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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648-XD256

Takes of Marine Mammals Incidental to Specified Activities; Low-Energy Marine Geophysical Survey in the Scotia Sea and South Atlantic Ocean, September to October 2014

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 two research institutions, University of Texas at Austin and University of Memphis, for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment, incidental to conducting a low-energy marine geophysical (seismic) survey in the Scotia Sea and South Atlantic Ocean, September to October 2014. 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, 26 species of marine mammals during the specified activity.

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

ADDRESSES: Comments on the application should be addressed to Jolie Harrison, Incidental Take Program, 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 e-mail comments sent to addresses other than the one provided here. Comments sent via e-mail, 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.htm#applications 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 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.htm#applications. 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 Conduct a Study of the Role of the Central Scotia Sea and North Scotia Ridge in the Onset and Development of the Antarctic Circumpolar Current" (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 will independently evaluate the IEE/EA and determine whether or not to adopt it. NMFS may prepare a separate NEPA analysis and incorporate relevant portions of the NSF and ASC's draft IEE/EA by reference. Information in the NSF and ASC's IHA application, EA and this notice 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 April 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 the Exclusive Economic Zone (EEZ) of the South Georgia and South Sandwich Islands and International Waters (i.e., high seas) in the Scotia Sea and southern Atlantic Ocean during September to October 2014.

The research would be conducted by two research institutions: University of Texas at Austin and University of Memphis. NSF and ASC plan to use one source vessel, the R/VIB Nathaniel B. Palmer (Palmer), and a seismic airgun array and hydrophone streamer to collect seismic data in the Scotia Sea and southern Atlantic Ocean. 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 Scotia Sea, including evaluation of lithosphere adjacent to and beneath the Scotia Sea and southern Atlantic Ocean in two areas, the South Georgia micro-continent and the seafloor of the eastern portion of the central Scotia Sea (see Figures 1 and 2 of the IHA application). In addition to the proposed operations of the seismic airgun array and hydrophone streamer, 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 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 26 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 30 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 proposes 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 "Role of Central Scotia Sea Floor and North Scotia Ridge in the Onset and Development of the Antarctic Circumpolar Current." In addition to the airguns, NSF and ASC intend to conduct a bathymetric survey, dredge sampling, and geodetic measurements from the Palmer during the proposed low-energy seismic survey.

Dates and Duration

The Palmer is expected to depart from Punta Arenas, Chile on approximately September 20, 2014 and arrive at Punta Arenas, Chile on approximately October 20, 2014. Research operations would be conducted over a span of 30 days, including to and from port. 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 seismic 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 Scotia Sea (located northeast of the Antarctic Peninsula) and the southern Atlantic Ocean and focus on two areas: (1) between the central rise of the Scotia Sea and the East Scotia Sea, and (2) the far southern Atlantic Ocean immediately northeast of South Georgia towards the northeastern Georgia Rise (both encompassing the region between 53 to 58º South, and between 33 to 40º West) (see Figure 2 of the IHA application). The majority of the proposed seismic survey would be within the EEZ of the Government of the South Georgia and South Sandwich Islands (United Kingdom) and a limited portion of the seismic survey would be conducted in International Waters. Figure 3 of the IHA application illustrates the general bathymetry of the proposed study area and the border of the existing South Georgia Maritime Zone. Water depths in the survey area exceed 1,000 m. There is limited information on the depths in the study area and therefore more detailed information on bathymetry is not available. The proposed seismic survey would be within an area of approximately 3,953 km^2 (1,152.5 nmi^2). This estimate is based on the maximum number of kilometers for the seismic survey (2,950 km) multiplied by the predicted rms radii (m) based on modeling and empirical measurements (assuming 100% use of the two 105 in^3 GI airguns in greater than 1,000 m water depths), which was calculated to be 675 m (2,214.6 ft).

Detailed Description of the Proposed Specified Activity

NSF and ASC propose to conduct a low-energy seismic survey in the Scotia Sea and the southern Atlantic Ocean from September to October 2014. In addition to the low-energy seismic survey, scientific 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; collecting global positioning system (GPS) information through the temporary installation of three continuous Global Navigation Satellite Systems (cGNSS) on the South Georgia micro-continent; and collecting dredge sampling around the edges of seamounts or ocean floor with significant magnetic anomalies to determine the nature and age of bathymetric highs near the eastern edge of the central Scotia Sea. Water depths in the survey area are greater than 1,000 meters (m) (3,280.1 feet [ft]). The seismic survey is scheduled to occur for a total of approximately 325 hours over the course of the entire cruise, which would be for approximately 30 operational days in September to October 2014. The proposed seismic survey would be conducted during the day and night, and for up to 40 hours of continuous operations at a time. The operation hours and survey length would include equipment testing, ramp-up, line changes, and repeat coverage. The long transit time between port and the study site constrains how long the ship can be in the study area and effectively limits the maximum amount of time the airguns can operate. Some minor deviation from these dates would be possible, depending on logistics and weather.

The proposed survey of the Scotia Sea and southern Atlantic Ocean would involve conducting single channel seismic reflection profiling across the northern central Scotia Sea along two lines that cross the seismically active and apparently compressive boundary between the South Georgia micro-continent and the Northeast Georgia Rise. The targeted seismic survey would occur in the unexplored zones of elevated crust in the eastern central Scotia Sea and is designed to address several critical questions with respect to the tectonic nature of the northern and southern boundaries of the South Georgia micro-continent.

Opening of deep Southern Ocean gateways between Antarctica and South America and between Antarctica and Australia permitted complete circum-Antarctic circulation. This Antarctic Circumpolar Current is not well understood. The Antarctic Circumpolar Current may have been critical in the transition from a warm Earth in the early Cenozoic to the subsequent much cooler conditions that persist to the present day. Opening of Drake Passage and the west Scotia Sea likely broke the final barrier formed by the Andes of Tierra del Fuego and the "Antarctandes" of the Antarctic Peninsula. Once this deep gateway, usually referred to as the Drake Passage gateway, was created, the strong and persistent mid-latitude winds could generate one of the largest deep currents on Earth, at approximately 135 Sverdrup (a Sverdrup [Sv] is a measure of average flow rate in million cubic meters of water per second). This event is widely believed to be closely associated in time with a major, abrupt drop in global temperatures and the rapid expansion of the Antarctic ice sheets at 33 to 34 Million Annus (Ma, i.e., million years from the present/before the current date), the Eocene-Oligocene boundary.

The events leading to the complete opening of the Drake Passage gateway are very poorly known. The uncertainty is due to the complex tectonic history of the Scotia Sea and its enclosing Scotia Ridge, the eastward-closing, locally emergent submarine ridge that joins the southernmost Andes to the Antarctic Peninsula and deflects the Antarctic Circumpolar Current through gaps in its northern limb. The critical keys to this problem are the enigmatic floor of the central Scotia Sea between the high relief South Georgia (approximately 3,000 m [9,842.5 ft]) and the lower South Orkney islands (approximately 1,200 m [3,937 ft]), emergent parts of micro-continental blocks on the North and South Scotia ridges respectively, and the North Scotia Ridge itself.

In 2008, an International Polar Year research program was conducted using the RVIB Nathaniel B. Palmer (Palmer) (Cruise NBP 0805) that was designed to elucidate the structure and history of this area to help provide the constraints necessary for understanding of the initiation of the critical Drake Passage – Scotia Sea gateway. Underway data and dredged samples produced unexpected results that led to a structurally different view of the central Scotia Sea and highlighted factors bearing on initiation of the Antarctic Circumpolar Current that had not been previously considered.

The results of this study of the central Scotia Sea are fragmentary due to the limited time available during Cruise NBP 0805. Therefore, the extent, geometry, and physiography of a submerged volcanic arc that may have delayed formation of a complete Antarctic Circumpolar Current until after the initiation of Antarctic glaciation are poorly defined, with direct dating limited to a few sites. To remedy these deficiencies, thereby further elucidating the role of the central Scotia Sea in the onset and development of the Antarctic Circumpolar Current, the proposed targeted surveying and dredging would determine likely arc constructs in the eastern central Scotia Sea. These would be combined with a survey of the margins of the South Georgia micro-continent and installation of three continuous GPS stations on South Georgia that would test the hypothesis regarding the evolution of the North Scotia Ridge, also an impediment to the present Antarctic Circumpolar Current. The Principal Investigators are Dr. Ian Dalziel and Dr. Lawrence Lawver of the University of Texas at Austin, and Dr. Robert Smalley of the University of Memphis.

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 greater than 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 and sea conditions would be closely monitored, including for conditions that could limit visibility. Pack ice is not anticipated to be encountered during the proposed cruise; therefore, no icebreaking activities are expected. 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 2,950 kilometers (km) (1,592.9 nautical miles [nmi]) of transect lines (including turns) in the survey area in the Scotia Sea and southern Atlantic Ocean (see Figures 1, 2, and 3 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 seismic 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.

Table 1. Proposed low-energy seismic survey activities in the Scotia Sea and the southern Atlantic Ocean.

Survey Length (km)	Cumulative Duration (hr)[1]	Airgun Array Total Volume	Time Between Airgun Shots (Distance)	Streamer Length (m)
2,950 (1,592.9 nmi)	~325	2 x 105 in^3 (2 x 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 40 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 270º 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 360º 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 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 is 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. At vessel speeds of approximately 9.3 km/hr, the shot intervals correspond to spacing of approximately 12.5 m (41 ft) during the study. 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 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. The airguns would fire the compressed air volume in unison in a harmonic mode. 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 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 at 3 m tow depth that are close approximations. For the two 105 in^3 airgun array, the source output (downward) is 234.4 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 160 Hz for a pair of GI airguns towed at 3 m depth and 35 to 230 Hz for a pair of GI airguns towed at 2 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 40 hours at a time. The cumulative duration of the airgun operations would not exceed 325 hrs. The relatively short, 24-channel hydrophone streamer would provide operational flexibility to allow the seismic survey to proceed along the designated cruise track. 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 228.2 dB re 1 μPam peak or 233.5 dB re 1 μPam peak-to-peak for the two 105 in^3 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 in^3 G airguns, in relation to distance and direction from the airguns (see Figure 2 in Attachment A of the IEE/EA). 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 in^3 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 deep water are shown in Table 2 (see Table 1 of Attachment A of the IEE/EA).

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; 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 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 a two GI airgun array in 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 deep 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 in^3) operating in deep water (greater than 1,000 m [3,280 ft]) depths.

Table 2**.** Predicted and modeled (two 105 in^3 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 Scotia Sea and the southern Atlantic Ocean, September to October 2014.

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 in^3)	3 to 4	Deep (>1,000)	670 (2,198.2 ft)	100 (328.1 ft)	20 (65.6 ft) *100 would be used for pinnipeds as well as cetaceans*

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 acquisition should allow marine mammals to avoid the vessel.

Bathymetric Survey

Along with the low-energy airgun operations, other additional geophysical measurements would be made using swath bathymetry, backscatter sonar imagery, high-resolution sub-bottom profiling ("CHIRP"), imaging, and magnetometer instruments. In addition, several other transducer-based instruments onboard the vessel would be operated continuously during the cruise for operational and navigational purposes. During 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 30º 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.

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 (<2º) beam fore to aft and 150º 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 30º 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.

Passive Instruments – During the seismic survey in the Scotia Sea and southern Atlantic Ocean, a precession magnetometer and Air-Sea gravity meter would be deployed. In addition, numerous (approximately 60) 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.

Dredge Sampling

The primary sampling goals involve the acquisition of in situ rock samples from deep marine rises (escarpments) at 3,000 to 4,000 m (9,842.5 to 13,123.4 ft) depths to determine the composition and age of the seafloor. Underway multi-beam and seismic data would be used to locate submarine outcrops. Dredging would be conducted upslope on escarpments. No dredging would be undertaken across the top of any seamounts, and final selection of dredge sites would include review to ensure that the tops of seamounts and corals in the area are avoided.

It is anticipated that researchers would survey and dredge two deep marine rises and one topographic high (see areas A and B in Figure 2 of the IHA application). There will be only six deployments of the dredge. The dredge buckets would be less than 1 m (3.28 ft) across and each sample area to be dredged would be no longer than approximately 1,000 m. Approximately 1,000 m^2 (10,763.9 ft^2) of seafloor would be disturbed by each deployment of the dredge at two different sites (resulting in a total of approximately 6,000 m^2 [64,583.46 ft^2] of affected seafloor for the proposed project). Six samples would be taken, with each dredge effort being 1,000 m^2 in length. Two samples would be collected from each of two locations (seamount sides) at Box A and two samples would be collected from one location at Box B (see Figure 2 of the IHA application).

Table 3. Proposed dredging activities in the Scotia Sea and southern Atlantic Ocean.

Sampling Device	Area (see Figure 2 of the IHA application)	Number of Deployments
Scripps Institution of Oceanography (SIO)-style Deep Sea Rock Dredge	A and B	3

The Government of South Georgia and South Sandwich Islands has established a large sustainable use Marine Protected Area covering over 1 million km^2 (291,553.35 nmi^2) of the South Georgia and South Sandwich Islands Maritime Zone. Activities within the Marine Protected Area are subject to the requirements of the current Management Plan (see Attachment C of the IHA application). The area was designated as a Marine Protected Area to ensure the protection and conservation of the resources and biodiversity and support important ecosystem roles, such as feeding areas for marine mammals, and penguins and other seabirds. Research activities, including trawling and sampling the seafloor, require application for a permit issued by the Government of South Georgia and South Sandwich Islands.

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has adopted Conservation Measures 22-06, 22-07, and 22-09 to protect vulnerable marine ecosystems, which include seamounts, hydrothermal vents, cold water corals, and sponge fields. These measures apply to the entire proposed study area. Additionally, the area surrounding South Georgia Island was designated by CCAMLR as an Integrated Study Area to assist with the collection and management of information relating to the CCAMLR Ecosystem Monitoring Program. The Conservation Measure 22-07 includes mitigation and reporting requirements if vulnerable marine ecosystems are encountered. The science team would follow these requirements (see Attachment C of the IHA application) if vulnerable marine ecosystems are encountered while sampling the sea bottom; however, the specific intent of the proposed dredging activities is to avoid obtaining material from the tops of seamounts.

Geodetic Measurements

Researchers would install three continuous Global Navigation Satellite System (cGNSS) stations on the South Georgia micro-continent (see Figure 3 of the IHA application). The cGNSS systems would collect GPS and meteorological data with daily data recovery using IRIDIUM-based communications. These stations would complement the cGNSS station installed at King Edward Point in Cumberland Bay on the northeastern side of the island (see the "red star" in Figure 3 of the IHA application). One station would be installed near Cooper Bay on the southeastern extremity of the island, the second station would be installed on a reef or islet between Cooper Bay and Annenkov Island, and the third station would be installed on Bird Island. The stations would be removed after three years of operation.

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

Various national Antarctic research programs (e.g., British Antarctic Survey, Australian Antarctic Division, and NMFS National Marine Mammal Laboratory), academic institutions (e.g., Duke University, University of St. Andrews, and Woods Hole Oceanographic Institution), and other organizations (e.g., South Georgia Museum, Fundacion Cethus, Whale and Dolphin Conservation, and New England Aquarium) have conducted scientific cruises and/or examined data on marine mammal sightings along the coast of Antarctica, south Atlantic Ocean, Scotia Sea, and around South Georgia and South Sandwich islands, 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 Atlantic Ocean in proximity to the proposed action area in the Scotia Sea include 32 species of cetaceans and 7 species of pinnipeds.

The waters of the Scotia Sea and southern Atlantic Ocean, especially those near South Georgia Island, are characterized by high biomass and productivity of phytoplankton, zooplankton, and vertebrate predators, and may be a feeding ground for many of these marine mammals (Richardson, 2012). In general, many of the species present in the sub-Antarctic study area may be present or migrating through the Scotia 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 six species of pinnipeds that are found in the southern Atlantic Ocean and Southern Ocean and may be present in the proposed study area include the crabeater (Lebodon carcinophagus), leopard (Hydrurga leptonyx), Weddell (Leptonychotes weddellii), southern elephant (Mirounga leonina), Antarctic fur (Arctocephalus gazella), and Subantarctic fur (Arctocephalus tropicalis) seal. Many of these pinniped species breed on either the pack ice or subantarctic islands. The southern elephant seal and Antarctic fur seal have haul-outs and rookeries that are located on subantarctic islands and prefer beaches. The Ross seal (Ommatophoca rossii) is generally found in dense consolidated pack ice and on ice floes, but may migrate into open water to forage. This species' 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 26 species known to occur in the Scotia Sea and the southern Atlantic Ocean, there are 14 cetacean species with ranges that are known to potentially occur in the waters of the study area: pygmy right (Caperea marginata), Bryde's (Balaenoptera brydei), dwarf minke (Balaenoptera acutorostrata spp.), pygmy blue (Balaenoptera musculus brevicauda), pygmy sperm (Kogia breviceps), dwarf sperm (Kogia sima), Andrew's beaked (Mesoplodon bowdoini), Blainville's beaked (Mesoplodon densirostris), Hector's beaked (Mesoplodon hectori), and spade-toothed beaked (Mesoplodon traversii) whale, and Commerson's (Cephalorhynchus commersonii), Dusky (Lagenorhynchus obscurus), bottlenose (Tursiops truncatus), and Risso's (Grampus griseus) dolphin. 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 status, and conservation status of the species of marine mammals that may occur in the proposed study area during September to October 2014.

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 Scotia Sea and southern Atlantic Ocean (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	Common	Circumpolar 20 to 55º South	8,000[3] to 15,000[4]	EN	D
Pygmy right whale (Caperea marginata)	Coastal, pelagic	Rare	30 to 55º South	NA	NL	NC
Humpback whale (Megaptera novaeangliae)	Pelagic, nearshore 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 65º South	NA	NL	NC
Antarctic minke whale (Balaenoptera bonaerensis)	Pelagic, ice floes	Common	7º South to ice edge (usually 20 to 65º South)	Several 100,000[3] - Worldwide 18,125[5] - Scotia Sea and Antarctica Peninsula	NL	NC
Bryde's whale (Balaenoptera brydei)	Pelagic and coastal	Rare	Circumglobal 40º North to 40º South	NA	NL	NC
Sei whale (Balaenoptera borealis)	Primarily offshore, pelagic	Uncommon	Migratory, Feeding Concentration 40 to 50º 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 55º South	8,000 to 9,000[3] - Worldwide 1,700[6] - Southern Ocean	EN	D
Odontocetes						
Sperm whale (Physeter	Pelagic, deep sea	Common	Cosmopolitan, Migratory	360,000[3] – Worldwide	EN	D

macrocephalus)				9,500[3] - Antarctic		
Pygmy sperm whale (Kogia breviceps)	Pelagic, slope	Rare	Widely distributed in tropical and temperate zones	NA	NL	NC
Dwarf sperm whale (Kogia sima)	Pelagic, slope	Rare	Widely distributed in tropical and temperate zones	NA	NL	NC
Arnoux's beaked whale (Berardius arnuxii)	Pelagic	Common	Circumpolar in Southern Hemisphere, 24 to 78º South	NA	NL	NC
Cuvier's beaked whale (Ziphius cavirostris)	Pelagic	Uncommon	Cosmopolitan	NA	NL	NC
Shepherd's beaked whale (Tasmacetus shepherdi)	Pelagic	Common	Circumpolar – south of 30º South	NA	NL	NC
Southern bottlenose whale (Hyperoodon planifrons)	Pelagic	Common	Circumpolar - 30º South to ice edge	500,000[3] – South of Antarctic Convergence	NL	NC
Andrew's beaked whale (Mesoplodon bowdoini)	Pelagic	Rare	32 to 55º South	NA	NL	NC
Blainville's beaked whale (Mesoplodon densirostris)	Pelagic	Rare	Temperate and tropical waters worldwide	NA	NL	NC
Gray's beaked whale (Mesoplodon grayi)	Pelagic	Common	30º 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	30º 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	Pelagic,	Common	Circumpolar -	200,000[3,8] – South	NL	NC

whale (Globicephala melas)	shelf, coastal		19 to 68º South in Southern Hemisphere	of Antarctic Convergence		
Risso's dolphin (Grampus griseus)	Shelf, slope, seamounts	Rare	60º North to 60º South	NA	NL	NC
Bottlenose dolphin (Tursiops truncatus)	Offshore, inshore, coastal, estuaries	Rare	45º North to 45º South	>625,500[3] - Worldwide	NL	NC
Southern right whale dolphin (Lissodelphis peronii)	Pelagic	Uncommon	12 to 65º South	NA	NL	NC
Peale's dolphin (Lagenorhynchus australis)	Coastal, continental shelf, islands	Uncommon	33 to 60º South	NA 200 – southern Chile[3]	NL	NC
Commerson's dolphin (Cephalorhynchus commersonii)	Coastal, continental shelf, islands	Rare	South America Falkland Islands Kerguelen Islands	3,200 – Strait of Magellan[3]	NL	NC
Dusky dolphin (Lagenorhynchus obscurus)	Coastal, continental shelf and slope	Rare	Widespread in Southern Hemisphere	NA	NL	NC
Hourglass dolphin (Lagenorhynchus cruciger)	Pelagic, ice edge	Common	33º South to pack ice	144,000[3] – South of Antarctic Convergence	NL	NC
Spectacled porpoise (Phocoena dioptrica)	Coastal, pelagic	Uncommon	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]	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]	NL	NC
Ross seal (Ommatophoca rossii)	Pack ice, smooth ice floes, pelagic	Rare	Circumpolar - Antarctic	130,000[3] 20,000 to 220,000[14]	NL	NC
Weddell seal (Leptonychotes weddellii)	Fast ice, pack ice, sub-Antarctic islands	Uncommon	Circumpolar – Southern Hemisphere	500,000 to 1,000,000[3,11]	NL	NC
Southern elephant seal (Mirounga leonina)	Coastal, pelagic, sub-Antarctic waters	Common	Circumpolar - Antarctic Convergence to pack ice	640,000[12] to 650,000[3], 470,000 – South Georgia Island[14]	NL	NC

Antarctic fur seal (Arctocephalus gazella)	Shelf, rocky habitats	Common	Sub-Antarctic islands to pack ice edge	1,600,000[13] to 3,000,000[3]	NL	NC
Subantarctic fur seal (Arctocephalus tropicalis)	Shelf, rocky habitats	Uncommon	Subtropical front to sub-Antarctic islands and Antarctica	Greater than 310,000[3]	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 project area. The IHA application also presents how NSF and ASC calculated the estimated densities for the marine mammals in the proposed survey 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) 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, 26 marine mammal species (20 cetacean and 6 pinniped species) are likely to occur in the proposed seismic survey area. Of the 20 cetacean species likely to occur in NSF and ASC's proposed action area, 7 are classified as low-frequency cetaceans (southern right, humpback, minke, Antarctic minke, sei, fin, and blue whale), 12 are classified as mid-frequency cetaceans (sperm, Arnoux's beaked, Cuvier's beaked, Shepherd's beaked, southern bottlenose, Gray's beaked, strap-toothed beaked, killer, and long-finned pilot whale, and southern right whale, Peale's, and hourglass dolphin), and 1 is classified as a high-frequency cetacean (spectacled porpoise) (Southall et al., 2007). Of the 6 pinniped species likely to occur in NSF and ASC's proposed action area, 4 are classified as phocid pinnipeds (crabeater, leopard, Weddell, and southern elephant seal), and 2 are classified as otariid pinnipeds (Antarctic and Subantarctic fur 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 survey 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).

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 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. 372ff; 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 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 area. 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 2º) in fore-aft extent and wide (150º) 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.

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 acoustic Doppler current profiler 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 30º 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 30º 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.

Dredging Activities

During dredging, 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. Dredging 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 dredging (NSF/USGS PEIS, 2011). NMFS believes that the brief exposure of marine mammals to noise created from the mechanical action of the devices for dredging is not likely to result in the harassment of marine mammals.

The dredge would be attached to the main winch cable using a chain bridle. To dredge a rocky bottom, the dredge would be lowered slowly to the seafloor and the vessel would move slowly down the dredge line while paying out on the winch (30 m per minute). Then the vessel would hold station while slowly paying in the dredge to obtain the sample. This method allows

NSF and ASC to manage the tension spikes if the dredge gets hung up or skips on the ocean bottom. The mechanical wire is protected with a weak link system and the cable is laid over an oversized head sheave for proper support of the wire. Each dredging effort would require approximately 6 hours; therefore, dredges would be in the water for a total of approximately 36 hours. The vessel speed would be less than 2 kts during dredge 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 <u>Palmer</u> 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 compared to the number of commercial ships 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. This large of an array carries the risk of entanglement for marine mammals. 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 entanglement 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 not significant because of the vessel speed and the monitoring efforts onboard the survey vessel.

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 seismic survey is not anticipated to have any permanent impact on habitats used by the marine mammals in the proposed survey 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 3,953 km^2 proposed project area, previously discussed in this notice.

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 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).

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 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 shallow, intermediate, and deep 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 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 deep 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 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, pygmy and dwarf 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 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 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 operated, ramp-up to full power would be permissible 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. A ramp-up from a shut-down may occur at night, but only where the exclusion zone is small enough to be visible. 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 during the day or close to the vessel at night.

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 will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the proposed action area. 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 will 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 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 Scotia Sea and southern Atlantic Ocean, 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. NSF and ASC would appoint the PSOs with NMFS's concurrence. The lead PSO would be experienced with marine mammal species in the Scotia Sea, southern Atlantic Ocean, 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 Scotia Sea and southern Atlantic Ocean. Observations would take place during ongoing daytime operations and nighttime 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 270º and from the aloft observation tower is 360º.

Standard equipment for PSOs would be reticle binoculars. Night-vision equipment would not be available. 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 daytime, the PSO(s) would scan the area around the vessel systematically with reticle binoculars (e.g., 7 x 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.

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 daytime periods when the Palmer is underway without seismic 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, 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 seismic activity.

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

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 seismic operations;
- Sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability);
- Initial sighting distances versus airgun activity state;
- Closest point of approach versus airgun activity state;
- Observed behaviors and types of movements versus airgun activity state;
- Numbers of sightings/individuals seen versus airgun activity state; and
- Distribution around the source vessel versus airgun 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 website at: http://www.nmfs.noaa.gov/pr/permits/incidental.htm#iha**Error! Hyperlink reference not valid.**.

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.

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.

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 Scotia Sea and southern Atlantic Ocean. Acoustic stimuli (i.e., increased underwater sound) generated during the operation of the seismic airgun array 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 Scotia Sea and southern Atlantic Ocean. The estimates are based on a consideration of the number of marine mammals that could be harassed during the approximately 325 hours and 2,950 km of seismic airgun operations with the two GI airgun array to be used.

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.

There are no stock assessments and very limited population information available for marine mammals in the Scotia Sea and southern Atlantic Ocean. Published estimates of marine mammal densities are limited for the proposed low-energy seismic survey's action area. Available density estimates from the Naval Marine Species Density Database (NMSDD) (NAVFAC, 2012) were used for 5 mysticetes and eight odontocetes. Density of spectacled porpoise was based on the density reported in Santora et al. (2009; as reported in NOAA SWFSC, 2013). Densities for minke (including the dwarf sub-species) whales and Subantarctic fur seals were unavailable and the densities for Antarctic minke whales and Antarctic fur seals were used as proxies, respectively.

For other mysticetes and odontocetes, reported sightings data from two previous research surveys in the Scotia Sea and vicinity were used to identify species that may be present in the proposed action area and to estimate densities. While these surveys were not specifically designed to quantify marine mammal densities, there was sufficient information to develop density estimates. The data collected for the two studies were in terms of animals sighted per time unit, and the sighting data were then converted to an areal density (number of animals per square km) by multiplying the number of animals observed by the estimated area observed during the survey.

Some marine mammals that were present in the area 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 animals.

Sighting data collected during the 2003 RRS James Clark Ross Cruise JR82 (British Antarctic Survey, undated) were used as the basis to estimate densities for four species: southern right whale, southern bottlenose whale, hourglass dolphin, and Peale's dolphin. The cruise length was 4,143 km (2,237 nmi); however, lateral distance from the vessel where cetaceans were viewed was not identified in the report. Therefore, it was assumed that all species were sighted within 2.5 km (1.4 nmi) of the vessel (5 km [2.7 nmi] width) because this was the assumed sighting distance (half strip width). This resulted in a survey area of 20,715 km^2 (6,039 nmi^2). Density of the strap-toothed beaked whale was based on sighting data reported in Rossi-Santos et al. (2007). The survey length was 1,296 km (699.8 nmi); however, lateral distance from the vessel where cetaceans were sighted was not identified in the report. Therefore, it was assumed that all species were sighted within 2.5 km of the vessel (5 km width) because this was assumed as a conservative distance where cetaceans could be consistently observed. This width was needed to calculate densities from data sources where only cruise distance and animal numbers were available in the best available reports. This resulted in a survey area of 6,480 km^2 (1,889.3 nmi^2)

With respect to pinnipeds, one study (Santora et al., 2009 as reported in NOAA SWFSC, 2013) provided a density estimate for southern elephant seals. No other studies in the region of the Scotia Sea provided density estimates for pinnipeds. Therefore, reported sighting data from two previous research surveys in the Scotia Sea and vicinity were used to identify species that may be present and to estimate densities. Sighting data collected during the 2003 RRS James Clark Ross Cruise JR82 (British Antarctic Survey, undated) were used as the basis to estimate densities for four species: Antarctic fur seal, crabeater seal, leopard seal, and Weddell seal. The survey length was 4,143 km (1,207.9 nmi); however, lateral distance from the vessel where pinnipeds were viewed was not identified in the report. Therefore, it was assumed that all species were sighted within 0.4 km (0.2 nmi) of the vessel (0.8 km [0.4 nmi] width), based on Southwell et al. (2008). This resulted in a survey area of 3,315 km^2 (966.5 nmi^2).

Some pinnipeds that were present in the area during the British Antarctic Survey cruise may not have been observed. Therefore, a correction factor of 1.66 was applied to the pinniped density estimates, which assumes 66% more animals than observed were present and potentially may have been in the water. This conservative correction factor takes into consideration that pinnipeds are relatively difficult to observe in the water due to their small body size and surface behavior, and some pinnipeds may not have been observed due to poor visibility conditions.

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; therefore, the pinniped densities have been adjusted downward to account for this consideration. Take was not requested for Ross seals because preferred habitat for this 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) during NSF and ASC's proposed low-energy seismic survey (approximately 2,950 km of tracklines/approximately 3,953 km^2 [0.67 km x 2 x 2,950 km] ensonified area for airgun operations) in the Scotia Sea and southern Atlantic Ocean, September to October 2014.

Species	Density (# 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]	Requested Take Authorization	Abundance[3]	Approximate Percentage of Population Estimate (Requested Take)[4]	Population Trend[5]
Mysticetes						
Southern right whale	0.0079652	31	31	8,000 to 15,000	0.39	Increasing at 7 to 8% per year
Humpback whale	0.0006610	3	3	35,000 to 40,000 – Worldwide 9,484 – Scotia Sea and Antarctica Peninsula	0.03	Increasing
Antarctic minke whale	0.1557920	616	616	Several 100,000 – Worldwide 18,125 – Scotia Sea and Antarctica Peninsula	3.4	Stable
Minke whale (including dwarf minke whale sub-species)	0.1557920	616	616	NA	NA	NA
Sei whale	0.0063590	25	25	80,000 - Worldwide	0.03	NA
Fin whale	0.0182040	72	72	140,000 – Worldwide 4,672 – Scotia Sea and Antarctica	1.54	NA

				Peninsula		
Blue whale	0.0000510	1	1	8,000 to 9,000 - Worldwide	0.01	NA
Odontocetes						
Sperm whale	0.0020690	8	8	360,000 – Worldwide 9,500 - Antarctic	<0.01	NA
Arnoux's beaked whale	0.0113790	45	45	NA	NA	NA
Cuvier's beaked whale	0.000548	3	3	NA	NA	NA
Gray's beaked whale	0.0018850	7	7	NA	NA	NA
Shepherd's beaked whale	0.0092690	37	37	NA	NA	NA
Strap-toothed beaked whale	0.0007716	3	3	NA	NA	NA
Southern bottlenose whale	0.0089307	35	35	50,000 – South of Antarctic Convergence	0.07	NA
Killer whale	0.0153800	61	61	80,000 – South of Antarctic Convergence	0.08	NA
Long-finned pilot whale	0.2145570	848	848	200,000 – South of Antarctic Convergence	0.42	NA
Peale's dolphin	0.0026551	10	10	NA – Worldwide; 200 – southern Chile[3]	NA 5	NA
Hourglass dolphin	0.0154477	61	61	144,000	0.04	NA
Southern right whale dolphin	0.0061610	24	24	NA	NA	NA
Spectacled porpoise	0.0015000	6	6	NA	NA	NA
Pinnipeds						
Crabeater seal	0.0185313	73	73	5,000,000 to 15,000,000	<0.01	Increasing
Leopard seal	0.0115194	46	46	220,000 to 440,000	0.02	NA
Weddell seal	0.0027447	11	11	500,000 to 1,000,000	<0.01	NA
Southern elephant seal	0.0003000	1	1	640,000 to 650,000 – Worldwide;	<0.01	Increasing, decreasing, or stable

				470,000 – South Georgia Island		depending on breeding population
Antarctic fur seal	0.5103608	2,017	2,017	1,600,000 to 3,000,000	0.13	Increasing
Subantarctic fur seal	0.5103608	2,017	2,017	>310,000	0.65	Increasing

NA = Not available or not assessed.

[1] Sightings from a 47 day (7,560 km) period on the RRS James Clark Ross JR82 survey during January to February 2003 and sightings from a 34 day (1,296 km) period on the Kotic II from January to March 2006.

[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] 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).

Note: Take was not requested for Ross seals because preferred habitat for these species is not within the proposed action area.

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 Scotia Sea and southern Atlantic Ocean 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 on one or more occasions by considering the total marine area that would be within the 160 dB radius around the operating airgun array on at least one occasion and the expected density of marine mammals in the area (in the absence of the a seismic survey). 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 670 m times 2) around the operating airguns. 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 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 greater than 1,000 m deep, the buffer zone of 670 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 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.

Applying the approach described above, approximately 3,953 km^2 (including the 25% contingency) would be ensonified within the 160 dB isopleth for seismic airgun operations on one or more occasions during the proposed 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. 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 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 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, 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 program) to occur in the waters that would be exposed to greater than or equal to 160 dB (rms) for seismic airgun operations.

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 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 middle column (fourth from the right) 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. NSF has already prepared a permit application for the Government of South Georgia and South Sandwich Islands for the proposed research activities, including trawling and sampling of the seafloor. 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 coastal Antarctica, provide additional data on marine mammals present in the Scotia Sea study areas, and communicate its findings 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 will 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 Scotia Sea and southern Atlantic Ocean 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 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 30 days. Additionally, the 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 26 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 5%). 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, the proposed activity is not expected to impact rates of recruitment or survival for any of these marine mammal species.

Of the 26 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 all six species. To protect these animals (and other marine mammals in the study area), NSF and ASC would be required to cease or reduce airgun operations if any marine mammal enters designated 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. Southall et al. (2007) provide a severity scale for ranking observed behavioral responses of both free-ranging marine mammals and laboratory subjects to various types of anthropogenic sound (see Table 4 in Southall et al. [2007]). 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 Scotia Sea and southern Atlantic Ocean, September to October 2014, 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 26 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 survey (including a 25% contingency) are in Table 6 of this document. Of the cetaceans, 31 southern right, 3 humpback, 616 Antarctic minke, 616 minke, 25 sei, 72 fin, 1 blue, and 8 sperm whales could be taken by Level B harassment during the proposed seismic survey, which would represent 0.39, 0.03, 3.4, unknown, 0.03, 1.54, and 0.01% of the affected worldwide or regional populations, respectively. In addition, 45 Arnoux's beaked, 3 Cuvier's beaked, 7 Gray's beaked, 37 Shepherd's beaked, 3 strap-toothed beaked, and 35 southern bottlenose whales could be taken be Level B harassment during the proposed seismic survey, which would represent unknown, unknown, unknown, unknown, unknown, and 0.07% of the affected worldwide or regional populations, respectively. Of the delphinids, 61 killer whales, 848 long-finned pilot whales, and 10 Peale's, 61 hourglass, and 24 southern right whale dolphins, and 6 spectacled porpoise could be taken by Level B harassment during the proposed seismic survey, which would represent 0.08, 0.42, unknown/5, 0.04, unknown, and unknown of the affected worldwide or regional populations, respectively. Of the pinnipeds, 73 crabeater, 46 leopard, 11 Weddell, and 1 southern elephant seals and 2,017 Antarctic and 2,017 Subantarctic fur seals could be taken by Level B harassment during the proposed seismic survey, which would represent <0.01, 0.02, <0.01, <0.01, 0.13, and 0.65 of the affected worldwide or regional population, respectively.

No known current worldwide or regional population estimates are available for 9 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, Cuvier's beaked, Gray's beaked, Shepherd's beaked, and strap-toothed beaked whales, and Peale's and southern right whale dolphins and spectacled porpoises. 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 34º South. Cuvier's beaked whales generally occur in deep, offshore waters of tropical to polar regions worldwide. They seem to prefer waters over and near the continental slope (Jefferson et al., 2008). Gray's beaked whales are generally found in deep waters of temperate regions (south of 30º South) in the Southern Hemisphere (Jefferson et al., 2008). Shepherd's beaked whales are generally found in deep temperate waters (south of 30º South) of the Southern Hemisphere and are thought to have a circumpolar distribution (Jefferson et al., 2008). Strap-toothed beaked whales are generally found in deep temperate waters (between 35 to 60º South) of the Southern Hemisphere (Jefferson et al., 2008). Peale's dolphins generally occur in the waters around the southern tip of South America from 33 to 38º South, but may extend to islands further south. This species is considered coastal as they are commonly found in waters over the continental shelf (Jefferson et al., 2008). Southern right whale dolphins are generally found in temperate to subantarctic waters (30 to 65º South), with a southern limit bounded by the Antarctic Convergence (Jefferson et al., 2008). Spectacled porpoises are generally found in subantarctic waters and may have a circumpolar distribution in the Southern Hemisphere (as far south as 64º South). They have been sighted in oceanic waters, near islands, as well as in rivers and channels (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 5%). 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 two other research institutions, 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 will 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 will 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 Conduct a Study of the Role of the Central Scotia Sea and North Scotia Ridge in the Onset and Development of the Antarctic Circumpolar Current," (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. Prior to making a final decision on the IHA application, NMFS will either prepare an independent EA or, after review and evaluation of the NSF and ASC IEE/EA for consistency with the regulations published by the Council of Environmental Quality (CEQ) and NOAA Administrative Order 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act, adopt the NSF and ASC IEE/EA, and decide whether or not to issue a Finding of No Significant Impact (FONSI).

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 Scotia Sea and southern Atlantic Ocean, 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 Scotia Sea and southern Atlantic Ocean, September to October 2014:

1. This Authorization is valid from September 20 through December 1, 2014.

2. This Authorization is valid only for NSF and ASC's activities associated with low-energy seismic survey, bathymetric profile, GPS installation, and dredge sampling operations conducted aboard the Palmer that shall occur in the following specified geographic area:

In selected regions of the Scotia Sea (located northeast of the Antarctic Peninsula) and southern Atlantic Ocean off the coast of East Antarctica, with a focus on two areas: (1) between the central rise of the Scotia Sea and the East Scotia Sea, and (2) the far South Atlantic Ocean immediately northeast of South Georgia toward the Northeast Georgia Rise (both encompassing the region between 53 and 58º, and between 33 and 40º West. Water depths in the survey area are expected to be deeper than 1,000 m. The low-energy seismic survey will be conducted in the Exclusive Economic Zone (EEZ) for the South Georgia and South Sandwich Islands and International Waters (i.e., high seas), as specified in NSF and ASC's Incidental Harassment Authorization 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 Scotia Sea and southern Atlantic Ocean:

(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, 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);

(b) A multi-beam echosounder;

(c) A single-beam echosounder;

(d) An acoustic Doppler current profiler; and

(e) A sub-bottom profiler.

5. 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 daytime 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 x 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 daytime 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 a180 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. See Table 2 (above) for distances and exclusion zones.

Visually 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 (day or night).

(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 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 at Night

(j) Marine seismic surveying may continue into night and 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 at night or 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 Scotia Sea and southern Atlantic Ocean 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 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 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 Incidental Harassment Authorization. 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.

<u>Reporting Prohibited Take</u>

(c) (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:

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

(ii) 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

(iii) 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.

8. Endangered Species Act Biological Opinion and Incidental Take Statement

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.

9. 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: July 30, 2014.

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Donna S. Wieting,
Director,
Office of Protected Resources,
National Marine Fisheries Service.

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