from the bridge is 270° and from the aloft observation tower is 360°.

Standard equipment for PSOs would be reticle binoculars. Night-vision equipment would not be available or necessary as there would be 24-hour daylight or nautical twilight during the cruise. The PSOs would be in communication with ship's officers on the bridge and scientists in the vessel's operations laboratory, so they can advise promptly of the need for avoidance maneuvers or seismic source shut-down. During daylight, the PSO(s) would scan the area around the vessel systematically with reticle binoculars (e.g., 7 × 50 Fujinon FMTRC–SX) and the naked eye. These binoculars would have a built-in daylight compass. Estimating distances is done primarily with the reticles in the binoculars. The PSO(s) would be in direct (radio) wireless communication with ship's officers on the bridge and scientists in the vessel's operations laboratory during seismic operations, so they can advise the vessel operator, science support personnel, and the science party promptly of the need for avoidance maneuvers or a shut-down of the seismic source. PSOs would monitor for the presence pinnipeds and cetaceans during icebreaking activities, and would be limited to those marine mammal species in proximity to the ice margin habitat. Observations within the buffer zone would also include pinnipeds that may be present on the surface of the sea ice (i.e., hauled-out) and that could potentially dive into the water as the vessel approaches, indicating disturbance from noise generated by icebreaking activities).

When a marine mammal is detected within or about to enter the designated exclusion zone, the airguns would immediately be shut-down, unless the vessel's speed and/or course can be changed to avoid having the animal enter the exclusion zone. The PSO(s) would continue to maintain watch to determine when the animal is outside the exclusion zone by visual confirmation. Airgun operations would not resume until the animal is confirmed to have left the exclusion zone, or is not observed after 15 minutes for species with shorter dive durations (small odontocetes and pinnipeds) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, killer, and beaked whales).

PSO Data and Documentation

PSOs would record data to estimate the numbers of marine mammals exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data would be used to estimate numbers of animals potentially ''taken'' by harassment (as defined in the MMPA). They would also provide information needed to order a shut-down of the airguns when a marine mammal is within or near the exclusion zone. Observations would also be made during icebreaking activities as well as daylight periods when the *Palmer* is underway without seismic airgun operations (i.e., transits to, from, and through the study area) to collect baseline biological data.

When a sighting is made, the following information about the sighting would be recorded:

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

2. Time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or shut-down), sea state, wind force, visibility, and sun glare.

The data listed under (2) would also be recorded at the start and end of each observation watch, and during a watch whenever there is a change in one or more of the variables.

All observations, as well as information regarding ramp-ups or shut-downs would be recorded in a standardized format. Data would be entered into an electronic database. The data accuracy would be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database by the PSOs at sea. These procedures would allow initial summaries of data to be prepared during and shortly after the field program, and would facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations would provide the following information:

1. The basis for real-time mitigation (airgun shut-down).

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

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

4. Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without airgun operations and icebreaking activities.

5. Data on the behavior and movement patterns of marine mammals seen at times with and without airgun operations and icebreaking activities.

Proposed Reporting

NSF and ASC would submit a comprehensive report 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 submitted to NMFS 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 (i.e., dates, times, locations, activities, and associated seismic survey activities). The report would include, at a minimum:

• Summaries of monitoring effort—total hours, total distances, and distribution of marine mammals through the study period accounting for Beaufort sea state and other factors affecting visibility and detectability of marine mammals;

• Analyses of the effects of various factors influencing detectability of marine mammals including Beaufort sea state, number of PSOs, and fog/glare;

• Species composition, occurrence, and distribution of marine mammals sightings including date, water depth, numbers, age/size/gender, and group sizes, and analyses of the effects of airgun operations and icebreaking activities;

• Sighting rates of marine mammals during periods with and without airgun operations and icebreaking activities (and other variables that could affect detectability);

• Initial sighting distances versus airgun operations and icebreaking activity state;

• Closest point of approach versus airgun operations and icebreaking activity state;

• Observed behaviors and types of movements versus airgun operations and icebreaking activity state;

• Numbers of sightings/individuals seen versus airgun operations and icebreaking activity state; and

• Distribution around the source vessel versus airgun operations and icebreaking activity state.

The report would also include estimates of the number and nature of exposures that could result in ''takes'' of marine mammals by harassment or in other ways. NMFS would review the draft report and provide any comments it may have, and NSF and ASC would incorporate NMFS's comments and prepare a final report. After the report is considered final, it would be publicly available on the NMFS Web site at: *http://www.nmfs.noaa.gov/pr/permits/incidental/.*

Reporting Prohibited Take—In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this IHA, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), NSF and ASC would immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov.* The report must include the following information:

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

• Name and type of vessel involved;

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

• Description of the incident;

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

• Water depth;

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

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

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

• Fate of the animal(s); and

• Photographs or video footage of the animal(s) (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with NSF and ASC to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. NSF and ASC may not resume their activities until notified by NMFS via letter or email, or telephone.

Reporting an Injured or Dead Marine Mammal with an Unknown Cause of Death—In the event that NSF and ASC discover an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition), NSF and ASC shall immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401, and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov.* The report must include the same information identified in the paragraph above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS shall work with NSF and ASC to determine whether modifications in the activities are appropriate.

Reporting an Injured or Dead Marine Mammal Not Related to the Activities—In the event that NSF and ASC discover an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in the IHA (e.g., previously wounded animal, carcass with moderate or advanced decomposition, or scavenger damage), NSF and ASC shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401, and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov,* within 24 hours of discovery. NSF and ASC shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. Activities may continue while NMFS reviews the circumstances of the incident.

Estimated Take by Incidental Harassment

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

TABLE 5—NMFS'S CURRENT UNDERWATER ACOUSTIC EXPOSURE CRITERIA

Impulsive (non-explosive) sound		
Criterion	Criterion definition	Threshold
Level A harassment (injury)	Permanent threshold shift (PTS) (Any level above that which is known to cause TTS).	180 dB re 1 μPa-m (root means square [rms]) (cetaceans). 190 dB re 1 μPa-m (rms) (pinnipeds).
Level B harassment	Behavioral disruption (for impulsive noise)	160 dB re 1 μPa-m (rms).
Level B harassment	Behavioral disruption (for continuous noise)	120 dB re 1 μPa-m (rms).

Level B harassment is anticipated and proposed to be authorized as a result of the proposed low-energy seismic survey in the Ross Sea. Acoustic stimuli (i.e., increased underwater sound) generated during the operation of the seismic airgun array and icebreaking activities are expected to result in the behavioral disturbance of some marine mammals. There is no evidence that the planned activities for which NSF and ASC seek the IHA could result in injury, serious injury, or mortality. The required mitigation and monitoring measures would minimize any potential risk for injury, serious injury, or mortality.

The following sections describe NSF and ASC's methods to estimate take by incidental harassment and present the applicant's estimates of the numbers of marine mammals that could be affected during the proposed low-energy seismic survey in the Ross Sea. The estimates are based on a consideration of the number of marine mammals that could be harassed during the approximately 200 hours and 1,750 km of seismic airgun operations with the two GI airgun array to be used and 500 km of icebreaking activities.

During simultaneous operations of the airgun array and the other sound sources, any marine mammals close enough to be affected by the single and multi-beam echosounders, ADCP, or sub-bottom profiler would already be affected by the airguns. During times when the airguns are not operating, it is unlikely that marine mammals would exhibit more than minor, short-term responses to the echosounders, ADCPs, and sub-bottom profiler given their characteristics (e.g., narrow, downward-directed beam) and other considerations described previously. Therefore, for this activity, take was not authorized specifically for these sound sources beyond that which is already proposed to be authorized for airguns and icebreaking activities.

There are no stock assessments and very limited population information available for marine mammals in the Ross Sea. Published estimates of marine mammal densities are limited for the proposed low-energy seismic survey's action area. Available density estimates (using number of animals per km^2) from the Naval Marine Species Density Database (NMSDD) (NAVFAC, 2012) were used for one mysticete and one odontocete (i.e., sei whale and Arnoux's beaked whale). Densities for minke (including the dwarf sub-species) whales were unavailable and the densities for Antarctic minke whales were used as proxies, respectively.

For other mysticetes and odontocetes, reported sightings data from one previous research survey (i.e., International Whaling Commission Southern Ocean Whale and Ecosystem Research [IWC SOWER]) in the Ross Sea and vicinity were used to identify species that may be present in the proposed action area and to estimate densities. Available sightings data from the 2002 to 2003 IWC SOWER Circumpolar Cruise, Area V (Ensor *et al.,* 2003) were used to estimate densities for five mysticetes (i.e., humpback, Antarctic minke, minke, fin, and blue whale) and six odontocetes (i.e., sperm, southern bottlenose, strap-toothed beaked, killer, long-finned pilot whale and hourglass dolphin). Densities of pinnipeds (i.e., crabeater, leopard, Ross, Weddell, and southern elephant seal) were estimated using data from two surveys (NZAI, 2001; Pinkerton and Bradford-Grieve, n.d.) and dividing the estimated population of animals by the area of the Ross Sea (approximately 300,000 km^2 [87,466 nmi^2]). While these surveys were not specifically designed to quantify marine mammal densities, there was sufficient information to develop density estimates.

The densities used for purposes of estimating potential take do not take into account the patchy distributions of marine mammals in an ecosystem, at least on the moderate to fine scales over which they are known to occur. Instead, animals are considered evenly distributed throughout the assessed study area and seasonal movement patterns are not taken into account as none are available.

Some marine mammals that were present in the area during these surveys may not have been observed. Southwell *et al.* (2008) suggested a 20 to 40% sighting factor for pinnipeds, and the most conservative value from Southwell *et al.* (2008) was applied for cetaceans. Therefore, the estimated frequency of sightings data in this proposed IHA for cetaceans incorporates a correction factor of 5, which assumes only 20% of the animals present were reported due to sea and other environmental conditions that may have hindered observation, and therefore, there were 5 times more cetaceans actually present. The correction factor (20%) was intended to conservatively account for unobserved (i.e., not sighted and reported) animals.

The pinnipeds that may be present in the study area during the proposed action and are expected to be observed occur mostly near pack ice, coastal areas, and rocky habitats on the shelf, and are not prevalent in open sea areas where the low-energy seismic survey would be conducted. Because density estimates for pinnipeds in the sub-Antarctic and Antarctic regions typically represent individuals that have hauled-out of the water, those estimates are not necessarily representative of individuals that are in the water and could be potentially exposed to underwater sounds during the seismic airgun operations and icebreaking activities; therefore, the pinniped densities have been adjusted downward to account for this consideration. Take was not requested for Antarctic and Subantarctic seals because preferred habitat for these species is not within the proposed action area. Although there is some uncertainty about the representativeness of the data and the assumptions used in the calculations below, the approach used here is believed to be the best available approach, using the best available science.

TABLE 6—ESTIMATED DENSITIES AND POSSIBLE NUMBER OF MARINE MAMMAL SPECIES THAT MIGHT BE EXPOSED TO GREATER THAN OR EQUAL TO 160 dB (AIRGUN OPERATIONS) AND 120 dB (ICEBREAKING) DURING NSF AND ASC'S PROPOSED LOW-ENERGY SEISMIC SURVEY (APPROXIMATELY 500 km OF TRACKLINES/APPROXIMATELY 21,540 km^2 ENSONIFIED AREA FOR ICEBREAKING ACTIVITIES AND APPROXIMATELY 1,750 km OF TRACKLINES/APPROXIMATELY 3,882 km^2 [1.109 km × 2 × 1,750 km] ENSONIFIED AREA FOR AIRGUN OPERATIONS) IN THE ROSS SEA, JANUARY TO FEBRUARY 2015

Species	Density (number of animals/km^2) [1]	Calculated take from seismic airgun operations (i.e., estimated number of individuals exposed to sound levels ≥ 160 dB re 1 μPa) [2]	Calculated take from icebreaking operations (i.e., estimated number of individuals exposed to sound levels ≥ 120 dB re 1 μPa) [2]	Total requested take authorization	Abundance [3]	Approximate percentage of population estimate (requested take) [4]	Population trend [5]
Mysticetes:							
Southern right whale	NA	0	0	0	8,000 to 15,000	NA	Increasing at 7 to 8% per year.

TABLE 6—ESTIMATED DENSITIES AND POSSIBLE NUMBER OF MARINE MAMMAL SPECIES THAT MIGHT BE EXPOSED TO GREATER THAN OR EQUAL TO 160 dB (AIRGUN OPERATIONS) AND 120 dB (ICEBREAKING) DURING NSF AND ASC'S PROPOSED LOW-ENERGY SEISMIC SURVEY (APPROXIMATELY 500 km OF TRACKLINES/APPROXIMATELY 21,540 km^2 ENSONIFIED AREA FOR ICEBREAKING ACTIVITIES AND APPROXIMATELY 1,750 km OF TRACKLINES/APPROXIMATELY 3,882 km^2 [1.109 km × 2 × 1,750 km] ENSONIFIED AREA FOR AIRGUN OPERATIONS) IN THE ROSS SEA, JANUARY TO FEBRUARY 2015—Continued

Species	Density (number of animals/km^2) [1]	Calculated take from seismic airgun operations (i.e., estimated number of individuals exposed to sound levels ≥ 160 dB re 1 μPa) [2]	Calculated take from icebreaking operations (i.e., estimated number of individuals exposed to sound levels ≥ 120 dB re 1 μPa) [2]	Total requested take authorization	Abundance [3]	Approximate percentage of population estimate (requested take) [4]	Population trend [5]
Humpback whale	0.0321169	125	692	817	35,000 to 40,000—Worldwide. 9,484—Scotia Sea and Antarctica Peninsula.	0.03—Worldwide 9.88—Scotia Sea and Antarctic Peninsula.	Increasing.
Antarctic minke whale	0.0845595	329	1,822	2,151	Several 100,000—Worldwide. 18,125—Scotia Sea and Antarctica Peninsula.	11.87—Scotia Sea and Antarctica Peninsula.	Stable.
Minke whale (including dwarf minke whale sub-species).	0.08455	329	1,822	2,151	NA	NA	NA.
Sei whale	0.0046340	18	100	118	80,000—Worldwide	0.15	NA.
Fin whale	0.0306570	120	661	781	140,000—Worldwide 4,672—Scotia Sea and Antarctica Peninsula.	0.56—Worldwide 16.72—Scotia Sea and Antarctica Peninsula.	NA.
Blue whale	0.0065132	26	141	167	8,000 to 9,000—Worldwide. 1,700—Southern Ocean.	2.09—Worldwide 9.82—Southern Ocean.	NA.
Odontocetes:							
Sperm whale	0.0098821	39	213	252	360,000—Worldwide 9,500—Antarctic	0.07—Worldwide 2.65—Antarctic	NA.
Arnoux's beaked whale.	0.0134420	53	290	343	NA	NA	NA.
Strap-toothed beaked whale.	0.0044919	18	97	115	NA	NA	NA.
Southern bottlenose whale.	0.0117912	46	254	300	50,000—South of Antarctic Convergence.	0.6	NA.
Killer whale	0.0208872	82	450	532	80,000—South of Antarctic Convergence. 25,000—Southern Ocean.	0.67—South of Antarctic Convergence. 2.13—Southern Ocean.	NA.
Long-finned pilot whale.	0.0399777	156	862	1,018	200,000—South of Antarctic Convergence.	0.51	NA.
Hourglass dolphin	0.0189782	74	409	483	144,000—South of Antarctic Convergence.	0.34	NA.
Pinnipeds:							
Crabeater seal	0.6800000	2,640	14,648	17,288	5,000,000 to 15,000,000—Worldwide.	0.35	Increasing.
Leopard seal	0.0266700	104	575	679	220,000 to 440,000—Worldwide.	0.31	NA.
Ross seal	0.0166700	65	360	425	130,000 20,000 to 220,000—Worldwide.	2.13	NA.
Weddell seal	0.1066700	415	2,298	2,713	500,000 to 1,000,000—Worldwide.	0.54	NA.
Southern elephant seal.	0.0001300	1	3	4	640,000 to 650,000—Worldwide;. 470,000—South Georgia Island.	<0.01—Worldwide or South Georgia Island.	Increasing, decreasing, or stable depending on breeding population.

NA = Not available or not assessed.
[1] Densities based on sightings from IWC SOWER Report 2002, NMSDD, or State of the Ross Sea Region (NZAI, 2001) data.
[2] Calculated take is estimated density (reported density times correction factor) multiplied by the area ensonified to 160 dB (rms) around the planned seismic lines, increased by 25% for contingency.
[3] Calculated take is estimated density (reported density times correction factor) multiplied by the area ensonified to 120 dB (rms) around the planned transit lines where icebreaking activities may occur.
[3] See population estimates for marine mammal species in Table 4 (above).
[4] Total requested authorized takes expressed as percentages of the species or regional populations.
[5] Jefferson *et al.* (2008).

Icebreaking in Antarctic waters would occur, as necessary, between the latitudes of approximately 76 to 78° South and between 165 and 170° West. Based on a historical sea ice extent and the proposed tracklines, it is estimated that the *Palmer* would actively break ice up to a distance of 500 km. Based on the ship's speed of 5 kts under moderate ice conditions, this distance represents approximately 54 hours of icebreaking activities. This calculation is likely an overestimation because icebreakers often follow leads when they are available and thus do not break ice at all times. The estimated number of takes for pinnipeds accounts for both animals that may be in the water and those hauled-out on ice surfaces. While the number of cetaceans that may be encountered within the ice margin habitat would be expected to be less than open water, the estimates utilize densities for open water and therefore represent conservative estimates.

Numbers of marine mammals that might be present and potentially disturbed are estimated based on the available data about marine mammal distribution and densities in the proposed Ross Sea study area. NSF and ASC estimated the number of different individuals that may be exposed to airgun sounds with received levels greater than or equal to 160 dB re 1 µPa (rms) for seismic airgun operations and greater than or equal to 120 dB re 1 µPa (rms) for icebreaking activities on one or more occasions by considering the total marine area that would be within the 160 dB radius around the operating airgun array and 120 dB radius for icebreaking activities on at least one occasion and the expected density of marine mammals in the area (in the absence of the a seismic survey and icebreaking activities). The number of possible exposures can be estimated by considering the total marine area that would be within the 160 dB radius (the diameter is 1,109 m multiplied by 2) around the operating airguns. The ensonified area for icebreaking was estimated by multiplying the distance of the icebreaking activities (500 km) by the estimated diameter for the area within the 120 dB radius (i.e., diameter is 43.08 km [21.54 km × 2]). The 160 dB radii are based on acoustic modeling data for the airguns that may be used during the proposed action (see Attachment B of the IHA application). As summarized in Table 2 (see above and Table 8 of the IHA application), the modeling results for the proposed low-energy seismic airgun array indicate the received levels are dependent on water depth. Since the majority of the proposed airgun operations would be conducted in waters 100 to 1,000 m deep, the buffer zone of 1,109 m for the two 105 in^3 GI airguns was used.

The number of different individuals potentially exposed to received levels greater than or equal to 160 dB re 1 µPa (rms) from seismic airgun operations and 120 dB re 1 µPa (rms) for icebreaking activities was calculated by multiplying:

(1) The expected species density (in number/km^2), times

(2) The anticipated area to be ensonified to that level during airgun operations and icebreaking activities.

Applying the approach described above, approximately 3,882 km^2 (including the 25% contingency) would be ensonified within the 160 dB isopleth for seismic airgun operations and approximately 21,540 km^2 would be ensonified within the 120 dB isopleth for icebreaking activities on one or more occasions during the proposed low-energy seismic survey. The take calculations within the study sites do not explicitly add animals to account for the fact that new animals (i.e., turnover) not accounted for in the initial density snapshot could also approach and enter the area ensonified above 160 dB for seismic airgun operations and 120 dB for icebreaking activities. However, studies suggest that many marine mammals would avoid exposing themselves to sounds at this level, which suggests that there would not necessarily be a large number of new animals entering the area once the seismic survey and icebreaking activities started. Because this approach for calculating take estimates does not account for turnover in the marine mammal populations in the area during the course of the proposed low-energy seismic survey, the actual number of individuals exposed may be underestimated. However, any underestimation is likely offset by the conservative (i.e., probably overestimated) line-kilometer distances (including the 25% contingency) used to calculate the survey area, and the fact the approach assumes that no cetaceans or pinnipeds would move away or toward the tracklines as the *Palmer* approaches in response to increasing sound levels before the levels reach 160 dB for seismic airgun operations and 120 dB for icebreaking activities, which is likely to occur and which would decrease the density of marine mammals in the survey area. Another way of interpreting the estimates in Table 6 is that they represent the number of individuals that would be expected (in absence of a seismic and icebreaking program) to occur in the waters that would be exposed to greater than or equal to 160 dB (rms) for seismic airgun operations and greater than or equal to 120 dB (rms) for icebreaking activities.

NSF and ASC's estimates of exposures to various sound levels assume that the proposed seismic survey would be carried out in full; however, the ensonified areas calculated using the planned number of line-kilometers has been increased by 25% to accommodate lines that may need to be repeated, equipment testing, etc. As is typical during offshore ship surveys, inclement weather and equipment malfunctions would be likely to cause delays and may limit the number of useful line-kilometers of seismic operations that can be undertaken. The estimates of the numbers of marine mammals potentially exposed to 160 dB (rms) received levels are precautionary and probably overestimate the actual numbers of marine mammals that could be involved. These estimates assume that there would be no weather, equipment, or mitigation delays that limit the seismic operations, which is highly unlikely.

Table 6 shows the estimates of the number of different individual marine mammals anticipated to be exposed to greater than or equal to 120 dB re 1 µPa (rms) for icebreaking activities and greater than or equal to 160 dB re 1 µPa (rms) for seismic airgun operations during the low-energy seismic survey if no animals moved away from the survey vessel. The total requested take authorization is given in the column that is fifth from the left) of Table 6.

Encouraging and Coordinating Research

NSF and ASC would coordinate the planned marine mammal monitoring program associated with the proposed low-energy seismic survey with other parties that express interest in this activity and area. NSF and ASC would coordinate with applicable U.S. agencies (e.g., NMFS), and would comply with their requirements. The proposed action would complement fieldwork studying other Antarctic ice shelves, oceanographic studies, and ongoing development of ice sheet and other ocean models. It would facilitate learning at sea and ashore by students, help to fill important spatial and temporal gaps in a lightly sampled region of the Ross Sea, provide additional data on marine mammals present in the Ross Sea study areas, and communicate its findings concerning the chronology and cause of eastern Ross Sea grounding-line translations during the last glacial cycle via reports, publications, and public outreach.

Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses

Section 101(a)(5)(D) of the MMPA also requires NMFS to determine that the authorization would not have an unmitigable adverse effect on the availability of marine mammal species or stocks for subsistence use. There are no relevant subsistence uses of marine mammals implicated by this action (in the Ross Sea study area). Therefore, NMFS has determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Analysis and Preliminary Determinations

Negligible Impact

Negligible impact is ''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 Level B harassment 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 behavioral harassment, NMFS must consider other factors, such as the likely nature of any responses (their intensity, duration, etc.) and the context of any responses (critical reproductive time or location, migration, etc.), as well as the number and nature of estimated Level A harassment takes, the number of estimated mortalities, effects on habitat, and the status of the species.

In making a negligible impact determination, NMFS evaluated factors such as:

(1) The number of anticipated serious injuries and or mortalities;

(2) The number and nature of anticipated injuries;

(3) The number, nature, intensity, and duration of takes by Level B harassment (all of which are relatively limited in this case);

(4) The context in which the takes occur (e.g., impacts to areas of significance, impacts to local populations, and cumulative impacts when taking into account successive/contemporaneous actions when added to baseline data);

(5) The status of stock or species of marine mammals (i.e., depleted, not depleted, decreasing, increasing, stable, impact relative to the size of the population);

(6) Impacts on habitat affecting rates of recruitment/survival; and

(7) The effectiveness of monitoring and mitigation measures.

NMFS has preliminarily determined that the specified activities associated with the marine seismic survey are not likely to cause PTS, or other non-auditory injury, serious injury, or death, based on the analysis above and the following factors:

(1) The likelihood that, given sufficient notice through relatively slow ship speed, marine mammals are expected to move away from a noise source that is annoying prior to its becoming potentially injurious;

(2) The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the survey area during the operation of the airgun(s) to avoid acoustic harassment;

(3) The potential for temporary or permanent hearing impairment is relatively low and would likely be avoided through the implementation of the required monitoring and mitigation measures (including shut-down measures); and

(4) The likelihood that marine mammal detection ability by trained PSOs is high at close proximity to the vessel.

No injuries, serious injuries, or mortalities are anticipated to occur as a result of the NSF and ASC's planned low-energy seismic survey, and none are proposed to be authorized by NMFS. Table 6 of this document outlines the number of requested Level B harassment takes that are anticipated as a result of these activities. Due to the nature, degree, and context of Level B (behavioral) harassment anticipated and described in this notice (see ''Potential Effects on Marine Mammals'' section above), the activity is not expected to impact rates of annual recruitment or survival for any affected species or stock, particularly given NMFS's and the applicant's proposed mitigation, monitoring, and reporting measures to minimize impacts to marine mammals. Additionally, the low-energy seismic survey would not adversely impact marine mammal habitat.

For the marine mammal species that may occur within the proposed action area, there are no known designated or important feeding and/or reproductive areas. Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (i.e., 24 hr cycle). Behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.*, 2007). While airgun operations are anticipated to occur on consecutive days, the estimated duration of the survey would not last more than a total of approximately 27 operational days. Additionally, the low-energy seismic survey would be increasing sound levels in the marine environment in a relatively small area surrounding the vessel (compared to the range of the animals), which is constantly travelling over distances, so individual animals likely would only be exposed to and harassed by sound for less than a day.

As mentioned previously, NMFS estimates that 18 species of marine mammals under its jurisdiction could be potentially affected by Level B harassment over the course of the IHA. The population estimates for the marine mammal species that may be taken by Level B harassment were provided in Table 4 and 6 of this document. As shown in those tables, the proposed takes all represent small proportions of the overall populations of these marine mammal species (i.e., all are less than or equal to 16%).

Of the 18 marine mammal species under NMFS jurisdiction that may or are known to likely occur in the study area, six are listed as threatened or endangered under the ESA: Southern right, humpback, sei, fin, blue, and sperm whales. These species are also considered depleted under the MMPA. None of the other marine mammal species that may be taken are listed as depleted under the MMPA. Of the ESA-listed species, incidental take has been requested to be authorized for five species. No incidental take has been requested for the southern right whale as they are generally not expected in the proposed action area; however, a few animals have been sighted in Antarctic waters in the austral summer. To protect these marine mammals in the study area, NSF and ASC would be required to cease airgun operations if any marine mammal enters designated exclusion zones. No injury, serious injury, or mortality is expected to occur for any of these species, and due to the nature, degree, and context of the Level B harassment anticipated, and the activity is not expected to impact rates of recruitment or survival for any of these species.

NMFS's practice has been to apply the 160 dB re 1 μPa (rms) received level threshold for underwater impulse sound levels to determine whether take by Level B harassment occurs. NMFS has preliminarily determined that, provided that the aforementioned mitigation and monitoring measures are implemented, the impact of conducting a low-energy marine seismic survey in the Ross Sea, January to February 2015, may result, at worst, in a modification in behavior and/or low-level physiological effects (Level B harassment) of certain species of marine mammals.

While behavioral modifications, including temporarily vacating the area during the operation of the airgun(s), may be made by these species to avoid the resultant acoustic disturbance, the availability of alternate areas for species to move to and the short and sporadic duration of the research activities, have led NMFS to preliminary determine that the taking by Level B harassment from the specified activity would have a negligible impact on the affected species in the specified geographic region. Due to the nature, degree, and context of Level B (behavioral) harassment anticipated and described (see ''Potential Effects on Marine Mammals'' section above) in this notice, the proposed activity is not expected to impact rates of annual recruitment or survival for any affected species or stock, particularly given the NMFS and applicant's proposal to implement mitigation and monitoring measures would minimize impacts to marine mammals. Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that the total marine mammal take from NSF and ASC's proposed low-energy seismic survey would have a negligible impact on the affected marine mammal species or stocks.

Small Numbers

As mentioned previously, NMFS estimates that 18 species of marine mammals under its jurisdiction could be potentially affected by Level B harassment over the course of the IHA. The population estimates for the marine mammal species that may be taken by Level B harassment were provided in Tables 4 and 6 of this document.

The estimated numbers of individual cetaceans and pinnipeds that could be exposed to seismic sounds with received levels greater than or equal to 160 dB re 1 μPa (rms) during the proposed low-energy seismic survey (including a 25% contingency) and greater than or equal to 120 dB re 1 μPa (rms) for icebreaking activities are in Table 6 of this document. Of the cetaceans, 937 humpback, 2,151 Antarctic minke, 2,151 minke, 118 sei, 781 fin, 167 blue, and 252 sperm whales could be taken be Level B harassment during the proposed low-energy seismic survey, which would represent 9.88, 11.87, unknown, 0.15, 16.72, 9.82, and 2.65% of the affected worldwide or regional populations, respectively. In addition, 343 Arnoux's beaked, 115 strap-toothed beaked, and 300 southern bottlenose whales could be taken be Level B harassment during the proposed low-energy seismic survey, which would represent unknown, unknown, and 0.6% of the affected worldwide or regional populations, respectively. Of the delphinids, 532 killer whales, 1,018 long-finned pilot whales, and 483 hourglass dolphins could be taken be Level B harassment during the proposed low-energy seismic survey, which would represent 2.13, 0.51, and 0.34 of the affected worldwide or regional populations, respectively. Of the pinnipeds, 17,288 crabeater, 679 leopard, 425 Ross, 2,713 Weddell, and 4 southern elephant seals could be taken by Level B harassment during the proposed low-energy seismic survey, which would represent 0.35, 0.31, 2.13, 0.54, and <0.01 of the affected worldwide or regional population, respectively.

No known current worldwide or regional population estimates are available for 3 species under NMFS's jurisdiction that could potentially be affected by Level B harassment over the course of the IHA. These species include the minke, Arnoux's beaked, and strap-toothed beaked whales. Minke whales occur throughout the North Pacific Ocean and North Atlantic Ocean and the dwarf sub-species occurs in the Southern Hemisphere (Jefferson *et al.*, 2008). Arnoux's beaked whales have a vast circumpolar distribution in the deep, cold waters of the Southern Hemisphere generally southerly from 34° South. Strap-toothed beaked whales are generally found in deep temperate waters (between 35 to 60° South) of the Southern Hemisphere (Jefferson *et al.*, 2008). Based on these distributions and preferences of these species, NMFS concludes that the requested take of these species likely represent small numbers relative to the affected species' overall population sizes.

NMFS makes its small numbers determination based on the number of marine mammals that would be taken relative to the populations of the affected species or stocks. The requested take estimates all represent small numbers relative to the affected species or stock size (i.e., all are less than or equal to 16%), with the exception of the three species (i.e., minke, Arnoux's beaked, and strap-toothed beaked whales) for which a qualitative rationale was provided. 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 mitigation and monitoring measures, NMFS preliminary finds that small numbers of marine mammals would be taken relative to the populations of the affected species or stocks. See Table 6 for the requested authorized take numbers of marine mammals.

Endangered Species Act

Of the species of marine mammals that may occur in the proposed survey area, six are listed as endangered under the ESA: The southern right, humpback, sei, fin, blue, and sperm whales. Under section 7 of the ESA, NSF, on behalf of ASC and one other research institution, has initiated formal consultation with the NMFS, Office of Protected Resources, Endangered Species Act Interagency Cooperation Division, on this proposed low-energy seismic survey. NMFS's Office of Protected Resources, Permits and Conservation Division, has initiated formal consultation under section 7 of the ESA with NMFS's Office of Protected Resources, Endangered Species Act Interagency Cooperation Division, to obtain a Biological Opinion evaluating the effects of issuing the IHA on threatened and endangered marine mammals and, if appropriate, authorizing incidental take. NMFS would conclude formal section 7 consultation prior to making a determination on whether or not to issue the IHA. If the IHA is issued, in addition to the mitigation and monitoring requirements included in the IHA, NSF and ASC would be required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS's Biological Opinion issued to both NSF and ASC, and NMFS's Office of Protected Resources.

National Environmental Policy Act

With NSF and ASC's complete application, NSF and ASC provided NMFS a ''Draft Initial Environmental Evaluation/Environmental Assessment to Perform Marine Geophysical Survey, Collect Bathymetric Measurements, and Conduct Sediment Coring by the RVIB *Nathaniel B. Palmer* in the Ross Sea,'' (IEE/EA), prepared by AECOM on behalf of NSF and ASC. The IEE/EA analyzes the direct, indirect, and cumulative environmental impacts of the proposed specified activities on marine mammals, including those listed as threatened or endangered under the ESA. NMFS, after independently reviewing and evaluating the document for sufficiency and compliance with Council on Environmental Quality (CEQ) NEPA regulations and NOAA Administrative Order 216–6 § 5.09(d), will conduct a separate NEPA analysis and has prepared a ''Draft Environmental Assessment on the Issuance of an Incidental Harassment Authorization to the National Science Foundation and Antarctic Support Contract to Take Marine Mammals by Harassment Incidental to a Low-Energy Marine Geophysical Survey in the Ross Sea, January to April 2015,'' and decide whether to sign a Finding of No Significant Impact (FONSI), prior to making a determination on the issuance of the IHA.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to NSF and ASC for conducting the low-energy seismic survey in the Ross Sea, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. This section contains a draft of the IHA itself. The wording contained in this section is proposed for inclusion in the IHA (if issued). The proposed IHA language is provided below:

The NMFS hereby authorizes the National Science Foundation, Division of Polar Programs, 4201 Wilson Boulevard, Arlington, Virginia 22230 and Antarctic Support Contract, 7400 South Tucson Way, Centennial, Colorado 80112, under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)), to harass small numbers of marine mammals incidental to a low-energy marine geophysical (seismic) survey conducted by the RVIB *Nathaniel B. Palmer* (*Palmer*) in the Ross Sea, January to February 2015:

1. *Effective Dates*

This Authorization is valid from January 24, 2015 through April 9, 2015.

2. *Specified Geographic Region*

This Authorization is valid only for NSF and ASC's activities associated with low-energy seismic survey, bathymetric profile, and core sampling operations as well as icebreaking activities conducted aboard the *Palmer* that shall occur in the following specified geographic area:

(a) In selected regions of the Ross Sea (located north of the Ross Ice Shelf) in International Waters with a focus on the Whales Deep Basin trough (encompassing the region between 76 and 78° South, and between 165 and 170° West). Water depths in the survey area are expected to be 100 to 1,000 m. No airgun operations would occur in shallow (less than 100 m) water depths. The low-energy seismic survey would be conducted in International Waters (i.e., high seas), as specified in NSF and ASC's IHA application and the associated NSF and ASC Initial Environmental Evaluation/ Environmental Assessment (IEE/EA).

3. *Species Authorized and Level of Takes*

(a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in the waters of the Ross Sea:

(i) *Mysticetes*—see Table 6 (above) for authorized species and take numbers.

(ii) *Odontocetes*—see Table 6 (above) for authorized species and take numbers.

(iii) *Pinnipeds*—see Table 6 (above) for authorized species and take numbers.

(iv) If any marine mammal species are encountered during seismic activities that are not listed in Table 6 (above) for authorized taking and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 dB re 1 μPa (rms) for seismic airgun operations or greater than or equal to120 dB re 1 μPa (rms) for icebreaking activities, then the NSF and ASC must alter speed or course or shut-down the airguns to prevent take.

(b) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 3(a) above or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this Authorization.

4. The methods authorized for taking by Level B harassment are limited to the following acoustic sources, without an amendment to this Authorization:

(a) A two Generator Injector (GI) airgun array (each with a discharge volume of 105 cubic inches [in^3]) with a total volume of 210 in^3 (or smaller); and

(b) Icebreaking.

5. *Prohibited Take*

The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, National Marine Fisheries Service (NMFS), at 301–427–8401.

6. *Mitigation and Monitoring Requirements*

The NSF and ASC are required to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable impact on affected marine mammal species or stocks:

Protected Species Observers and Visual Monitoring

(a) Utilize at least one NMFS-qualified, vessel-based Protected Species Observer (PSO) to visually watch for and monitor marine mammals near the seismic source vessel during daylight airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during ramp-ups of airguns day or night. Three PSOs shall be based onboard the vessel.

(i) The *Palmer*'s vessel crew shall also assist in detecting marine mammals, when practicable.

(ii) PSOs shall have access to reticle binoculars (7 × 50 Fujinon) equipped with a built-in daylight compass and range reticles.

(iii) PSO shifts shall last no longer than 4 hours at a time.

(iv) PSO(s) shall also make observations during daylight periods when the seismic airguns are not operating, when feasible, for comparison of animal abundance and behavior.

(v) PSO(s) shall conduct monitoring while the airgun array and streamer(s) are being deployed or recovered from the water.

(b) PSO(s) shall record the following information when a marine mammal is sighted:

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

(ii) Time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or shut-down), Beaufort sea state and wind force, visibility, and sun glare; and

(iii) The data listed under Condition 6(b)(ii) shall also be recorded at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

Buffer and Exclusion Zones

(c) Establish a 160 dB re 1 μPa (rms) buffer zone, as well as a 180 dB re 1 μPa (rms) exclusion zone for cetaceans and a 190 dB re 1 μPa (rms) exclusion zone for pinnipeds before the two GI airgun array (210 in^3 total volume) is in operation. Establish a 120 dB re 1 μPa (rms) buffer zone for cetaceans and pinnipeds before icebreaking activities begin. See Table 2 (above) for distances and buffer and exclusion zones.

Visual Monitoring at the Start of the Airgun Operations

(d) Visually observe the entire extent of the exclusion zone (180 dB re 1 μPa [rms] for cetaceans and 190 dB re 1 μPa [rms] for pinnipeds; see Table 2 [above] for distances) using NMFS-qualified PSOs, for at least 30 minutes prior to starting the airgun array.

(i) If the PSO(s) sees a marine mammal within the exclusion zone, NSF and ASC must delay the seismic survey until the marine mammal(s) has left the area. If the PSO(s) sees a marine mammal that surfaces, then dives below the surface, the PSO(s) shall continue to observe the exclusion zone for 30 minutes, and if the PSO sees no marine mammals during that time, the PSO should assume that the animal has moved beyond the exclusion zone.

(ii) If for any reason the entire radius cannot be seen for the entire 30 minutes (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or in the exclusion zone, the airguns may not be ramped-up. If one airgun is already running at a source level of at least 180 dB re 1 μPa (rms), NSF and ASC may start the second airgun without observing the entire exclusion zone for 30 minutes prior, provided no marine mammals are known to be near the exclusion zone (in accordance with Condition 6[e] below).

Ramp-Up Procedures

(e) Implement a ''ramp-up'' procedure, which means starting with a single GI airgun and adding a second GI airgun after five minutes, when starting up at the beginning of seismic operations or anytime after the entire array has been shut-down for more than 15 minutes. During ramp-up, the two PSOs shall monitor the exclusion zone, and if marine mammals are sighted, a shut-down shall be implemented as though the full array (both GI airguns) were operational. Therefore, initiation of ramp-up procedures from shut-down requires that the PSOs be able to view the full exclusion zone as described in Condition 6(d) (above).

Shut-Down Procedures

(f) Shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 2, above). A shut-down means all operating airguns are shut-down (i.e., turned off).

(g) Following a shut-down, the airgun activity shall not resume until the PSO(s) has visually observed the marine mammal exiting the exclusion zone and determined it is not likely to return, or has not seen the marine mammal within the exclusion zone for 15 minutes, for species with shorter dive durations (small odontocetes and pinnipeds), or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, killer, and beaked whales).

(h) Following a shut-down and subsequent animal departure, airgun operations may resume, following the ramp-up procedures described in Condition 6(e).

Speed or Course Alteration

(i) Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant exclusion zone. If speed or course alteration is not safe or practicable, or if after alteration the marine mammal still appears likely to enter the exclusion zone, further mitigation measures, such as a shut-down, shall be taken.

Survey Operations During Low-Light Hours

(j) Marine seismic surveying may continue into low-light hours if such segment(s) of the survey is initiated when the entire relevant exclusion zones are visible and can be effectively monitored.

(k) No initiation of airgun array operations is permitted from a shut-down position during low-light hours (such as in dense fog or heavy rain) when the entire relevant exclusion zone cannot be effectively monitored by the PSO(s) on duty.

(l) To the maximum extent practicable, schedule seismic operations (i.e., shooting airguns) during daylight hours.

7. *Reporting Requirements*

The NSF and ASC are required to:

(a) Submit a draft report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *Palmer's* Ross Sea cruise. This report must contain and summarize the following information:

(i) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings;

(ii) Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (e.g., number of shut-downs), observed throughout all monitoring activities.

(iii) An estimate of the number (by species) of marine mammals that: (A) Are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 120 dB re 1 μPa (rms) (for icebreaking activities), greater than or equal to 160 dB re 1 μPa (rms) (for seismic airgun operations), and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds, with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on modeled values for the two GI airgun array) to the seismic activity at received levels greater than or equal to 120 dB re 1 μPa (rms) (for icebreaking activities), greater than or equal to 160 dB re 1 μPa (rms) (for seismic airgun operations), and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds, with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

(iv) A description of the implementation and effectiveness of the: (A) Terms and Conditions of the Biological Opinion's Incidental Take Statement (ITS) (attached); and (B) mitigation measures of the IHA. For the Biological Opinion, the report shall confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on Endangered Species Act-listed marine mammals.

(b) Submit a final report to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, within 30 days after receiving comments from NMFS on the draft report. If NMFS decides that the draft report needs no comments, the draft report shall be considered to be the final report.

8. *Reporting Prohibited Take*

(a)(i) In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (e.g., through ship-strike, gear interaction, and/or entanglement), NSF and ASC shall immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401 and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov.* The report must include the following information:

(ii) Time, date, and location (latitude/longitude) of the incident; the name and type of vessel involved; the vessel's speed during and leading up to the incident; description of the incident; status of all sound source use in the 24 hours preceding the incident; water depth; environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility); description of marine mammal observations in the 24 hours preceding the incident; species identification or description of the animal(s) involved; the fate of the animal(s); and photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with NSF and ASC to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. NSF and ASC may not resume their activities until notified by NMFS via letter, email, or telephone.

Reporting an Injured or Dead Marine Mammal With an Unknown Cause of Death

(b) In the event that NSF and ASC discover an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition), NSF and ASC shall immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401, and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov.* The report must include the same information identified in Condition 7(c)(i) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS shall work with NSF and ASC to determine whether modifications in the activities are appropriate.

Reporting an Injured or Dead Marine Mammal Not Related to the Activities

(c) In the event that NSF and ASC discover an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), NSF and ASC shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301–427–8401, and/or by email to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov,* within 24 hours of the discovery. NSF and ASC shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. Activities may continue while NMFS reviews the circumstances of the incident.

9. *Endangered Species Act Biological Opinion and Incidental Take Statement*

(a) NSF and ASC are required to comply with the Terms and Conditions of the ITS corresponding to NMFS's Biological Opinion issued to both NSF and ASC, and NMFS's Office of Protected Resources.

(b) A copy of this Authorization and the ITS must be in the possession of all contractors and PSO(s) operating under the authority of this Incidental Harassment Authorization.

Request for Public Comments

NMFS requests comment on our analysis, the draft authorization, and any other aspect of the notice of the proposed IHA for NSF and ASC's low-energy seismic survey. Please include with your comments any supporting data or literature citations to help inform our final decision on NSF and ASC's request for an MMPA authorization. Concurrent with the publication of this notice in the **Federal Register**, NMFS is forwarding copies of this application to the Marine Mammal Commission and its Committee of Scientific Advisors.

Dated: November 7, 2014.

Perry F. Gayaldo,

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

[FR Doc. 2014–26915 Filed 11–14–14; 8:45 am]

BILLING CODE 3510–22–P