Draft
Request by the National Science Foundation for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Marine Geophysical Survey by the R/VIB Nathaniel B. Palmer in the Dumont d'Urville Sea, Antarctica

NSF-Funded Research Project: Study of the Totten Glacier System

Period of Performance for the Proposed Action:
45-Day Cruise in 2014

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INTRODUCTION

In support of the United States Antarctic Program (USAP), the National Science Foundation (NSF) proposes to perform marine-based studies in the Dumont D'Urville Sea to include evaluation of geophysical and physical oceanographic features in two areas along the coast of East Antarctica, as shown in Figures 1, 2, and 3. The primary area proposed for study is the Totten Glacier (TG) system (preferred study area) including the Moscow University Ice Shelf (MUIS) along the Sabrina Coast and a secondary area, the Mertz Glacier (MG) and Cook Ice Shelf (CIS), along the Oates Coast.

Pursuant to 50 C.F.R. § 216.104, items required to be addressed in a Submission of Requests for an Incidental Harassment Authorization (IHA) are set forth below. Table 1 provides a summary of these requirements and a cross-reference to supplemental information that is available in related environmental documents including the Initial Environmental Evaluation (IEE)/Environmental Assessment (EA) to conduct marine-based studies of the Totten Glacier system and the Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) (hereafter called PEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey Observatory (http://www.nsf.gov/geo/oce/envcomp/index.jsp).

Descriptions of the marine mammal species that may be found in the proposed study areas are derived primarily from information contained in the PEIS. In addition, a significant portion of the analysis for the effects to marine mammals was based on the PEIS and information contained in the Environmental Analysis of a Marine Geophysical Survey by the R/V Marcus G. Langseth on the mid-Atlantic Ridge, April–May 2013 prepared by LGL Ltd., environmental research associates on behalf of Lamont-Doherty Earth Observatory and the National Science Foundation Revised 4 April 2013 (LGL Report TA8220-1).

Figure 1. Totten Glacier System and Mertz Glacier Study Areas

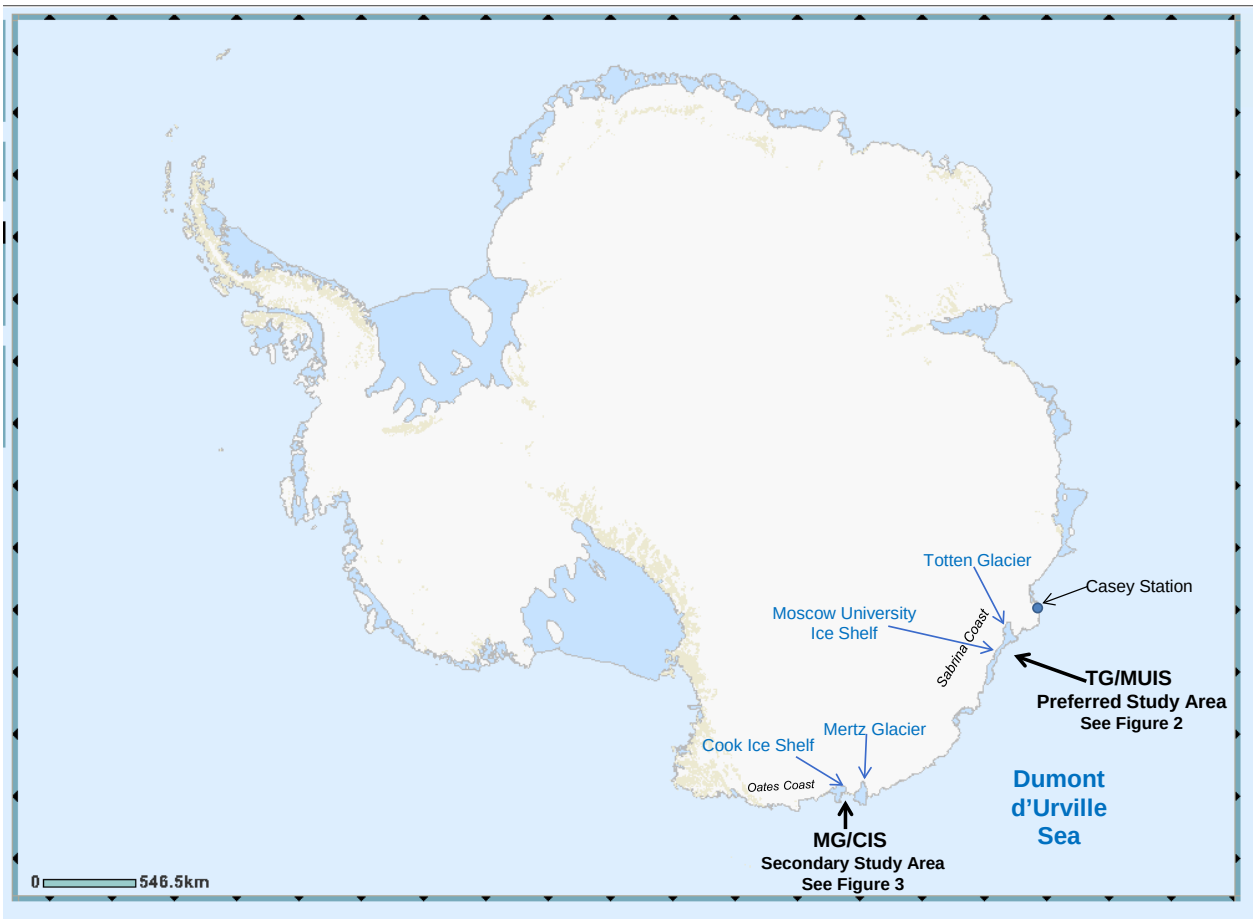

Figure 2. Totten Glacier System Study Area

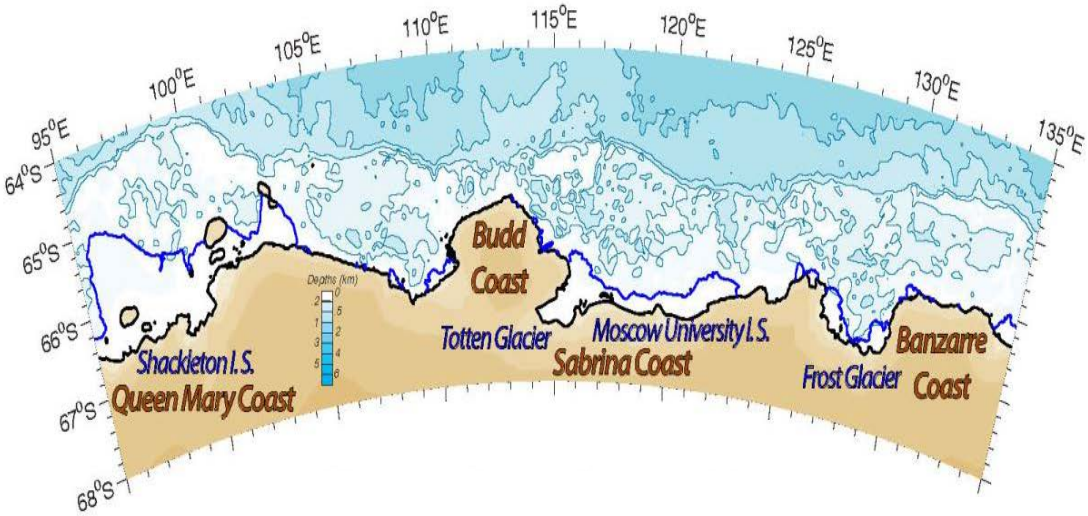

Figure 3. Mertz Glacier Study Area

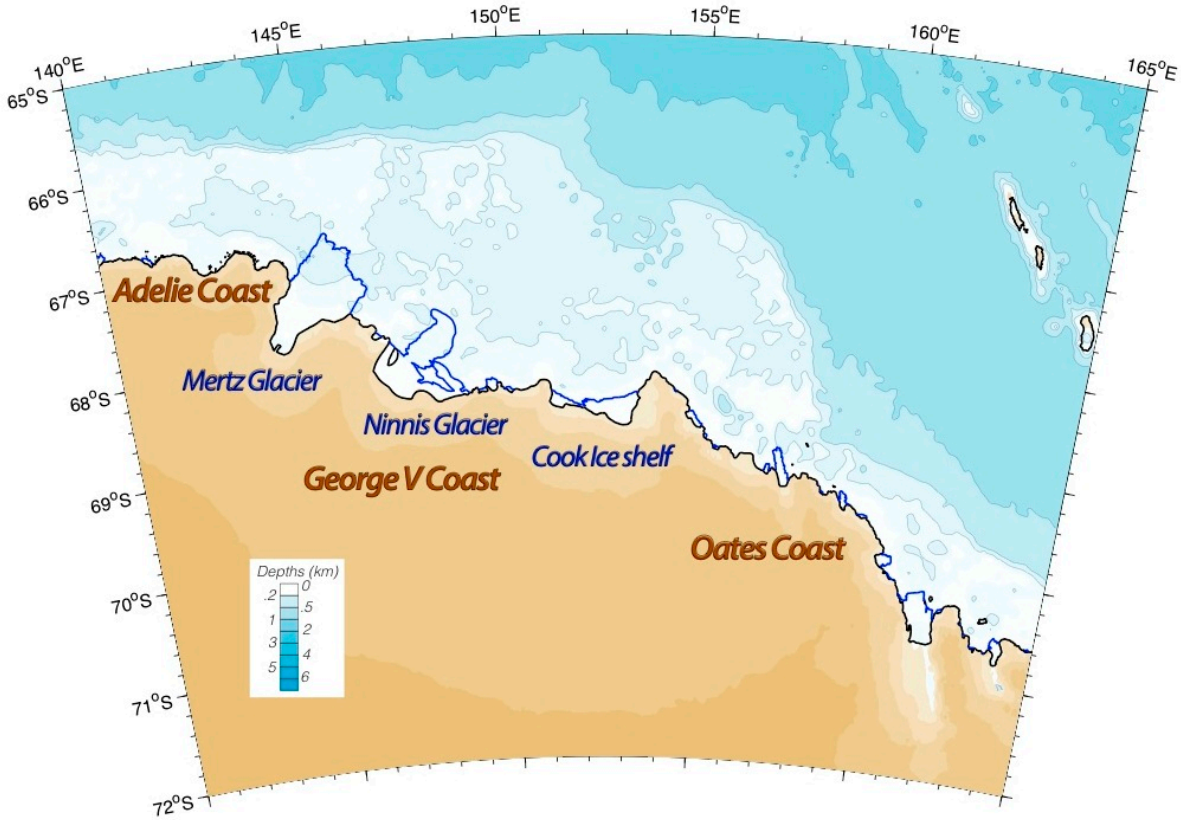

Table 1. IHA Application and IEE/EA/PEIS Information Crosswalk Table

IHA Section	NOAA Fisheries Requirement	Related IEE/EA and PEIS Documentation
1.0	A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals	Section 2.1 of the IEE/EA provides a description of the seismic survey activities (seismic survey with low-energy acoustic source, sediment, and water sampling).
2.0	The date(s) and duration of such activity and the specific geographical region where it will occur	Section 3.0 of the IEE/EA provides a description of the study areas and dates of proposed activities (45-day cruise in 2014).
3.0	The species and numbers of marine mammals likely to be found within the activity area	Tables 12 and 13 of the IEE/EA provide detailed estimates of the number of animals (Note: estimates based on historical sightings; comprehensive population density data for most marine mammal species in the Southern Ocean is not available).
4.0	A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities	Section 3.3.6 of the IEE/EA provides a description of the marine mammals in the study area, their migration and breeding patterns (Note: information is based on historical sightings; comprehensive migration and breeding pattern data for most marine mammal species in the Southern Ocean is not available).
5.0	The type of incidental taking authorization that is being requested (i.e., takes by harassment only; takes by harassment, injury and/or death) and the method of incidental taking	Level B harassment.
6.0	By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in paragraph (a)(5) of this section, and the number of times such takings by each type of taking are likely to occur	Section 5.1.6 of the IEE/EA provides a description of the number of marine mammals expected to be encountered in the study area (detailed data characterizing the age, sex, and reproductive condition for marine mammals in the Southern Ocean is not available).
7.0	The anticipated impact of the activity upon the species or stock	Section 4.1 of the IEE/EA describes the impacts of the proposed survey activities to the species expected to be present in the Dumont d'Urville Sea; Sections 3.6, 3.7, and 3.8 of the PEIS describe the impacts of low-energy seismic surveys to marine mammals.

Table 1. IHA Application and IEE/EA/PEIS Information Crosswalk Table

IHA Section	NOAA Fisheries Requirement	Related IEE/EA and PEIS Documentation
8.0	The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses	No impact; species or stocks of marine mammals found in the proposed study areas are not used for subsistence purposes.
9.0	The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat	No impacts to marine mammal habitats are expected.
10.0	The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved	No impacts to marine mammal habitats are expected.
11.0	The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance	Section 4.1 of the IEE/EA summarizes the mitigation measures that will be used during the proposed seismic survey, to incorporate using the smallest airgun array needed to attain research objectives; Section 2.4.2 of the PEIS describes mitigation measures for low-energy acoustic sources; Section 3.2.5 identifies the use of low-energy sources as the preferred alternative.
12.0	Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a "plan of cooperation" or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses	Not applicable.
13.0	The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding. Guidelines for developing a site-specific monitoring plan may be obtained by writing to the Director, Office of Protected Resources	Section 4.1 of the IEE/EA summarizes the monitoring and mitigation measures that will be used during the proposed seismic survey. Additionally, Section 2.4.2 of the PEIS described generic mitigation measures for low-energy acoustic sources.

Table 1. IHA Application and IEE/EA/PEIS Information Crosswalk Table

IHA Section	NOAA Fisheries Requirement	Related IEE/EA and PEIS Documentation
14.0	Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects	The proposed action will complement fieldwork studying other Antarctic ice shelves, oceanographic studies, and ongoing development of ice sheet and other ocean models. It will 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 East Antarctic study areas, and communicate its findings via reports, publications and public outreach.

1.0 DESCRIPTION OF ACTIVITIES

NOAA NMFS Requirement: A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

The proposed research activities would include: 1) conducting a seismic survey along a 2,800-kilometer (km) track using a two generator-injector airgun array as a low-energy seismic source and a hydrophone streamer, 2) conducting a bathymetric profile survey of the seafloor using transducer-based instruments such as a multibeam sonar and sub-bottom profiler, 3) conducting imaging surveys using an underwater camera assembly, 4) collecting sediment cores or dredge samples, and 5) collecting water samples and conductivity (salinity), temperature, depth (CTD) and current data through the deployment and recovery of short-term moorings (in place for approximately one month) and long-term moorings (in place for approximately one year) moorings, CTD equipment casts, and the use of transducer-based Acoustic Doppler Current Profiler (ADCP) instruments. Incidental takes, if they were to occur, would be anticipated to result primarily from the proposed airgun activities.

This survey of TG and MUIS along the Sabrina Coast continental shelf is designed to address several critical questions. The TG system, which drains one-eighth of the East Antarctic Ice Sheet (EAIS) and contains more ice volume than the entire West Antarctic Ice Sheet (WAIS), remains the single largest and least understood glacial system which possesses a potentially unsteady dynamic. If it were to melt, sea-level would rise by more than five meters worldwide. The proposed marine studies would help to understand both the dynamics and the controls of the TG system, and to resolve ambiguity in large ice mass dynamic behavior. This research would be accomplished via the collection of glaciological, geological, and physical oceanographic data. In order to place the modern system, as well as more recent changes to the system, into a longer-term perspective, researchers would collect and interpret marine geologic, geochemical and geophysical records of the longer term behavior and response of this system.

The proposed research would complement fieldwork studying other Antarctic ice shelves, oceanographic studies near the Antarctic Peninsula, 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 sparsely sampled region of coastal Antarctica, and communicate its findings via publications and outreach. Obtaining records of currents and oceanographic properties in this region are consistent with the objectives of the Southern Ocean Observing System for climate change. The work would enhance general understanding of air-sea-ice interactions, ocean circulation, ice shelf sensitivity to climate change, and the present and future roles of EAIS in sea level rise.

Vessel Specifications

The USAP research vessel RVIB Nathaniel B. Palmer (NBP) would be used to conduct the proposed research activities. The NBP has a length of 93.9 m, a beam of 18.3 m, and a design draft of 6.8 m. It is equipped with four Caterpillar Model 3608 diesel engines (each rated at 3300 brake horsepower (BHP) @ 900 rpm) and a water jet azimuthing bow thruster. Electrical power is provided by four Caterpillar 3512, 1050-kW diesel generators. The maximum speed of the NBP is 14.5 knots and the average speed is 10.1 knots. The cruising speed would be approximately 5 knots (vary between 4 and 6 knots) when the GI guns are operating. The NPB operating range is 27,780 km (approximately 70 to 75 days).

The NBP also would serve as the platform from which vessel-based protected species observers (PSOs) will watch for marine mammals before and during airgun operations. The characteristics of the vessel that make it suitable for visual monitoring are described in § XI. Other details of the NBP include the following:

Owner:	Edison Chouest Offshore, Inc
Operator:	Edison Chouest Offshore, Inc
Chartered:	NSF
Flag:	United States of America
Date Built:	1992
Gross Tonnage:	6,174 GT
GI Airgun Comprssor:	Borsig-LMF Seismic Air Compressors, 1,200 cfm at 2000 psi
Accommodation Capacity:	22 crew plus 37 scientists

2.0 DATE, DURATION, AND GEOGRAPHICAL REGION OF ACTIVITIES

NOAA NMFS Requirement: The date(s) and duration of such activity and the specific geographical region where it will occur.

The proposed action would occur in selected regions of the Dumont d'Urville Sea in East Antarctica and focus on the TG and MUIS located along the Sabrina Coast (>64°0′S, between 95°E and 135°0′E) as shown on Figure 2, and the MG and CIS systems, located along the George V and Oates Coast (>65°0′S, between 140°0′E and 165°E). The proposed studies would occur in both areas, or entirely in one or the other, depending on ice conditions. The species present are

expected to be the same in both locations. Figure 3 illustrates the limited detailed bathymetry of the two study areas. Ice conditions encountered during previous surveys in the region limited the area where bathymetric data could be collected.

The seismic surveys would be within an area of approximately 2,814 sq km. This estimate is based on the maximum number of kilometers for the seismic survey (2,800 km) times the Predicted RMS radii (m) based on modeling and empirical measurements (assuming 100% use of 2 x 105in^3 GI guns in 100-1000 m water depths) which was calculated to be 1,005 m (1.005 km).

The research would begin in 2014 and span a 45-day period (including transit time to and from Hobart, Tasmania) using the NBP. The approximate departure date would be 29 January 2014 and the approximate arrival date would be 16 March 2014. Ice-free or very low concentrations of sea ice are required in order to collect high quality seismic data and not impede passage of the vessel between sampling locations. This requirement restricts the cruise to operating in mid to late austral summer when the ice concentrations are typically the lowest. The preferred period for the proposed 45-day cruise is February-March, also the period when the maximum density of marine mammals may be encountered. Specific details of the activities to be performed are described below.

Seismic Survey

The proposed seismic survey would be performed in the Dumont d'Urville Sea along track lines totaling up to 2,800 km and in water primarily 100 to 1,000 m deep and possibly exceeding 1,000 m in some areas. The total track lines include equipment testing, start-up, line changes, repeat coverage, and equipment recovery. Due to dynamic ice conditions, which cannot be predicted on a local scale, it is not possible to develop track lines a priori. The seismic survey would be conducted in one or both of the two study areas depending on the sea ice conditions; however, the preferred study area is the TG region (Figure 2).

The seismic survey would involve the use of a low-energy acoustic source consisting of a two generator-injector (GI) airgun array and a 100-m solid-state hydrophone streamer towed behind the vessel. The detailed specs, including dominant frequency and source output, for the airguns can be found in appendix B. The airguns would be deployed at a depth of up to 3 m below the surface, spaced approximately 3 or 6 m apart and between 15 and 40 m astern. Each airgun would be initially configured to a displacement volume of 45 in^3 (737 cm^3) for both the generator and injector. The guns would fire the compressed air volume (with a maximum firing pressure of 2,000 psi) 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 guns 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).

If needed to improve penetration of the strata, two airguns may be reconfigured to a displacement volume of 105 in^3 (1,720 cm^3) each and would still be considered a low-energy acoustic source defined in the PEIS. Therefore, there are three possible 2-airgun array configurations: two 45/45 in^3 airguns separated by 3 m, two 45/45 in^3 airguns separated by 6 m, and two 105/105 in^3 airguns separated by 3 m. The two 45/45 guns separated by 3 m layout is

preferred, the two 45/45 gun configuration separated by 6 m would be used in the event the middle of the three 45/45 GI guns fails, and the two 105/105 guns separated by 3 m would be used only if additional penetration is needed. To summarize, two strings of GI guns would be available: 1) three 45/45 GI guns on a single string where one of these is used as a "hot spare" in the event of failure of one of the other 2 guns; these three GI guns are separated by 3 m; and 2) two 105/105 GI guns on a second string without a hot spare. Weather and sea ice conditions permitting, it is anticipated that the seismic surveying **would not exceed 300 hours of operation for the entire duration of the cruise** as summarized in Table 2. The operation hours and survey length would include equipment testing, ramp-up, line changes, and repeat coverage. Sea ice conditions will dictate areas where the ship and airguns can operate; therefore, specific tracklines cannot be given in advance. 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 guns can operate.

Table 2. Proposed Seismic Survey Activities in the Dumont d'Urville Sea

Survey Length (km)	Cumulative Duration [1] (hours)	Airgun Array Total Volume	Frequency (Distance) Between Seismic Shots	Streamer Length
2,800	≤ 300	2 x 45 in^3 (2 x 737 cm^3) or 2 x 105 in^3 (2 x 1,720 cm^3)	5 seconds (12.5 m)	100 m

Note: [1] Seismic operations are planned for no more than 16 continuous hours at a time.

During the seismic survey, the vessel would attempt to maintain a constant cruise speed of approximately 9 km/hr (5 knots). The airguns would operate continuously for no more than 16 hours at a time and duration of continuous operation is dependent on ice concentration. The cumulative duration of airgun operation will not exceed 300 hours. The relatively short, 24-channel streamer would provide operational flexibility to allow the survey to proceed along the designated cruise track with minimal interruption due to variable sea ice conditions. The design of the seismic equipment is to achieve high-resolution images of the glacial marine sequence stratigraphy 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. The cruise path would be designated once in the study region and would take care to avoid heavy ice conditions such as icebergs or dense areas of pack ice that could potentially damage the airguns or streamer and minimize proximity to potential marine receptors.

Weather conditions that could affect the movement of sea ice and hinder the streamer would be closely monitored, as well as conditions that could limit visibility. If situations are encountered which pose a risk to the equipment, impede data collection, or require the vessel to stop forward progress, the seismic survey equipment would be shut down and retrieved until conditions improve. In general, the streamer and sources could be retrieved in less than 30 minutes.

In addition to the seismic survey, a number of geophysical measurements would be made using non-seismic acoustic sources. These sources, described below, are similar to the non-seismic

acoustic sources described in the PEIS. The PEIS concluded that the intermittent and narrow downward-directed nature of the non-seismic acoustic sources would result in no more than one or two brief ping exposures of any individual mysticete, odontocete, or pinniped given the movement and speed of the vessel; such brief exposure to this sound is not expected to cause injury or PTS based on results of limited studies of some odontocete and pinniped species.

Bathymetric Survey

Besides the seismic survey, other geophysical measurements would be made using swath bathymetry, backscatter sonar imagery, high-resolution sub-bottom profiling ("CHIRP"), imaging, and magnetometer instruments. In addition, other transducer-based instruments onboard the vessel would be used continuously during the cruise for operational and navigational purposes. Operating characteristics for the instruments to be used are described below.

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

Single Beam Echo Sounder (Bathy 2000) – The hull-mounted sonar would be operated instead of the Knudesn 3260 only if needed (i.e., only one would be in continuous operation during the cruise). The characteristics of the Bathy 2000 are similar to the Knudsen 3260.

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 and has an estimated maximum source energy level of 242 dB re 1μPa (rms) and emits a very narrow (< 2°) beam fore to aft and 150° in cross-track. The multi-beam system emits a series of nine consecutive 15 ms pulses.

Acoustic Doppler Current Profiler (ADCP) (Teledyne RDI VM-150) – The hull-mounted ADCP would be operated continuously throughout the cruise. The ADCP operates at a frequency of 150 kHz with an estimated acoustic output level at the source of 223.6 dB re 1μPa (rms). Sound energy from the ADCP is emitted as a 30^0 conically-shaped beam.

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

Acoustic Locator (Pinger) – An acoustic locator (pinger) may be deployed when using the Smith- McIntyre grab sampler and multi-corer (Mega-corer) to enable these devices to be located in the event they become detached from their lines. A pinger typically operates at a frequency of 12 kHz, generates a 5 ms pulse per second, and has an acoustical output of 162 dB re 1μPa (rms). A maximum total of 30 samples would be obtain using these devices and require approximately one hour per sample. Therefore, the pinger would operate a total of 30 hours.

Passive Instruments - During the seismic survey in the Dumont d'Urville Sea, a precession magnetometer and Air-Sea gravity meter would be deployed. In addition, 24 expendable bathythermographs (XBTs) would also be released (and not recovered) over the course of the

cruise to obtain temperature data necessary to calculate sound velocity profiles used by the multi-beam sonar.

Core and Dredge Sampling

The primary sampling goals involve the acquisition of marine sediment cores of various lengths up to 25 m. It is anticipated that up to 65 sediment cores and grab samples and 12 rock dredge samples would be collected as summarized in Table 3. All cores and dredges would be deployed using a steel cable/winch system.

Approximately 75 m^2 of seafloor would be disturbed by each of four deployments of the dredge at three different sites (resulting in a total of 900 m^2 of affected seafloor for the project). The selection of the bottom sampling locations and sampling method would be based on observations of the seafloor, subsurface reflectivity, sediment type, and accessibility due to ice and weather conditions. Bottom sampling in the MG area would be limited to strategically selected locations including possible re-sampling at a previous core site.

An acoustic locator (pinger) may be deployed when using the Smith- McIntyre grab sampler and multi-corer (Mega-corer) to enable these devices to be located in the event they become detached from their lines. A pinger typically operates at a frequency of 12 kHz, generates a 5 ms pulse per second, and has an acoustical output of 162 dB re 1μPa (rms). A maximum total of 30 samples would be obtain using these devices and require approximately one hour per sample. Therefore, the pinger would operate a total of 30 hours.

Table 3. Proposed Coring and Dredging activities in the Dumont d'Urville Sea

Sampling Device	No. of Deployments
Smith−McIntyre grab sampler	10-15
Multi−corer (Mega-corer)	10-15
Kasten corer (regular or jumbo)	20-25
Jumbo piston corer	8-10
Box cage dredge	10-12

Limited sampling of rock material would be conducted using a dredge that would be towed along the seafloor for short distances (~50 m) to collect samples of bedrock and ice rafted debris. The available dredges, which have openings of 0.5 to 1.5 m, would be deployed on rocky substrates. The locations of the proposed dredge sites are limited to the inner shelf (southern) perimeter of three areas: the Mertz Trough and two regions along the Sabrina Coast. Final selection of dredge sites will include review to ensure that the seamounts or corals in the area are avoided (AOA, 2011).

CCAMLR has adopted conservation measures (22-06, 22-07, and 22-09) to protect vulnerable marine ecosystems (VME), which include seamounts, hydrothermal vents, cold water corals and sponge fields. The conservation measure 22-07 includes mitigation and reporting requirements if VME are encountered. The science team would follow these requirements (Attachment C) if VMEs are encountered while sampling the sea bottom.

In addition, a camera and towed video system would be deployed at up to 25 sites. This device would lightly touch the seafloor to establish baseline and rise to an optimum elevation to obtain the desired images.

Water Sampling and Current Measurements

High-resolution CTD measurements would be collected to characterize the summer regional water mass stratification and circulation, and the meridional exchange of waters between the oceanic and shelf regimes. These physical measurements would involve approximately 120 SeaBird CTD system casts including the use of a lowered ADCP (LADCP).

The LADCP would consist of two Teledyne RDI Workhorse Monitor ADCPs mounted on the CTD/Rosette frame with one oriented upward and the other downward. The LADCP and frame would be raised and lowered by cable and winch. The LADCPs would operate at a frequency of 307.2kHz, with an estimated output acoustic pressure along each of 4 beams of 216.3dB re 1 micro-Pascal @ 1 meter. The beams are angled at 20 degrees from the centerline of the ADCP head, with a beam angle of 4 degrees for the individual beams. Typical pulse duration is 5.7 milliseconds, with a typical repetition rate of 1.75 seconds. The upward and downward-looking ADCPs are operated in master-slave mode so that only one head pings at a time. The LADCP would be operated approximately one hour at every CTD/rosette station (maximum of 100 stations) for a total of 100 hours of operation.

These instruments would be used to profile the full water column for temperature, salinity (conductivity), dissolved oxygen and currents at a series of transects in the study area. Discrete water samples would be collected for salinity and dissolved oxygen to monitor CTD/rosette performance, and for oxygen isotopes ($\delta O18$) to assess meltwater content. Water samples would also be collected for development and interpretation of marine sediment proxies using Niskin bottles.

Observations of the thermal structure along other portions of the cruise track would be made using an underway CTD system and XBTs while the sea floor is swath-mapped. The number and spacing of stations would be adjusted according to ocean features discovered through multibeam swath mapping and the sea ice conditions. If portions of the study area are inaccessible to the NBP, a contingency sampling focused on the inflows of MCDW would be pursued in adjacent shelf troughs.

It is noted that the underway ADCP on the NBP can, under ideal conditions, obtain profiles of ocean currents to depths greater than 800 m. On continental shelves where depths may be less than the range of the ADCP, the underway profiles cannot resolve the deepest 15% of the water column due to side lobe reflections from the bottom which contaminate the water column Doppler returns. For a depth of 800 m, expected in the MCDW, currents in the lower 120 m could not be measured by the ship ADCP; therefore, the lowered ADCP can provide accurate current profiles to within a few meters of the bottom and provide complete coverage of the velocity field at each CTD station.

Instrumentation Moorings

Four instrumented moorings would be deployed during the cruise. Two of the moorings would be deployed for approximately one month (short-term moorings) and two moorings would be deployed for approximately one year (long-term moorings) The two short-term moorings and one long-term mooring would include Acoustic Doppler Current Profilers (ADCP) paired with CTD recorders, and additional intermediate T (temperature) recorders. The characteristics of the ADCP units deployed on the moorings are similar to the Teledyne VM-150; the moored ADCPs operate at frequencies of 75 kHz (one unit) and 300 kHz (two units). The fourth mooring would be equipped with sediment traps, a CTD recorder and intermediate T recorders, and be deployed for approximately one year (long-term mooring). The two long-term moorings would be retrieved approximately one year later by a USAP vessel or collaborators from other countries.

Subject to sea ice conditions, these moorings would preferably be placed in front of Totten Glacier (TG), but otherwise as close as possible inside adjacent cross-shelf troughs. If access to the inner shelf is not allowed by sea ice conditions we would attempt mooring deployments within the outer shelf close to the troughs mouth, where the TG is more directly connected to inflows from the oceanic domain offshore. The two long-term moorings would be deployed within 16 km of each other. The short-term moorings would be within a few kilometers of each other and no farther than 32 km from the long-term moorings. All instruments would be kept at depths below 250 m to minimize damage or loss by icebergs.

The mooring recovery process would be similar regardless of mooring type or when they would be retrieved. Locating the moorings and releasing the moorings from the steel railroad wheel anchors (which would not be recovered) would be accomplished by transmitting sound over a period of several seconds. This is done with an acoustic deck command unit that sends a sequence of coded pulses to the receiving units, the acoustic releases, connected to the mooring anchors. The acoustic releases response to acknowledge the receipt of commands from the deck unit is by transmitting a short sequence of pulses back. Both of the acoustic units (onboard deck unit and moored releases) operate at frequencies between approximately 7 and 15 kHz. The beam pattern is approximately omnidirectional. The acoustic source level is < 192 dB rel 1micropascal at 1 m.

In addition to the U.S. moorings described above, three new moorings would be deployed on behalf of Australia's national science agency the *Commonwealth Scientific and Industrial Research Organisation* (CSIRO)_ Physical Oceanography group in the Totten Glacier region by the project team. These moorings would be retrieved approximately one year later by collaborators from other countries. Also during this cruise, three CSIRO moorings that were deployed over a year ago in the western outlet of the Mertz-Ninnis Trough would be recovered. The recovery process and acoustic sources described above for the U.S. moorings would be used for recovery of the CSIRO moorings.

3.0 TYPE AND ABUNDANCE OF MARINE MAMMALS IN PROJECT AREA

NOAA NMFS Requirement: The species and numbers of marine mammals likely to be found within the activity area

3.1 Number of Animals

The Final PEIS examines the potential impacts that may result from geophysical exploration and scientific research using seismic surveys that are funded by NSF or conducted by the USGS. Due to the potential for NSF-funded marine seismic cruises to occur across the world's oceans, it was necessary to narrow the focus of the impact analysis presented in the PEIS to a number of representative or exemplary analysis areas. In this regard, 13 exemplary (representative) analysis areas were proposed for analysis within the PEIS, including 5 areas with detailed analyses [Detailed Analysis Areas (DAAs)] and 8 subject to qualitative analysis [Qualitative Analysis Areas (QAAs)]. One of the QAAs was designated the Sub-Antarctic and is particularly relevant to the proposed action described in this request for IHA.

Functionally, this document will use the environmental setting and impact assessment data presented in the PEIS for the Sub-Antarctic QAA as a basis for the evaluation. A conservative assumption is made that the species present in the Sub-Antarctic QAA may seasonally migrate to higher latitude areas along the East Antarctic Coast and be present during the proposed marine seismic research activities. In addition, historical sightings data from previous cruises in the proposed study areas will be used to augment the Sub-Antarctic QAA data and provide semi-quantitative estimates of species population density.

The Dumont d'Urville Sea is a feeding ground for a variety of marine mammals, including pinnipeds (seals) and cetaceans (whales) including baleen (mysticetes) and toothed whales (odontocetes). Six species of seals that are found in the Southern Ocean and which may be present in the study areas include the crabeater, leopard, Weddell, Ross, elephant, and Antarctic fur seals. Seal species breed on either the pack ice or sub-Antarctic Islands. A cross-reference of species names to common names appears in Attachment A.

Table 4 identifies the whale species that may occur in the sub-Antarctic area, defined as the region between 42°S and 60°S (NSF, 2011) and therefore may be present in the proposed study areas. However, it is noted that several of these species may not be encountered below 60°S latitude. Many of these whale species such as fin or sperm whales are capable of diving to great depths (>1,000 m) and remaining underwater for more than 30 minutes. Some species, particularly Minke and killer whales, are expected to be present at higher concentrations along the ice edge (SCAR, 2002). In general, most species except for the killer whale migrate north in the middle of the austral winter and return to Antarctica in the early austral summer.

Table 4. Cetacean Species Identified in the PEIS Sub-Antarctic Area

Species	Potential Occurrence (austral summer)
Mysticetes	
Southern right whale	F u
Pygmy right whale	F u-c
Humpback whale	M r
Minke whale	F c

Table 4. Cetacean Species Identified in the PEIS Sub-Antarctic Area

Species	Potential Occurrence (austral summer)
Dwarf minke whale subsp.	F r?
Antarctic minke whale	M r
Bryde's	F c
Sei whale	F c
Fin whale	M u
Blue whale	M u
Pygmy blue whale subsp.	F u
Odontocetes	
Sperm whale	BF c
Pygmy and dwarf sperm whales	F c [2]
Beaked whales	F u [1]
Shepherd's beaked whale	F u
Cuvier's beaked whale	F c
Longman's beaked whale	-
Beaked whales	B? F r-u-c [7]
Bottlenose whales	F c
Killer whale	F c
False killer whale	F c
Pygmy killer whale	F c
Melon-headed whale	-
Pilot whales	F c [2]
Irrawaddy (snubfin) dolphin	-
Risso's dolphin	F u
Common dolphins	F r [1]
Fraser's dolphin	-
Indo-Pacific humpbacked dolphin	-
Tucuxi	-
Bottlenose dolphins	B? F c [1]
Dolphins (5 Stenella spp.)	F c [3]
Dolphins (6 Lagenorhynchus spp.)	F u [1]
Rough-toothed dolphin	-
Right whale dolphins	F na
Finless porpoise	-
Porpoises	B? F r [1]

Note: [ ] = number of species found. **B** = known to breed or calve within the area/season; **F** = known to feed within the area/season; **M** = known to migrate through the area/season; **?** = unknown / possible; **a** = abundant: the species is expected to be encountered during a single visit to the area and the number of individuals encountered during an average visit may be as many as hundreds or more; **c** = common: the species is expected to be encountered once or more during 2-3 visits to the area, and the number of individuals encountered during an average visit is unlikely to be more than a few 10s; **u** = uncommon: the species is expected to be encountered at most a few times a year during

the season assuming many visits to the area; **r** = rare: the species is not expected to be encountered more than once in several years during the relevant season; **na** = reliable data not available or uncertain or species status was not assessed; - = species does not occur. Table reproduced from the PEIS.
Sources: NSF 2011.

As a secondary check to the species identified in Table 4, various national Antarctic research programs along the coast of East Antarctic have conducted scientific cruises that included data on marine mammal sightings. These observations were made primarily between 30°E and 170°E longitude and north to 60°S. The reported cetacean sightings are summarized in Tables 5 through 7 and compare favorably with the occurrence data presented in Table 4. Because these data represent observations made over multiple cruises by different parties, were collected over a broad period of time and were extracted from several databases, some data may overlap.

For pinnipeds, observations made during a scientific cruise over a 13-day period in East Antarctica are summarized in Table 8. These observations were made below 60°S and between 110°E to 165°E and include sightings of individual animals in the water as well as individuals that were hauled out (i.e., resting on the surface of the sea ice).

Table 5. Cetaceans Observed in the Southern Ocean in Proximity to the Proposed Study Areas (July 1995 - November 2004)

Common Name	No. of Animals
Minke whale	393
Blue whale	26
Fin whale	70
Arnoux's beaked whale	6
Dolphin (unidentified)	9
Southern right whale	8
Long-finned pilot whale	19
Southern Bottlenose whale	13
Dusky dolphin	2
Hourglass dolphin	27
Southern Right whale dolphin	4
Humpback whale	308
Baleen whale (unidentified)	4
Killer whale	101
Sperm whale	92
Bottlenose dolphin	3

Source: GBIF, OBIS, SCAR-MarBIN and through the AADC web site

Table 6. Cetaceans Observed in the Southern Ocean in Proximity to the Proposed Study Areas (February 1991 – March 1997)

Common Name	No. of Animals
Minke whale	73
Sei whale	2

Table 6. Cetaceans Observed in the Southern Ocean in Proximity to the Proposed Study Areas (February 1991 – March 1997)

Common Name	No. of Animals
Southern right whale	2
Long-finned pilot whale	7
Southern bottlenose whale	1
Hourglass dolphin	2
Humpback whale	8
Baleen whale (unidentified)	1
Killer whale	14
Sperm whale	3

Source: ANARE-From SCAR-MarBIN

Table 7. Cetaceans Observed in the Southern Ocean in Proximity to the Proposed Study Areas (52-day period, January – March 2006)

Common Name	No. of Animals
Minke whale	114
Sei whale	3
Blue whale	2
Fin whale	195
Dolphin (unidentified)	13
Long-finned pilot whale	20
Hourglass dolphin	20
Humpback whale	200
Whale (unidentified)	116
Killer whale	52
Sperm whale	27

Source: AAD BROKE-West Survey

Table 8. Pinnipeds Observed in the Southern Ocean in Proximity to the Proposed Study Areas (December 1999)

Species	Reported Sightings [1]
Crabeater	2220
Leopard	17
Ross	42
Weddell	0
Elephant	0
Antarctic Fur	0

Note: [1] Sightings 12/3-12/16/99 (312 hours) below 60°S between 110°E to 165°E.
Source: Australian Antarctic Data Centre, May 2013, https://data.aad.gov.au/aadc/biodiversity/

3.2 Endangered Species

Marine organisms inhabiting the Southern Ocean are included in the International Union for Conservation of Nature (IUCN) Red List, a comprehensive inventory of the global status of plant and animal species. The Red List uses established criteria to evaluate the extinction risk of thousands of species and subspecies. Table 9 identifies the status of species in the Southern Ocean including blue, fin, and sei whales which are identified as endangered.

Table 9. IUCN Red List and CITES Species – Southern Ocean

Common Name(s)	Red List Category	CITES
Emperor penguin	NT ver 3.1 (2012)	
King penguin	LC ver 3.1 (2012)	
Antarctic fur seal, Kerguelen fur seal	LC ver 3.1 (2008)	App II
Antarctic minke whale	DD ver 3.1 (2008)	App I
Sei whale	EN A1d ver 3.1 (2008)	
Blue whale, sibbald's rorqual, sulphur-bottom whale	EN A1d ver 3.1 (2008)	App I
Common rorqual, fin whale, fin-backed whale, finback, finner, herring whale, razorback	EN A1d ver 3.1 (2008)	App I
Arnoux's beaked whale	DD ver 3.1 (2008)	App I
Pygmy right whale	DD ver 3.1 (2008)	
Commerson's dolphin	DD ver 3.1 (2008)	
Southern right whale	LC ver 3.1 (2008)	App I
Long-finned pilot whale	DD ver 3.1 (2008)	
Leopard seal	LC ver 3.1 (2008)	
Flatheaded bottlenose whale, southern bottlenose whale	LC ver 3.1 (2008)	
Hourglass dolphin	LC ver 3.1 (2008)	App I
Weddell seal	LC ver 3.1 (2008)	
Southern right whale dolphin	DD ver 3.1 (2008)	App I
Crabeater seal	LC ver 3.1 (2008)	
Humpback whale	LC ver 3.1 (2008)	App I
Gray's beaked whale, southern beaked whale	DD ver 3.1 (2008)	
Layard's beaked whale, strap-toothed whale	DD ver 3.1 (2008)	
Southern elephant seal	LC ver 3.1 (2008)	App II
Ross seal	LC ver 3.1 (2008)	
Killer whale, orca	DD ver 3.1 (2008)	App I
Spectacled porpoise	DD ver 3.1 (2008)	
Sperm whale	VU A1d ver 3.1 (2008)	
Adelie penguin	NT ver 3.1 (2012)	
Chinstrap penguin	LC ver 3.1 (2012)	
Gentoo penguin	NT ver 3.1 (2012)	

Note: IUCN Red List Categories: EX - Extinct, **EW** - Extinct in the Wild, **CR** - Critically Endangered, **EN** - Endangered, **VU** - Vulnerable, **LR/cd** - Lower Risk/conservation dependent, **NT** - Near Threatened (includes **LR/nt** - Lower Risk/near threatened), **DD** - Data Deficient, **LC** - **Least** Concern (includes LR/lc - Lower Risk, least concern); **CITES** = Convention on International Trade in Endangered Species of Wild Fauna and Flora (www.cites.org); **APP** – Appendix I or II

CITES is an international agreement between governments, whose purpose is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Roughly 5,000 species of animals and 29,000 species of plants are protected by CITES against over-exploitation through international trade. They are listed in the three CITES Appendices, with data compiled and provided by the UNEP World Conservation Monitoring Centre. Table 9 also indicates those species that are included in one of the CITES Appendices.

The National Marine Fisheries Service (NMFS) is responsible for listing marine species under the Endangered Species Act (ESA) and implementing conservation and recovery efforts under its Protected Resource Program. The ESA listings include species inhabiting the Southern Ocean around Antarctica. The seismic survey, as a proposed Federal action funded by NSF, has the potential to affect these species. Table 10 identifies the ESA-listed species that may be present during the proposed action, including in the study areas and transit to and from the study areas.

Table 10. Status of ESA-listed Species Found in the Southern Ocean

ESA-listed Species	Year Listed	Status	Critical Habitat	Recovery Plan
Cetaceans				
Blue whale	1970	E	n/a	final
Fin whale	1970	E	n/a	final
Humpback whale	1970	E	n/a	final
Sei whale	1970	E	n/a	final
Southern right whale	1970	E (F)	n/a	n/a
Sperm whale	1970	E	n/a	final
Pinnipeds				
None identified in the study area				
Sea Turtles				
None identified in the study area; expected to be present in the transit to and from the study area.				

Note: E = endangered; **F**= foreign species that occur entirely outside of U.S. territory; Critical habitat and recovery plans are not required for foreign species; critical habitat is also not required for species listed prior to the 1978 ESA amendments that added critical habitat provisions.
Source: NOAA Fisheries, April 2013. NSF consulted the published FWS listing of foreign species and noted that no Antarctic species are on the list http://ecos.fws.gov/tess_public/SpeciesReport.do?lead=10&listingType=L

3.3 Protected Area Status

Two areas in the Dumont d'Urville Sea are under consideration as designated Marine Protected Areas (MPAs) and, if adopted, will be managed by the Commission for the Conservation of

Antarctic Marine Living Resources (CCAMLR). The areas contain distinctive deep-water flora and fauna and support important ecosystem roles, such as feeding areas for marine mammals, penguins and other seabirds. These proposed MPAs are being developed by Australia, France, and the European Union for the purpose of protecting the resources and biodiversity of the East Antarctic region. The two planned MPAs encompass both of the research areas for the proposed action including the Wilkes Subregion MPA (from 110°E to 137°E) and the Oates Region MPA (from 137°E to 150°E). It is anticipated that the MPAs may be designated as early as October 2014.

4.0 DESCRIPTION OF MARINE MAMMALS IN PROJECT AREA

NOAA NMFS Requirement: A description of the status, distribution, and seasonal distribution of the affected species or stocks of marine mammals likely to be affected by such activities.

4.1 Pinnipeds

There are six species of seals that live in the Southern Ocean. These six species belong to two families. The first family is called the Phocidae, or true seals, of which there are five Antarctic species: the crabeater, leopard, Weddell, Ross, and elephant seals. The second family is Otariidae, or eared seals, which includes the Antarctic fur seal. The following general information on the six species was derived from information prepared by the Antarctic and Southern Ocean Coalition (ASOC, 2013).

Crabeater Seals

Crabeater seals are found throughout Antarctica, but are almost never spotted on land because they breed and rest on pack ice. Crabeaters account for over half of the world's seal population; worldwide population estimates range up to forty million. Crabeater is actually a misnomer; 90% of this seal's diet is krill. Female crabeaters can reach eight feet (two and a half meters) and weigh 500 pounds (225 kg) but males are smaller.

Leopard Seals

The leopard seal's name comes from their spotted coat. Leopard seals hunt and travel alone on the northern edge of the pack ice and move north to the Sub-Antarctic islands in the winter. Population estimates range between 220,000 and 440,000. The strong jaws and highly developed teeth of leopard seals allow them to feed on krill, crabeater pups, and penguins. Larger than crabeaters, female leopard seals measure about eleven and a half feet (nearly three meters) and weigh on average 1,200 pounds (540 kilos). Males are smaller.

Ross Seals

Ross seals are considered the rarest of the Antarctic seals and are the least documented because they are spotted infrequently. With population estimates at 20,000 members Ross seals have a short snout, big eyes, long flippers, and hooked teeth. They breed on the pack ice in the summer, and feed on squid, fish, and krill. They are the smallest of the five species of true seals in the Antarctic. The females grow to seven feet (slightly more than two meters) and weigh 400 pounds (185 kg). The males are slightly smaller.

Weddell Seals

Approximately 800,000 Weddell seals live in Antarctica. The range for Weddell seals is further south than the rest of the Antarctic seals. Since they do not migrate north, Weddell seals live under the vast coating of sea ice during the coldest months, keeping breathing holes open with their teeth. Ironically, they suffer shortened lives due to damage sustained by their teeth and gums. Weddell seals can remain underwater for more than one hour, diving to 2000 feet (600 m). Weddell seals use sonar to hunt and navigate and feed on fish, krill, and squid. The females can grow longer than ten feet (over three meters) and weigh nearly 1000 pounds (450 kg).

Elephant Seals

Their name comes from their size and from the males' inflatable nose, or "trunk." There are about 500,000 elephant seals that spend most of their time at sea feeding on squid and fish, but in September they come ashore to breed in three large groups in the Sub-Antarctic Islands. Elephant seals are fiercely territorial. The males use their inflatable nose during breeding, to stake out claims and intimidate other males by erupting into resonating bellows. Male elephant seals often scar each other violently during breeding season, and they also scar the females' necks during intercourse. The largest of all the Antarctic seals, elephant seals can weigh up to 7,900 pounds (3600 kg) and grow to a length of fifteen feet (four and a half meters). Females are much smaller, at about one ton (900 kg) and nine feet (2.8 m).

Antarctic Fur Seal

The sole Antarctic representative of the Otariids is the Antarctic fur seal. Its coat consists of two layers of fur - a coarse outer layer and a fine inner layer – which provides insulation in lieu of thick blubber. Fur seals also have exposed flippers to provide temperature regulation. Population estimates range from 1.4 million to 4 million. Antarctic fur seals breed on the Sub-Antarctic Islands, returning to the same place each year. During breeding seasons, the territorial males can inflict fierce wounds upon one another. Fur seals survive on krill, fish, squid, and the occasional bird. Males are larger than females and can grow to six and a half feet long (two meters), and weigh 200-250 pounds (90-110 kg).

4.2 Cetaceans

Mysticetes

The following information is derived from the PEIS and identifies characteristics of mysticetes species found in the sub-Antarctic area which may also feed and/or migrate to the Southern Ocean during the austral summer.

Southern Right Whale

Small numbers of feeding southern right whales could be present in the Southern Ocean during the austral summer. Summer feeding grounds have not been fully characterized for this species, but could potentially include this area based on the latitude of known feeding areas in the southern hemisphere. Historic whaling data suggest that this species migrates south past New Zealand during the austral spring, arriving in feeding waters near approximately 40°S 140°W by

November and December. Southern right whales have been observed moving south and east from the Kermadec Islands beginning in November, continuing across 40°S, and reaching 50°S in January. The migration followed the line of the Louisville Ridge, where the whales may have fed on copepod and krill populations stimulated by upwelling from the ridge.

Pygmy Right Whale

Pygmy right whales are not well described and their feeding, breeding, and migration strategies are largely unknown. They are known to inhabit coastal and pelagic waters in the southern hemisphere between 30°S and 55°S. They are rarely seen at sea, but one group was seen in oceanic waters. As the reported distribution of this subspecies overlaps the Southern Ocean, some pygmy right whales might also be encountered during a survey there.

Humpback Whale

Southern hemisphere humpback whales typically feed near 60°S during austral summer (December-March). However, a small number of late- or early-migrating whales may pass further south of the area during early or late austral summer based on the species typical migration patterns. Animals using this region are likely part of the Area V stock that breeds in and around French Polynesia, the Cook Islands, and Tonga. Humpbacks that winter off New Caledonia and Tonga are estimated to number only in the few hundreds.

Blue Whale

Blue whales arrive in the Antarctic feeding grounds each austral summer, and some probably migrate pass 60^0 S during early austral summer (October-November). Visual and acoustic surveys conducted by the IWC in Antarctic waters recorded 710 blue whale calls in January and 2559 calls in February 2002. Blue whales begin migrating north out of the Antarctic to winter breeding grounds earlier than fin and sei whales.

Fin Whale

Fin whales likely migrate south beyond 60^0 S during early to mid-austral summer, arriving on more southern feeding grounds after blue whales. The distribution of fin whales during the austral summer ranges from 40 to 60^0 S in the southern Indian and South Atlantic oceans and 50 to 65^0 S in the South Pacific. The New Zealand stock summers from 170^0 E to 145^0 W. Fin whales migrate north before the end of austral summer toward breeding grounds in and around the Fiji Sea.

Sei Whale

Sei whales are mysticete whales that arrive in the Southern Ocean during the austral summer. Their main summer feeding concentration occurs between 40^0 and 50^0 S.

Antarctic Minke Whale

These whales begin their southern migration from breeding grounds in the north in November (austral spring) and arrive in Antarctic feeding grounds by early summer (January). A few are

probably still migrating south through the analysis area in early summer. By February, some begin migrating north.

Bryde's, Dwarf Minke, and Pygmy Blue Whales

The Bryde's, dwarf minke, and pygmy blue whales typically do not migrate as far south as other baleen whales in the southern hemisphere. However, these species may migrate south sufficiently to feed in areas around 60^0 S during the austral summer. Relatively little is known about the abundance or specific distribution of these species. Bryde's whales, given their general abundance, are the most likely to be present in the study areas, with denser concentrations to the northeast and northwest. The dwarf minke whale's range, although not well defined, covers 11^0 to 65^0 S, overlapping that of the Antarctic minke. Pygmy blue whales have a more northerly distribution than true blue whales and their total population size is believed to be low.

Odontocetes

Analogous to the previous descriptions of mysticete species in the PEIS sub-Antarctic area, the following is also derived from the PEIS sub-Antarctic QAA and provides general information on odontocetes that may feed or migrate to the Southern Ocean during the austral summer and may be present during the proposed action.

Sperm Whales

Sperm whales, consisting of solitary males and mixed sex/age classes, are likely to occur in the Southern Ocean during the austral summer. Young calves could also be present during summer. A single group of four sperm whales was sighted in February 2005 during an NSF-funded SIO academic seismic survey in the southwest Pacific Ocean. Female and immature sperm whales generally occur at tropical and temperate latitudes of 50^0 N to 50^0 S, while solitary adult males are found to 75^0 N and 75^0 S. Home ranges of individual females span distances of up to 620 mi (1,000 km); however, some females travel several thousand miles across large parts of an ocean basin. Sperm whales generally occur in waters >590 ft. (180 m) deep; waters in the sub-Antarctic to the Antarctic coastal shelf are >3,280 ft. (1,000 m) deep.

Pygmy Dwarf Sperm Whales

Pygmy and dwarf sperm whales may be present in the sub-Antarctic but are rarely sighted at sea due to avoidance of vessels, inconspicuous surfacing, and logging (lying still at the water surface) behaviors. Their distribution in more temperate regions of the Southern Ocean is mostly known from strandings. The pygmy sperm whale is a frequently stranded cetacean species in New Zealand (Brabyn, 1991).

Killer Whales

Orca, or killer whales, found from tropical oceans to pack ice in both hemispheres. In the Antarctic, they feed on seals and penguins.

Long-finned Pilot Whales

Millions of long-finned pilot whales are found throughout the mid-latitude waters of the North Atlantic and Southern hemisphere. They are pelagic; feeding on squid and some fish.

Hourglass Dolphins

Hourglass dolphins are found throughout the southern hemisphere, south of 45^0S, feeding at high latitudes in summer, exploiting biologically productive areas.

Spectacled Porpoises

Spectacled porpoises are rare throughout their range, and are found in deep oceanic waters. They are known to be circumpolar in their range, in colder temperate to Antarctic waters.

Beaked Whales

Ten species of beaked whales are typically present in the sub-Antarctic area and may also be encountered in the Southern Ocean, including Arnoux's, Cuvier's, Shepherd's, Andrew's, Blainville's, Gray's, and Hector's beaked whales, as well as ginkgo-toothed, strap-toothed, and spade-toothed whales.

Arnoux's beaked whales feed primarily on deep-water bottom fish. They have been sighted in waters near New Zealand and Antarctica during January-March. Cuvier's and Blainville's beaked whales have been recently sighted near French Polynesia and the Cook Islands. Shepherd's beaked whale and the *Mesoplodon* species are known primarily from strandings. Most mesoplodonts are thought to be rare, with the exception of Gray's beaked whales, strap-toothed whales, and Blainville's beaked whales, which appear to be widespread and fairly common based on stranding records.

5.0 REQUESTED TYPE OF INCIDENTAL TAKE AUTHORIZATION

NOAA NMFS Requirement: The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

The NSF Division of Polar Programs (PLR) requests an IHA pursuant to Section 101(a)(5)(D) of the MMPA for incidental take by harassment during its planned seismic survey in the Dumont d'Urville Sea off the coast of East Antarctica during a 45-day cruise in 2014.

Some of the research activities described in Section 1 may have the potential to "take" marine mammals by harassment. Takes by harassment may result when marine mammals near the activities are exposed and behaviorally disturbed by pulsed sounds generated from acoustic sources, mainly airguns, during seismic surveying. The potential impacts may depend on the species of marine mammal, the behavior of the animal at the time of exposure to the acoustic release, the received sound level (see Section 7), and the environmental conditions present in the proposed study areas such as sea ice. Marine mammals in the general vicinity of the seismic surveying source tracklines may display disturbance reactions to the airguns (Level B Harassment). No takes by serious injury (Level A) are anticipated, given the nature of the planned operations, the use of low-energy sources, and implementation of related mitigation measures (see Section 11). No lethal takes (Level A) are expected.

6.0 NUMBER OF INCIDENTAL TAKES BY ACTIVITY

NOAA NMFS Requirement: **By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in paragraph (a)(5) of this section, and the number of times such takings by each type of taking are likely to occur**

Detailed data characterizing the age, sex, and reproductive condition for marine mammals in the Southern Ocean is not available. Due to the use of low-energy acoustic sources, all potential takes due to the proposed action would be anticipated to be "takes by harassment", involving temporary changes in behavior. The mitigation measures to be applied (see Section 11) would further minimize the possibility of injurious takes. The following describes methods to estimate the number of potential exposures to various received sound levels and present estimates of the numbers of marine mammals that could be affected during the proposed seismic survey. The estimates are based on a consideration of the type and number of animals present in the sea along the East Antarctic coast during the austral summer based on previously reported sightings. The projected density was calculated from sightings data which took place over a reported period of time. There are no stock assessments and very limited population information for this area.

The lack of population data is furthered acknowledged in the NMFS recovery plans for several endangered (blue, fin, sei whales). The lack of abundance estimates and population trend data for marine mammals in the southern hemisphere including animals which are not threatened hinders traditional quantitative analysis of potentially affected organisms.

It should be noted that critical habitat and recovery plans are not required for foreign species and critical habitat is not required for species listed prior to the 1978 ESA amendments that included those provisions. The marine mammals inhabiting the Antarctic are considered foreign species by the Fish and Wildlife Service (FWS). NSF consulted the published FWS listing of foreign species and noted that no Antarctic species are on the list.

Potential Number of Marine Mammals Exposed

The number of different individuals that could be exposed to airgun sounds on one or more occasions was estimated by considering the total number and frequency of sightings expected during the 300-hour seismic survey and conservatively assuming all animals sighted within 600 or 1005 m depending on the airgun array used would be exposed to sound levels ≥160 dB re 1 μPa (rms) resulting in Level B Harassment. The 600 and 1005 m radii are based on acoustic modeling data for the airguns that may be used during the proposed action (Attachment B).

As summarized in Table 11, the modeling results for the proposed low-energy airguns indicate the received sound levels are dependent on the water depth. Since a majority of the proposed seismic survey would be conducted in waters 100 – 1,000 m deep, the Full Mitigation Zone (FMZ) criteria of 600 and 1,005 m would be used for the 2 x 45 in^3 or 2 x 105 in^3 GI guns, respectively, even if the survey intermittently entered waters deeper than 1,000 m.

Table 11. Proposed Mitigation Zone (MZ) and Full Mitigation Zone (FMZ) for the Seismic Survey

Source and volume	Water depth	Predicted RMS radii (m) based on modeling and empirical measurements			Proposed MZ and FMZ based on modeling/empirical measurements and the PEIS	
		190 dB	180 dB	160 dB	MZ (190/180 dB)	FMZ (160 dB) [1]
2 x 45 in^3 GI guns	>1000 m	10	40	400	100/100	400
	100–1000 m	15	60	600	100/100	600
	<100 m [2]	147	296	1176	147/296	1176
2 x 105 in^3 GI guns	>1000 m	20	69	670	100/100	670
	100-1000 m	30	104	1005	100/100	1005
	<100 m [2]	294	511	1970	294/511	1970

Note:
[1] The FMZ for the proposed seismic survey would be based on the 100 - 1,000 m deep criteria; the survey would not extend to water >100 m deep.
[2] The predicted RMS radii and proposed MZ and FMZ in water >100 m deep are included for reference purposes only.

Table 12 summarizes the estimated frequency and number of cetaceans that would be exposed during the 300-hr seismic survey, based upon sightings data from a previous research cruise over a 52-day period (Table 7). Since the sightings data which was used as the basis for the take estimates included "unidentified whale", this category was retained for the estimate of takes because environmental conditions may be present during the proposed action to limit identification of observed cetaceans. Relatedly, the estimated frequency of sightings data incorporates a correction factor of 5 that assumes only 20% of the animals present were reported due to sea ice and other conditions that may have hindered observation.

Table 12. Projected Number and Frequency of Cetacean Encounters in the Proposed Study Areas

Common Name	Reported Sightings AAD BROKE-West Survey 52-Day Period (1,248 hr)	Corrected Sightings (assume only 20% reported) [1]	Estimated Frequency of Sightings (no/hr)	Expected Sightings during the 300-hr Seismic Survey	Number of Estimated Takes and Requested Authorization [2]
Mysticetes [3]					
Blue whale	2	12	0.0095	2.9	3
Fin whale	232	1160	0.9276	278	278
Humpback whale	238	1189	0.9514	285	285
Minke whale	136	678	0.5423	163	163
Sei whale	4	18	0.0143	4	4
Odontocetes [3]					
Dolphin, Cruciger (hourglass)	27	135	0.1080	32	32

Table 12. Projected Number and Frequency of Cetacean Encounters in the Proposed Study Areas

Common Name	Reported Sightings AAD BROKE-West Survey 52-Day Period (1,248 hr)	Corrected Sightings (assume only 20% reported) [1]	Estimated Frequency of Sightings (no/hr)	Expected Sightings during the 300-hr Seismic Survey	Number of Estimated Takes and Requested Authorization [2]
Spectacled porpoise[4]	26	130	0.1040	31	31
Killer whale	62	309	0.2474	74	74
Long-finned pilot whale	24	119	0.0951	29	29
Sperm whale	32	161	0.1284	39	39

Note:
[1] Sightings data accounts for all individuals observed in groups; the corrected sightings assumes 20% of all animals present will be observed and reported;
[2] For cetaceans, conservatively assumes all sightings could result in Level B harassment;
[3] 116 unidentified whales, which could have been mysticetes and/or odontocetes were sighted and 13 unidentified dolphins. These unidentified animals were added to the observed species on a pro rated basis

[4] Reported sighting based on NOAA-NMFS recommendation.

While population density data for cetaceans in the Southern Ocean is sparse to nonexistent, reported sightings data from previous research cruises suggest cetaceans such as those identified in Table 12 span a range greater than 4,000 km off the coast of East Antarctica. As such, the estimated number of takes are likely to be a very small percentage of the population for each species and within the small number of takes definition in the MMPA.

For mysticetes species, auditory impairment or other non-auditory physical effects would be unlikely, and limited to exposures within short distances from the acoustic sources, since this group of whales typically avoid seismic vessels (Richardson et al. 1995). Level B disturbances may occur, but are not expected to result in long-term or significant consequences to disturbed individuals or their populations. No exposures resulting in injury or mortality are expected.

Odontocetes species display variable reactions to seismic surveys, but can be generally tolerant and show some disruption of foraging; therefore, short-term Level B exposures may occur. Injuries may occur at a received level from a single seismic pulse; however, similar to mysticetes, potential injuries (Level A exposures) are not likely due to behavioral avoidance.

Several of the cetacean species that may be taken during the proposed action including sei, fin, blue, humpback, and sperm whales are listed as Endangered (i.e., ESA). The number of possible exposures may include repeated exposures of the same individuals; however, these would be minimal over the short duration of the survey (300 hours over the entire cruise duration) and it is

unlikely that a particular animal would remain in the vicinity of the ship for the entire cruise. In addition, the monitoring and mitigating measures that would be used to protect endangered species during the seismic survey include immediately shutting down the airguns if an endangered species is observed in, or entering into the MZ (that would result in a Level A exposure).

Table 13 summarizes the estimated frequency and number of pinnipeds that would be exposed to underwater sounds during the 300-hr seismic survey, based on pinniped sightings data from a previous 13-day cruise (Table 8). The reported sightings data in Table 13 accounts for all individual animals that had hauled out of the water and were in groups. The expected sightings data incorporates a 40% correction factor to account for seals that may be in the water versus those hauled-out on ice surfaces. This correction factor was conservatively based on an estimate by Southwell et al (2012) that 20 to 40% of crabeater seals may be in the water in a particular area while the rest are hauled out. The correction factor takes into consideration some pinnipeds may not be observed due to poor visibility conditions.

Table 13. Projected Number and Frequency of Pinniped Encounters in the Proposed Study Areas

Species	Reported Sightings [1] (312 hours)	Estimated Fraction of Sighted Pinnipeds in the Water	Number of Pinnipeds in the Water	Estimated Frequency of Sightings (no/hr)	Expected Sightings during the 300-hr Seismic Survey	Number of Estimated Takes and Requested Authorization [2]
Crabeater	2220	40%	888	2.8462	853.86	
Leopard	17	40%	6	0.0218	6.54	
Ross	42	40%	16	0.0538	16.14	
Weddell[3]	302	40%	121	0.4033	1214	
Elephant[4]	0	40%	0	0.0000	0.00	
Antarctic Fur[4]	0	40%	0	0.0000	0.00	
					Total	1,037

Note:
[1] Sightings 12/3-12/16/99 (312 hours) below 60^0 S latitude between 110 to 165^0 E longitude. All sightings were animals hauled-out of the water and on the sea ice.
[2] Due to ice conditions and swimming characteristics, some seals in the water may be difficult or impossible to identify; as a result, the total number of takes (878) is not species specific.
[3] Reported sighting calculated from 0.054 animals/km^2 times anticipated survey distance and one km either side of the NBP (5600 km^2) over the 300 hours of proposed seismic surveying.
[4] A take was not requested for elephant seals and Antarctic fur seals because preferred habitat for these species is not within the project area.

While population density data for pinnipeds in the Southern Ocean is sparse, reported sightings data from previous research cruises suggest the pinnipeds identified in Table 13 span a large range greater than 4,000 km off the coast of East Antarctica. For example, Southwell, *et al.* (2008) estimated there may be more than 1 million crabeater seals in the Southern Ocean. As

such, the estimated number of takes are likely to be a very small percentage of the population for each species and within the small number of takes definition in the MMPA.

Of the six species of seals that may be present in the study area during the proposed action, only three species are expected to be observed during the proposed action, and mostly near pack ice or coastal areas and not prevalent in open sea areas where the seismic survey would be conducted. Because population density estimates for pinnipeds in the Antarctic regions typically represent individuals that have hauled-out of the water, those estimates are not representative of individuals that are in the water and could be potentially exposed to underwater sounds during the seismic survey activities. Based on the wide range distribution of pinnipeds in the South Ocean with over 1 million crabeater seals alone and the understanding that only animals in the water would be potentially affect by the seismic surveying activities, the estimated number of takes would affect significantly less than 20% of the local population for each pinniped species and would be within the small number of takes defined by the MMPA. The effects of exposure are expected to be limited to behavioral disturbance and, in some cases, localized avoidance of the area near the active airguns.

Possible Effects of Multibeam Echosounder and Sub-bottom Profiler Signals

It is assumed that, during simultaneous operations of the airgun array and the other sources, any marine mammals close enough to be affected by the MBES, SBP, pingers, and ADCPs would already be affected by the airguns. However, whether or not the airguns are operating simultaneously with the other sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to the MBES and SBP given their characteristics (e.g., narrow downward-directed beam) and other considerations described in Section 3.6.4.3, 3.7.4.3, and Appendix E of the PEIS. Similarly, the intermittent nature of ADCPs and pingers would, at most, result in short-term, localized behavioral changes. Such reactions are not considered to constitute “taking” (NMFS 2001). Therefore, no additional allowance is included for animals that could be affected by sound sources other than airguns.

Conclusions

The proposed seismic survey would involve towing an airgun array that introduces pulsed sounds into the ocean, along with simultaneous operation of an MBES and SBP and other transducer-based instruments. The survey would employ a 2-airgun array similar to the airgun arrays used for typical low-energy seismic surveys that were evaluated in the PEIS (NSF, 2011). The total airgun discharge volume would be ~90 in^3 or ~210 in^3 (~1,475 cm^3 or ~3,440 cm^3). Routine vessel operations, other than the proposed airgun operations, are conventionally assumed not to affect marine mammals sufficiently to constitute “taking”.

In Section 3.6.7 and 3.7.7, the PEIS concluded that low-energy airgun operations with implementation of the proposed monitoring and mitigation measures may result in a small number of Level B behavioral effects in some mysticete and odontocete species; that Level A effects were highly unlikely; and that operations were unlikely to adversely affect ESA-listed species. In this IHA Application, estimates of the numbers of marine mammals that could be exposed to low-energy airgun sounds during the proposed program have been presented, together with the requested “take authorization”. Because of the lack of quantitative population density data, sightings reported during previous research cruises and conservative correction factors were

used to estimate the number of takes. It is possible the estimated number of pinniped takes overestimates of the actual number of animals that would be exposed to and react to the seismic sounds because many pinnipeds may not be in the water and receptors or they leave the affected area when the disturbance is first recognized. The relatively short-term exposures that may occur would be unlikely to result in any long-term negative consequences for the individuals or their populations.

No "taking" of marine mammals is expected in association with echosounder or other transducer-based equipment operations given the considerations discussed in Section 3.6.4.3, 3.7.4.3, and Appendix E of the PEIS.

7.0 DESCRIPTION OF IMPACT ON MARINE MAMMALS

NOAA NMFS Requirement: The anticipated impact of the activity upon the species or stock of marine mammal.

Summary of Potential Effects of Airgun Sounds

A significant portion of the analysis for the potential effects of airgun sounds below was based on information contained in the Environmental Analysis of a Marine Geophysical Survey by the R/V Marcus G. Langseth on the mid-Atlantic Ridge, April–May 2013 prepared by LGL Ltd., (LGL, 2013).

The effects of sounds from airguns could include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Southall et al. 2007). Permanent hearing impairment (PTS), 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 project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. If marine mammals encounter the survey while it is underway, some behavioral disturbance could result, but this would be localized and short-term.

Tolerance

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 that 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 mammals of all three types have shown no overt reactions. The relative responsiveness of baleen and toothed whales are quite variable.

Masking

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data on this.

The proposed airguns for the seismic survey have dominant frequency components of 2-188 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 proportion 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), SBPs, pingers, and most of the MBESs, would likely be detectable by some mysticetes based on presumed mysticete hearing sensitivity. Odontocetes are presumably more sensitive to the mid- to high frequencies produced by the MBESs, SBPs, and pingers 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 PEIS.

Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. GI guns used in this survey are specifically designed to reduce reverberations in the water column and thus could mitigate this issue, although no studies have been undertaken to examine this issue. Some baleen and toothed whales are known to continue calling in the presence of seismic pulses and their calls usually can be heard between the seismic pulses. The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking. In general, masking effects of seismic pulses are expected to be minor, given the normally intermittent nature of seismic pulses.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Based on NMFS (2001, p. 9293), NRC (2005), and Southall et al. (2007), exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or “taking”, in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations.

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). 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). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, and the lack of abundance estimates and population trend data for marine mammals in the southern hemisphere, the conservative approach used in

this Application is to estimate how many marine mammals would be encountered during the 300-hr survey period and/or exposed to the acoustic outputs generated by the seismic source. This approach likely overestimates the numbers of marine mammals that would be affected in a biologically important manner. The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important degree by a seismic program are based primarily on behavioral observations of a few species. Detailed studies have been done on humpback, gray, bowhead, and sperm whales. Less detailed data are available for some other species of baleen whales and small toothed whales, but for many species, there are no data on responses to marine seismic surveys.

A description of the disturbance reactions observed for different types of cetaceans is presented below.

Baleen Whales **-** Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. 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 and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Responses of *humpback whales* to seismic surveys have been studied during migration, on summer feeding grounds, and on Angolan winter breeding grounds; there has also been discussion of effects on the Brazilian wintering grounds. Off western Australia, avoidance reactions began at 5–8 km from the array, and those reactions kept most pods ~3–4 km from the operating seismic boat; there was localized displacement during migration of 4–5 km by traveling pods and 7–12 km by more sensitive resting pods of cow-calf pairs. However, some individual humpback whales, especially males, approached within distances of 100–400 m.

In the Northwest Atlantic, sighting rates were significantly greater during non-seismic periods compared with periods when a full array was operating, and humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic vs. non-seismic periods. On their summer feeding grounds in southeast Alaska, there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re 1 μPa on an approximate rms basis. It has been suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys, but data from subsequent years indicated that there was no observable direct correlation between strandings and seismic surveys.

There are no data on reactions of *right whales* to seismic surveys, but results from the closely related *bowhead whale* show that their responsiveness can be quite variable depending on their activity (migrating vs. feeding). Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with substantial avoidance occurring out to distances of 20–30 km from a medium-sized airgun source. However, more recent research on bowhead whales corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. Reactions of migrating and feeding (but not

wintering) *gray whales* to seismic surveys have been studied off St. Lawrence Island in the northern Bering Sea, it was estimated, based on small sample sizes, that 50% 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% 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, and western Pacific gray whales feeding off Sakhalin Island, Russia.

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses; 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 vs. silent, although there was localized avoidance. Singing fin whales in the Mediterranean moved away from an operating airgun array.

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. The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year, and bowhead whales have continued to travel to the eastern Beaufort Sea each summer. Bowhead whale numbers have increased notably, despite seismic exploration in their summer and autumn range for many years.

Toothed Whales - Little systematic information is available about reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales, and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies. Seismic operators and marine mammal observers 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. In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance. The beluga, however, is a species that (at least at times) shows long-distance (10s of km) avoidance of seismic vessels. Captive bottlenose dolphins and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys, but the animals tolerated high received levels of sound before exhibiting aversive behaviors.

Most studies of *sperm whales* exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses; in most cases the whales do not show strong avoidance, and they continue to call, but foraging behavior can be altered upon exposure to airgun sound. There are almost no specific data on the behavioral reactions of *beaked whales* to seismic surveys. However, some northern bottlenose whales remained in the general area and continued to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys. Most beaked whales tend to avoid approaching vessels of other types, and may also dive for an extended period when approached by a vessel. It is likely that most beaked whales would also

show strong avoidance of an approaching seismic vessel, although this has not been documented explicitly. 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 the mysticetes and some other odontocetes. A ≥170 dB disturbance criterion (rather than ≥160 dB) is considered appropriate for delphinids, which tend to be less responsive than the more responsive cetaceans.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds exposed to strong sounds. However, there has been no specific documentation of TTS let alone permanent hearing damage, i.e., PTS, in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions. Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds with received levels ≥180 dB and 190 dB re 1 μPa (rms), respectively (NMFS 2000). These criteria have been used in establishing the exclusion (i.e., shutdown) zones planned for the proposed seismic survey. However, those criteria were established before there was any information about minimum received levels of sounds necessary to cause auditory impairment in marine mammals.

Recommendations for science-based noise exposure criteria for marine mammals, frequency weighting procedures, and related matters were published by Southall et al. (2007). Those recommendations have not, as of early 2013, been formally adopted by NMFS for use in regulatory processes and during mitigation programs associated with seismic surveys. However, some aspects of the recommendations have been taken into account in certain environmental impact statements and small-take authorizations.

As presented in the Supplemental Draft Environmental Impact Statement for the Effects of Oil and Gas Activities in the Arctic Ocean (NMFS, 2013), NMFS is currently in the process of revising and updating acoustic thresholds to incorporate newer science and utilize improved methods. NMFS is proposing to modify the criteria using more recent data, which suggest that: 1) hearing impairment effects to phocids differ from otariids, because of their inner ear anatomy, and; 2) that cetaceans are more likely to incur TTS and subsequent PTS within the frequency ranges of their best hearing sensitivity. NMFS is using a phased approach to conduct these updates. The thresholds currently being revised include: 1) the injury (Level A Harassment) thresholds to be applied to all sound sources and; 2) the behavioral (Level B Harassment) thresholds to be applied only to seismic activities and seismic-like sound sources (e.g., primarily mobile and impulsive sources). NMFS will provide a full description of the derivation of the revised acoustic thresholds once the internal review is complete and NMFS' revised acoustic thresholds are released for public comment through a separate process. Depending on the timing and implementation of revisions to the acoustic thresholds, changes to the distances from sound sources within which impacts are quantified would be revised for the proposed action.)

NMFS' preliminarily plans include exploring the use of dose-response or risk function-like curves to characterize the relationship between received sound level and behavioral responses. Additionally, it has become increasingly evident that the context in which marine mammals are

exposed to sound (e.g., the behavioral state of the animal, whether a sound source is approaching and how fast, etc.) can affect both how an animal initially responds to a sound and the ultimate impacts of the sound exposure on that individual. NMFS is also exploring additional methods of augmenting the use of a dose-response-like curve to address contextual factors beyond received level (such as distance from the sound or behavioral state of the animal), as well as the more chronic effects of sound sources operated over longer periods of time.

NMFS has conducted preliminary evaluation, and suspects that the distances from the source within which animals would be potentially exposed to injurious levels would primarily fall within the distances to the current 180-dB SPL rms threshold for cetaceans. However, for phocids, the distances within which received levels may exceed the new thresholds could be somewhat larger than the distances to the current 190-dB threshold. Depending on the timing and implementation of revisions to the acoustic thresholds, changes to the distances from sound sources within which impacts are quantified would be revised for the proposed action.) Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment (see Section 7). Also, many marine mammals show some avoidance of the area where received levels of airgun sound are high enough such that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves would reduce or (most likely) avoid any possibility of hearing impairment.

Non-auditory physical effects may also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong transient sounds. However, there is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. 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. The brief duration of exposure of any given mammal, the deep water in the study area, and the planned monitoring and mitigation measures would further reduce the probability of exposure of marine mammals to sounds strong enough to induce non-auditory physical effects.

Possible Effects of Multibeam Echosounders (MBES) and Sub-bottom Profilers (SBPs)

The PEIS discussed in Sections 3.6.4.3 and 3.7.4.3 that operation of MBES and SBPs is not likely to impact mysticetes or odontocetes because the intermittent and narrow, downward-directed nature of these acoustic sources would result in no more than one or two brief ping exposures of any individual animal, given the movement and speed of the vessel. Similarly, the intermittent nature of ADCPs and other pingers would, at most, result in short-term, localized behavioral changes.

Summary of Potential Effects from Coring and Dredging Activities

During coring and 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 towards the source. Coring and dredging activities would be highly localized and short-term in duration, and would not be expected to significantly interfere with marine mammal behavior. The PEIS identified potential direct effects to include temporary localized disturbance or displacement from associated sounds and/or physical movement/actions of the operations. Additionally, the potential indirect effects to mysticetes were identified to consist of very localized and transitory/short-term disturbance of bottom habitat and associated prey in shallow-water areas as a result of coring, dredging, and sediment sampling.

8.0 DESCRIPTION OF IMPACT ON SUBSISTENCE USES

NOAA NMFS Requirement: The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

There are no indigenous or native people in the Antarctic, and subsequently there is no subsistence hunting of marine mammals near the survey areas. Therefore, the proposed action would not have an adverse impact on the availability of the species or stocks used as a food source.

9.0 DESCRIPTION OF IMPACT ON MARINE MAMMAL HABITAT

NOAA NMFS Requirement: The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

The proposed seismic survey would not result in any permanent impact on habitats used by marine mammals or to the food sources they use. The main impact issue associated with the proposed activity would be temporarily elevated noise levels and the associated direct effects on marine mammals, as discussed in Section 7, above. Effects of airguns on fish and invertebrates are reviewed in Section 3.2.4.3, Section 3.3.4.3, and Appendix D of the PEIS.

10.0 DESCRIPTION OF IMPACT FROM LOSS OR MODIFICATION TO HABITAT

NOAA NMFS Requirement: The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The effects of the planned activity on marine mammal habitats and food resources are expected to be negligible, as described above. Some marine mammals present near the proposed action may be temporarily displaced as much as a few kilometers by the planned research activities.

During the proposed survey, marine mammals would be distributed according to their habitat preferences, in pelagic waters in depths 100 to 1,000 m (cetaceans) or on or near sea ice (pinnipeds). While some marine mammals may be encountered feeding in the proposed survey areas, the proposed activity would not be expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, because operations would be limited in duration.

11.0 MEASURES TO REDUCE IMPACTS TO MARINE MAMMALS

NOAA NMFS Requirement: **The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance**

Marine mammals are known to be present in the proposed study area. To minimize the likelihood that impacts would occur to the species and stocks, airgun operations would be conducted in accordance with the MMPA and the ESA, including obtaining permission for incidental harassment or incidental 'take' of marine mammals and other endangered species. The following provides more detailed information about the mitigation measures that would be an integral part of the planned activities, including the use of a mitigation zone (MZ), and procedures for ramp-up and shut-down.

Mitigation measures for the low-energy seismic survey would include:

- Pre-planning of the cruise to identify the smallest airgun array that could be used and still meet the geophysical scientific objectives.
- Employing two Protected Species Visual Observer (PSVO) consistent with NMFS requirements, including a marine mammal expert familiar with species in the Southern Ocean to serve as the lead PSVO.
- Establishing the MZ and FMZ
- Minimum of one observer maintaining a visual watch for marine mammals during all airgun operations.
- Two observers maintaining a visual watch for marine mammals from 30 min before the start of ramp ups through the duration of the ramp ups (and when possible at other times) during the day and at night. (Note: because of the high latitude locations of the study areas, twilight/darkness conditions are expected to be limited to between 3 and 6 hours per day during the proposed action).
- Shutdowns when marine mammals are detected in or about to enter the designated MZ. Following a shutdown, airgun activity would not resume until the PSVO has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return or has not been seen within the exclusion zone for 15 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes).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) - but probably not enough to allow continued one-airgun operations if a marine mammal came within the exclusion zone for two airguns.

Based on modeling data, the outputs from a pair of 45/45 or 105/105 in^3 GI airguns such as those being used in the proposed action are considered a low-energy acoustic source in the PEIS for marine seismic research (NSF, 2011). A low-energy source was defined in the PEIS as an acoustic source whose received level at 328 ft. (100 m) is less than 180 decibels re 1 microPascal (dB re 1μPa). The PEIS also established for these low-energy sources, a standard MZ of 100 m for all low-energy sources in water depths >100 m. This 100 m standard MZ would be used during the proposed activity.

The PEIS did not define a standard FMZ for low-energy acoustic sources, therefore L-DEO model results are proposed to be used during the proposed action for the region in which NMFS estimates behavioral disturbance (≥160 dB re 1 μPa [rms]) might occur (Level B Harassment). The FMZ is dependent on the array used and the water depth (see Table 11) and would be used accordingly to identify and report an event that could be interpreted as behavioral disturbance of marine mammals.

To implement these measures, PSVOs would monitor for the visual presence of cetaceans and pinnipeds prior to and during seismic survey operations. Resources used for these efforts would include two observation platforms (i.e., ship's bridge deck and the aloft observation tower) and equipment (e.g., reticular binoculars) sufficient to provide a clear view around the vessel. The ship bridge offers a 270 degree view and the aloft observation tower provides a 360 degree view. The binoculars used would be Fujinon FMTRC-SX 7x50 binoculars or equivalent. These binoculars a built-in daylight compass and range reticle, but are not big-eye binoculars. Night vision devices would not be required due to the constant daylight conditions during the Antarctic summer.

During seismic operations, two PSVOs would be based aboard the NBP. The PSVOs would be approved by NMFS and the lead PSVO would be experienced with species in the Southern Ocean. The second PSVOs would receive additional specialized training from the PSVO to ensure that they can identify Southern Ocean species. During the majority of seismic operations, one PSVO would monitor for marine mammals around the seismic vessel. Use of two simultaneous observers would increase the effectiveness of detecting animals around the source vessel and both PSVOs would be on duty during the 30 minutes prior to ramp up and during ramp up. In addition, PSOs will have direct radio contact with the bridge and chief scientist during the seismic surveys. The vessel operator, science support personnel, and the science party must comply immediately with the observer's call to shut down any/all the airguns.

Seismic operations would not extend more than 16 continuous hours during any portion of the survey. The PSVOs would be on duty in 4-hour shifts and each PSVO would not work more than two shifts per day; however during off hours, the resting PSVO may be called for consultation should a second opinion be needed. Other crew would also be instructed to assist in detecting marine mammals and implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew would be given additional instruction regarding how to do so.

For at least 30 minutes prior to the seismic survey, two observers would scan the surface looking for animals within the MZ from the ship. If no animals are in or approaching the 100-m MZ, the

airguns would be ramped up (gradually increasing the output sound level by first using one GI gun and then adding the second) to provide time for undetected animals to vacate the area. During ramp-up, the time between airgun shots would be five minutes. The observations would continue during the seismic survey and if a marine mammal is sighted within the FMZ, the crew would be notified of a possible shutdown if the animal approaches the inner MZ. Observations within the FMZ would also include searching for pinnipeds that may be present on the surface of the sea ice (i.e., hauled out) and that could potentially dive into the water as the vessel approaches. The ship may use evasive maneuvers (altering vessel course and speed) to avoid intercepting the path of an approaching marine mammal if the maneuver can be implemented safely and without damaging the deployed equipment.

Typically, the power-down procedure would involve reducing the acoustic output of airguns to minimize the sound level exposure risk. In these instances, regular airgun operations would resume when the PSVO has visually observed the marine mammal(s) exiting the MZ or the animal has not been seen within the MZ for 15 minutes (small odontocetes) or 30 minutes (mysticetes and large odontocetes). A complete shutdown of the airguns for any reason for more than 15 minutes would require visual monitoring and ramp-up procedures consistent with those used at the start of the survey.

Seismic survey activities would only be initiated during periods of optimum visibility when marine mammal observers could see the MZ without compromise by adverse weather or diminishing ambient light levels. During periods of reduced visibility, seismic survey activities would cease if observers cannot delineate the MZ.

12.0 MEASURES TO REDUCE IMPACTS TO SUBSISTENCE USERS

NOAA NMFS Requirement: Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a "plan of cooperation" or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses.

The activity would not take place in the Arctic, and there is no subsistence hunting near the proposed survey area; therefore, the proposed activities would not have any impact on the availability of the species or stocks for subsistence users.

13.0 MONITORING AND REPORTING

NOAA NMFS Requirement: The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting

requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding.

NSF proposes to sponsor marine mammal monitoring during the present 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's proposed Monitoring Plan is described below. NSF understands that this Monitoring Plan would be subject to review by NMFS, and that refinements may be required. The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same regions. NSF is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

Vessel-based Visual Monitoring

PSVO observations (described in detail in Section 11) would take place during daylight airgun operations (austral summer). Night airgun operations are not expected. Airgun operations would be suspended when marine mammals are observed within, or about to enter, designated mitigation zones (see Section 11 above) where there is concern about potential effects on hearing or other physical effects. PSVOs would also watch for marine mammals for at least 30 min prior to the planned start of airgun operations. Observations would also be made during daytime periods when the NBP is underway without seismic operations, such as during transits.

The NBP is a suitable platform for marine mammal observations. When stationed on the bridge, the eye level would be ~16.5 m above sea level (with a 270 degree view), and the observer would have a good view around the entire vessel. In addition, there is an aloft observation tower ~24.4 m above sea level that is protected from the weather, and affords observers an even greater view (360 degree). The PSVO would scan the area around the vessel systematically with reticle binoculars (e.g., 7×50) and with the naked eye. The reticular binoculars would be used to measure distances to animals directly.

PVSO Data and Documentation

PSVO and MMOs 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). PSVOs would also provide information needed to order a shutdown of the airguns when a marine mammal is within or near the MZ.

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

1. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace.
2. Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare. The data listed under (2) will 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 and shut downs would be recorded in a standardized format. Data would be entered into an electronic database. The accuracy of the data entry would be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database.

These procedures would allow initial summaries of data to be prepared during and shortly after the field program, and would facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations would provide:

1. The basis for real-time mitigation (airgun shutdown).
2. Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS. During the proposed action, the number of takes would be monitored and used to stop seismic operations should requested number of takes be reached.
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.

A report would be submitted to NMFS within 90 days after the end of the cruise. The report would describe the operations that were conducted and sightings of marine mammals near the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report would summarize the dates and locations of seismic operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities). The report would also include estimates of the number and nature of exposures that could result in “takes” of marine mammals by harassment or in other ways.

14.0 RESEARCH COORDINATION

NOAA NMFS Requirement: Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

ASC and NSF will coordinate the planned marine mammal monitoring program associated with the seismic survey with other parties that may have interest in this area. ASC and NSF will coordinate with applicable U.S. agencies (e.g., NMFS), and will comply with their requirements. NSF has already reached out the Australian Antarctic Division, who are the proponents of the proposed marine protected area and regularly conduct research expeditions in the marine environment off East Antarctica.

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 East Antarctic study areas, and communicate its findings via reports, publications and public outreach.

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Draft Addendum to the Draft IHA Application for a Marine Geophysical Survey of the Dumont d'Urville Sea by the National Science Foundation in 2014

1.0 INTRODUCTION

This addendum supplements the Incidental Harassment Authorization Application (IHAA) for the proposed marine seismic survey of portions of the Dumont d'Urville Sea, Antarctica to be conducted by the National Science Foundation (NSF) in the late austral summer-of 2014 (NSF, 2013a). NSF conducted early coordination with the National Marine Fisheries Service (NMFS) and solicited their comments on the preliminary draft of the subject EA. Supplemental information to the draft EA was requested by NMFS to address potential marine mammal "takes" from icebreaking activity intrinsic to the project.

Icebreaking is considered by NMFS to be a continuous sound and NMFS (2005) indicates the existing threshold for Level B harassment by continuous sounds is a received sound level of 120 dB SPL. Potential takes of marine mammals may ensue from the icebreaking activity in which the RVIB *Nathaniel B. Palmer (NBP)* is expected to engage, i.e. along the George V and Oates Coast of East Antarctica (>65°0′S, between 140°0′E and 165°E. The draft IHAA and draft Initial Environmental Evaluation/Environmental Assessment (IEE/EA) presents take estimates based exclusively on the seismic survey component of the project. If icebreaking does occur in Antarctica region, we expect it will occur during transit operations to gain access to dredging or sampling locations and not during seismic survey operations. The research activities and associated contingencies are designed to avoid areas of heavy sea ice condition. The safety radius for the marine mammal Level B harassment threshold during the proposed seismic activities is greater than the calculated radius during icebreaking. If the *NBP* breaks ice during transit operations within the Dumont d'Urville Sea or other areas of the Southern Ocean, the more conservative, greater radius, i.e. that for seismic operations, will be used and will supersede the safety radius for icebreaking.

Data characterizing the sound levels generated by icebreaking activities conducted by the *NBP* are not available. Therefore data for noise generated from an icebreaking vessel such as the USCGC *Healy* will be used for purposes of this addendum.

This addendum presents calculations of exposures to marine mammals due to icebreaking when the RVIB *NBP* is transiting through ice. It is noted that the RVIB *NBP* is a smaller vessel and has less icebreaking capability than the Coast Guard's polar icebreakers, being only capable of breaking ice up to 1 m thick at speeds of 3 knots. Therefore, the sound levels that may be generated by the NBP are expected to be lower than the conservative levels estimated and measured for the USCGC *Healy*.

It is important to note that non-icebreaking vessels, as well as natural sounds such as those arising from sea ice motion and whale flukes hitting the ocean surface, also present similar sound impacts. Underwater noise from various vessels, including tug boats, oceanographic research vessels, and fisheries research vessels in open water, as well as icebreakers traversing sea ice, often exceed 120 dB, the existing threshold for Level B harassment set by NMFS (2005).

The sound level and other estimates provided in this addendum are for information purposes only and do not represent any conclusions with regard to harassment. Further studies are needed before a precedent can be established.

The objectives and plans of the proposed project remain unchanged. The following includes specifics of the estimation of trackline while the RVIB *NBP* breaks ice outside U.S. waters and the calculation of the resulting potential takes. The supplemental information has been organized in a manner consistent with the draft IHAA. The estimated takes provided in this addendum are in addition to the number of estimated takes due to seismic activities within U.S. waters that are presented in the IHAA and IEE/EA submitted to the NMFS on 15 August 2013.

2.0 DATES, DURATION, AND REGION OF ACTIVITY

The proposed geophysical survey will be conducted for ~45 days from approximately 29 January to 16 March 2014. Icebreaking will occur, as necessary, between the latitudes of ~66 to 70^0S and between 140^0E and 165^0E. The total distance in the region the vessel will travel include the proposed seismic survey and transit to dredging or sampling locations and will represent approximately 5,600 kilometers (km), with seismic survey covering a distance of up to 2,800 km.

Researchers will work to minimize time spent breaking ice as science operations are more difficult to conduct in icy conditions since the ice noise degrades the quality of the geophysical and ADCP data and time spent breaking ice takes away from time supporting research. Logistically, if the vessel were in heavy ice conditions, researchers would not tow the air gun and streamer, as this would likely damage equipment and generate noisy data. It is possible that the seismic survey can be performed in low ice conditions if the RVIB *NBP* vessel could generate an open path behind the vessel.

Because the RVIB *NBP* is not rated to break multiyear ice routinely, operations generally avoid transiting through older ice (i.e., 2 years or older, thicker than 1 m). If sea ice is encountered during the cruise, it is anticipated the NBP will proceed primarily through one year sea ice, and possibly some new, very thin ice, and would follow leads wherever possible. Satellite imagery from the Totten region documents that sea ice is at its minimum extent during the month of February. The most recent ice image for the region, from November 21, 2013, shows that the sea ice is currently breaking up, with a significant coastal lead of open water.

Based on a maximum sea ice extent of 250 km and estimating that we will transit to the innermost shelf and back into open water twice – a round trip transit in each of potential work regions, we estimate that the RVIB *NBP* will actively break ice up to a distance of 1000 km. Based on a ship's speed of 5 knots under moderate ice conditions, this distance represents approximately 108 hours of icebreaking operation. It is noted that typical;l transit through areas of primarily open water and containing brash ice or pancake ice will not be considered icebreaking for the purposes of this addendum.

The seismic survey is estimated to esonify an area of approximately 2,814 sq km. This estimate is based on the maximum number of kilometers for the seismic survey (2,800 km) times the Predicted RMS radii (m) based on modeling and empirical measurements (assuming 100% use of 2 x $105in^3$ GI guns in 100-1000 m water depths) which was calculated to be 1,005 m (1.005 km). Takes associated with these activities were requested in the main body of the IHAA.

3.0 TYPE AND ABUNDANCE OF MARINE MAMMALS IN PROJECT AREA

A description of the cetacean and pinniped species that were previously observed by marine mammal observers (MMOs) during surveys conducted in the region from February 1991 through November 2004 are described in Section 3.0 of the IHA (NSF, 2013a). These species may be expected to be present in the project area during icebreaking operations.

4.0 DESCRIPTION OF MARINE MAMMALS IN PROJECT AREA

Within the latitudes of the proposed survey where the *NBP* will be breaking ice, cetaceans and pinnipeds may be in the area. A description of the cetacean and pinniped species that were previously observed Protected Species Visual Observers (PSVOs) during surveys conducted in the region from February 1991 through November 2004 are described in Section 3.0 of the IHA (NSF, 2013a).

At least one PVSO will stand watch at all times while the RVIB *NBP* is operating airguns during the seismic survey; this procedure will also be followed when the vessel is conducting icebreaking during transit. We expect

that PVSOs will observe few cetaceans during icebreaking activities, and will be limited to those species in proximity to the ice margin habitat. Observations would utilize the Proposed Mitigation Zone (MZ) and Full Mitigation Zone (FMZ) criteria described in Section 6.0 of the IHA (NSF, 2013a).

Observations within the FMZ would also include searching for pinnipeds that may be present on the surface of the sea ice (i.e., hauled out) and that could potentially dive into the water as the vessel approaches, indicating disturbance from noise generated by icebreaking activities.

5.0 REQUESTED TYPE OF INCIDENTIAL TAKE AUTHORIZATION

As described in Section 5.0 of the IHA (NSF, 2013a), marine mammals in the general vicinity of the vessel tracklines may display disturbance reactions to the operating airguns (Level B Harassment). These reactions may also occur as a result of icebreaking operations. No serious injury or lethal takes (Level A) are anticipated, given the nature of the planned icebreaking operations and implementation of related mitigation measures.

As described in the draft IEE/EA, marine mammals in the general vicinity of the vessel tracklines may display disturbance reactions to the operating airguns (non-lethal harassment). These reactions may also occur as a result of icebreaking operations. Therefore, the authors request non-lethal 'take' of odontocetes and mysticetes protected under the Endangered Species Act that may be in the area where icebreaking activities may occur during the cruise. The estimated 'take' is listed in Tables Add-1 and Add-2.

6.0 NUMBER OF INCIDENTAL TAKES BY ACTIVITY

All anticipated takes caused by icebreaking activities would be "takes by harassment", as described in Section 5 of the original IHAA, involving temporary changes in behavior. The mitigation measures to be applied will minimize the possibility of injurious takes. Few data are available on the distribution and numbers of marine mammals in the Dumont d'Urville Sea.

There are no stock assessments of marine mammals and very limited population information for the Dumont d'Urville Sea. The lack of population data is furthered acknowledged in the NMFS recovery plans for several endangered (blue, fin, sei whales). The lack of abundance estimates and population trend data for marine mammals in the southern hemisphere including animals which are not threatened hinders traditional quantitative analysis of potentially affected organisms.

Because estimates of marine mammal densities are not available for the Dumont d'Urville Sea, the numbers of marine mammals that may be encountered during the survey and potentially exposed to underwater sound (Table Add-4) were calculated as described below.

The number of different individuals that could be exposed to airgun sounds on one or more occasions was estimated in the original application by considering the total number and frequency of sightings expected during the 300-hour seismic survey and conservatively assuming all animals sighted within 600 or 1005 m depending on the airgun array used would be exposed to sound levels ≥160 dB re 1 μPa (rms) resulting in Level B Harassment. This method will be used for estimating the number of individuals that may be disturbed by icebreaking activities

The following estimates are based on a consideration of the number of marine mammals that might be disturbed appreciably over the ~1,000 kilometers of icebreaking that may occur during the proposed project as described above.

Marine Mammal Density Estimates

Numbers of marine mammals that might be present and potentially disturbed are estimated below based on available data about mammal sightings in the area. "Take by harassment" is calculated by multiplying the expected presence of marine mammals likely to occur in the vicinity of icebreaking by the estimated duration of potential

icebreaking operations. Table Add-1 summarizes the estimated number of cetaceans that may be encountered during icebreaking operations, and Table Add-2 summarizes the estimated number of pinnipeds that are expected to be present during icebreaking. The expected sightings data for pinnipeds accounts for both seals that may be in the water and those hauled-out on ice surfaces. While the number of cetaceans that may be encountered within the ice margin habitat would expected to be less than open water, the estimates below utilize the expected sightings for the open water and therefore; represent conservative estimates.

Table Add-1. Projected Number and Frequency of Cetacean Encounters in the Proposed Study Areas.

Common Name	Estimated Frequency of Sightings (no/hr)	Expected Sightings during the 108-hr Icebreaking Operations	Number of Estimated Takes and Requested Authorization [2]
Mysticetes[1]			
Blue whale	0.0095	1	1
Fin whale	0.9276	100	100
Humpback whale	0.9514	103	103
Minke whale	0.5423	59	59
Sei whale	0.0143	2	2
Odontocetes[1]			
Dolphin, Cruciger (hourglass)	0.1080	12	12
Spectacled porpoise	0.1040	12	12
Killer whale	0.2474	28	28
Long-finned pilot whale	0.0951	11	11
Sperm whale	0.1284	14	14

Note:
Species listed as endangered are in italics
[1] For cetaceans, conservatively assumes all sightings could result in Level B harassment

Table Add-2. Projected Number and Frequency of Pinniped Encounters in the Proposed Study Areas.

Common Name	Estimated Frequency of Sightings (no/hr)	Expected Sightings during the 108-hr Icebreaking Operations	Number of Estimated Takes and Requested Authorization [1]
Crabeater	7.1155	768	
Leopard	0.0545	6	
Ross	0.1345	15	
Weddell	1.0082	109	
Elephant[2,3]	0.0000	-	-
Antarctic Fur[2,3]	0.0000	-	-
		Total	898

Note:
Species listed as endangered are in italics
[1] Due to ice conditions and swimming characteristics, some seals in the water may be difficult or impossible to identify; as a result, the total number of takes (898) is not species specific.
[2] A take was not requested for elephant seals and Antarctic fur seals because preferred habitat for these species is not within the project area.
[3] A take was not requested for elephant seals and Antarctic fur seals because preferred habitat for these species is not within the project area

Potential Number of "Takes by Harassment"

Numbers of marine mammals that might be present and potentially disturbed are estimated below based on available data about mammal distribution and densities in the Dumon d'Urville Sea during the austral summer as described above.

It is conservatively assumed that individual marine mammals that are sighted are potentially exposed to received levels ≥120 dB re 1 μPa (rms) by icebreaking operations. Some of the animals estimated to be exposed to sound levels ≥120 dB re 1 μPa, might show avoidance reactions before actual exposure to this sound level. Thus, these calculations estimate the number of individuals potentially exposed to ≥120 dB rms that would occur if there were no avoidance of the area ensonified to that level.

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

NMFS (2005) indicates the existing threshold for Level B harassment for continuous sounds is a received sound level of 120 dB SPL. Therefore, the 120 dB received sound level radius around the *Healy* while icebreaking was estimated by researchers (USGS, 2010). Using a spherical spreading model, a source level of 185 dB decays to 120 dB in about 1,750 m. This model is corroborated by Roth and Schmidt (2010). Therefore, as the ship travels through the ice, a swath 3500 m wide would be subject to sound levels ≥120 dB. This results in the potential

exposure of 3,500 km^2 to sounds ≥120 dB from icebreaking. As previously mentioned in Section 1, the *NBP* is a smaller vessel and has less icebreaking capability than the *Healy*, being only capable of breaking ice up to 1 m thick at speeds of 3 knots. Therefore, the sound levels that may be generated by the NBP are expected to be lower than the conservative levels estimated and measured for the *Healy*.

Based on the operational plans and marine mammal densities described above, the estimates of marine mammals potentially exposed to sounds ≥120 dB during icebreaking are included in Table Add-1 and Add-2.

7.0 NUMBER OF INCIDENTAL TAKES BY ACTIVITY

A description of the potential effects of airgun sounds and multibeam echosounders (MBES) and sub-bottom profilers (SBPs) are described in Section 7.0 of the IHA (NSF, 2013a). These effects to marine mammals as result of icebreaking operations are expected be expected to be similar.

8.0 DESCRIPTION OF IMPACT ON SUBSISTENCE USES

There are no indigenous or native people in the Antarctic, and subsequently there is no subsistence hunting of marine mammals near the survey areas. Therefore, the proposed action would not have an adverse impact on the availability of the species or stocks used as a food source.

9.0 DESCRIPTION OF IMPACT ON MARINE MAMMAL HABITAT

The RVIB *NBP* is designed for continuous passage at 3 knots through ice 1 m thick. During this project the *NBP* will typically encounter first- or second-year ice while avoiding thicker ice floes, particularly large intact multi-year ice, whenever possible. In addition, the vessel will follow leads when possible while following the survey route. As the vessel passes through the ice, the ship causes the ice to part and travel alongside the hull. This ice typically returns to fill the wake as the ship passes. The effects are transitory, i.e. hours at most, and localized, i.e. constrained to a relatively narrow swath perhaps 10 m to each side of the vessel.

The *NBP*'s maximum beam is 18.3 m. Applying the maximum estimated amount of icebreaking, i.e. 1,000 km, to the corridor opened by the ship, we anticipate that a maximum of ~18 km^2 of ice may be disturbed. This represents an insignificant amount of the total ice present in the Southern Ocean.

10.0 ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF HABITAT ON MARINE MAMMALS

Icebreaking may damage seal breathing holes and will also reduce the haulout area in the immediate vicinity of the ship's track. Icebreaking along a maximum of 1,000 km of trackline will alter local ice conditions in the immediate vicinity of the vessel. This has the potential to temporarily lead to a reduction of suitable seal haul-out habitat. However the dynamic sea-ice environment requires that seals be able to adapt to changes in sea, ice, and snow conditions, and they therefore create new breathing holes and lairs throughout winter and spring (Hammill and Smith 1989). In addition, seals often use open leads and cracks in the ice to surface and breathe (Smith and Stirling 1975). Disturbance to the ice will occur in a very small area relative to the Southern Ocean icepack and no significant impact on marine mammals is anticipated by icebreaking during the proposed project.

11.0 MEASURES TO REDUCE IMPACTS TO MARINE MAMMALS

A description of the mitigating measure that will be conducted to reduce potential effects of are described in Section 11.0 of the IHA (NSF, 2013a). The applicable measures will also be used during icebreaking operations.

12.0 MEASURES TO REDUCE IMPACTS TO SUBSISTENCE USERS

The activity would not take place in the Arctic, and there is no subsistence hunting near the proposed survey area; therefore, the proposed activities would not have any impact on the availability of the species or stocks for subsistence users

13.0 MONITORING AND REPORTING

A description of the monitoring and reporting procedures that will be performed during the cruise are described in Section 13.0 of the IHA (NSF, 2013a). The applicable measures will also be used during icebreaking operations.

14.0 RESEARCH COORDINATION

A description of the research co-ordination that will be performed as a result of the cruise are described in Section 14.0 of the IHA (NSF, 2013a). The applicable measures will also be used during icebreaking operations.

15.0 LITERATURE CITED

Hammill, M.O. and T.G. Smith. 1989. Factors affecting the distribution and abundance of ringed seal structures in Barrow Strait, Northwest Territories. Canadian Journal of Zoology 67(9): 2212-2219.

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Roth, E. H, and V. Schmidt. 2010. Noise levels generated by research icebreakers and marine seismic sources in the deep-water, Arctic Ocean. MPL Tech. Mem. 527.

Smith, T.G. and I. Stirling. 1975. The breeding habitat of the ringed seal (*Phoca hispida*). The birth lair and associated structures. Can. J. Zool 53:1297-1305.

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Attachment A

Species Cross Reference

Species / Scientific Name	Common Name
Aptenodytes forsteri	Emperor penguin
Aptenodytes patagonicus	King penguin
Arctocephalus gazella	Antarctic fur seal, Kerguelen fur seal
Balaenoptera acutorostrata	Minke whale, dwarf minke whale
Balaenoptera bonaerensis	Antarctic minke whale
Balaenoptera borealis	Sei whale
Balaenoptera edeni	Bryde's whale, Omura's whale
Balaenoptera musculus	Blue whale, sibbald's rorqual, sulphur-bottom whale
Balaenoptera physalus	Fin whale, common rorqual, fin-backed whale, finback, finner, herring whale, razorback
Berardius arnuxii	Arnoux's beaked whale, Southern four-toothed whale
Caperea marginata	Pygmy right whale
Cephalorhynchus commersonii	Commerson's dolphin
Eubalaena australis	Southern right whale
Globicephala melas	Long-finned pilot whale
Grampus griseus	Risso's dolphin
Hydrurga leptonyx	Leopard seal
Hyperoodon planifrons	Southern bottlenose whale, flatheaded bottlenose whale
Hyperoodon spp	Bottlenose whales
Indopacetus pacificus	Longman's beaked whale
Kogia breviceps	Pygmy and dwarf sperm whales
Kogia sima	Dwarf sperm whale
Lagenodelphis hosei	Fraser's dolphin
Lagenorhynchus cruciger	Hourglass dolphin
Lagenorhynchus obscurus	Dusky dolphin
Lagenorhyncus cruciger	Hourglass dolphin
Leptonychotes weddellii	Weddell seal
Lissodelphis peronii	Southern Right whale dolphin
Lobodon carcinophagus	Crabeater seal
Megaptera novaeangliae	Humpback whale
Mesoplodon grayi	Gray's beaked whale, southern beaked whale
Mesoplodon layardii	Layard's beaked whale, strap-toothed whale
Mirounga leonina	Southern Elephant Seal
Neophocaena phocaenoides	Finless porpoise
Ommatophoca rossii	Ross seal
Orcinus orca	Killer whale, Orca
Oreaella brevirostris	Irrawaddy (snubfin) dolphin

Species / Scientific Name	Common Name
Peponocephala electra	Melon-headed whale
Phocoena dioptrica (Australophocaena dioptrica)	Spectacled porpoise
Physeter macrocephalus	Sperm whale
Pseudorca crassidens	False killer whale
Pygoscelis adeliae	Adelie penguin
Pygoscelis antarcticus	Chinstrap penguin
Pygoscelis papua	Gentoo penguin
Sotalia fluviatilis	Tucuxi dolphin
Sousa chinensis	Indo-Pacific humpbacked dolphin
Steno bredanensis	Rough-toothed dolphin
Tasmacetus shepherdi	Shepherd's beaked whale
Tursiops spp.	Bottlenose dolphins
Tursiops truncatus aduncus	Southern bottlenose dolphin
Ziphius cavirostris	Cuvier's beaked whale

Attachment B

Seismic Source Acoustic Modeling Data

prepared by Lamont-Doherty Earth Observatory

The RVIB Nathaniel B. Palmer (NBP) would tow a pair of 45-in^3 Sercel GI airguns (source #1) or - if penetration issues are encountered - a pair of 105-in^3 Sercel GI airguns (source #2). Seismic pulses would be emitted at intervals of 5 seconds. Data would be recorded on a 100-m long, 24-channel streamer. Acquisition is planned along a series of predetermined lines, ~95% of which would be in water depth >100 m.

For each source, the two GI guns would be towed on a string at 3 m spacing from each other, at a tow depth of 2-3 m. In addition, source #1 would include a hot spare in case one of the 45-in^3 GI gun breaks down. The two strings would be spaced 14 m apart, on either side of the midline of the vessel (however, only one string at a time would be used i.e. either source #1 or source #2), and between 15 and 40 m astern.

As the source is towed along the survey line, the towed hydrophone array (streamer) receives the reflected signals and transfers the data to the on-board acquisition system. Given the relatively short streamer length behind the vessel, the turning rate of the vessel while the gear is deployed is much higher than the limit of five degrees per minute for a seismic vessel towing a streamer of more typical length (>>l km). Thus, the maneuverability of the vessel is not limited much during operations.

The GI guns would be used in harmonic mode, that is, the volume of the injector chamber (I) of each GI gun is equal to that of its generator chamber (G): G=I=45 in^3 (737 cm^3) for each gun of source #1, and G=I=105 in^3 (1721 cm^3) for each gun of source #2. The generator chamber 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 thus prevent further oscillations, and does not introduce more acoustic energy into the water. The Nucleus modeling software used at Lamont-Doherty Earth Observatory of Columbia University (L-DEO) does not include GI guns as part of its airgun library, however signatures and mitigation models have been obtained for two 45-in^3 G guns at 2 m tow depth and two 105-in^3 G guns at 3 m tow depth that are close approximations.

For source #1 (total generator volume 90 in^3), the output (downward) is 230.6 dB re 1 μPa·m for 0-pk and 235.9 dB re 1 μPa·m for pk-pk. For source #2 (total generator volume 210 in^3), the source output (downward) is 234.4 dB re 1 μPa·m for 0-pk and 239.8 dB re 1 μPa·m for pk-pk. These numbers were determined using the aforementioned G-gun approximation to the GI gun and using signatures filtered with DFS V out-256 Hz 72 dB/octave. The dominant frequency range would be 20-160 Hz for a pair of GI guns towed at 3 m depth and 35-230 Hz for a pair of GI guns towed at 2 m depth.

The nominal downward-directed source levels indicated above 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 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. For source #1, that would be 224.6 dB re 1μPa-m peak, or 229.9 dB re 1μPa-m peak-to-peak, and for source #2, 228.2 dB pk or 233.5 dB pk-pk. Actual levels experienced by any organism more than 1 m from either GI gun would be significantly lower.

A further consideration is that the rms (root mean square) received levels that are used as impact criteria for marine mammals are not directly comparable to the peak (0–pk) or peak to peak (pk–pk) values normally used to characterize source levels of airgun arrays. The measurement units used to

describe airgun sources, peak or peak-to-peak decibels, are always higher than the rms decibels referred to in biological literature. A measured received level of 160 dB re 1 μPa rms in the far field would typically correspond to ~170 dB re 1 μPa pk, and to ~176–178 dB re 1 μPa pk-pk, as measured for the same pulse received at the same location (Greene 1997; McCauley et al. 1998, 2000). The precise difference between rms and peak or peak- to-peak values depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or peak-to-peak level for an airgun-type source.

Proposed Mitigation Zones

Received sound levels have been modeled by Lamont-Doherty Earth Observatory of Columbia University (L-DEO) for a number of airgun configurations, including two 45-in^3 G guns and two 105-in^3 G guns, in relation to distance and direction from the airguns (Fig. 2 and 3). The model does not allow for bottom interactions, and is most directly applicable to deep water. Because the model results are for G guns, which have more energy than GI guns of the same size, those distances overestimate (by ~10%) the distances for the 45-in^3 GI airguns and 105-in^3 GI airguns, respectively. Although the distances are overestimated, no adjustments for this have been made to the radii distances in Table 1.

Empirical measurements concerning the 180- and 160-dB re 1 μPa (rms) distances ("radii" around the source) have been acquired for various airgun arrays during acoustic verification studies conducted by L-DEO in the northern Gulf of Mexico in 2003 (6-, 10-, 12-, and 20-airgun arrays, and 2 GI airguns; Tolstoy et al. 2004 [Referenced in PEIS Appendix H]) and 2007–2008 (18- and 36-airgun arrays; Tolstoy et al. 2009; PEIS Appendix H [Diebold et al. 2010]). When compared to measurements acquired in deep water (>1000 m), mitigation radii derived from the L-DEO model are found to be conservative. The surveys also showed that distances to given received levels vary with water depth - these are larger in shallow water, while intermediate/slope environments show characteristics intermediate between those of shallow-water and those of deep-water environments - and documented the influence of a sloping seafloor. Correction factors were thus developed for water depths 100–1000 m and <100 m, such that mitigation radii for intermediate and shallow environments could be obtained from the deep-water radii predicted by the L-DEO model (a simple multiplication by these correction factors is used).

For the 2 x 105-in^3 GI gun source, measurements were obtained only in shallow water. The data suggests the 160 dB RMS distance is ~1500 m (Tolstoy et al., 2004 [Referenced in PEIS Appendix H]; their Table 1) with an upper bound of 1970 m based on interpolation between the highest received levels at distances of 1 km and 2.8 km (Tolstoy et al., 2004 [Referenced in PEIS Appendix H]; their Fig. 3). No direct constraints on the 190 dB or 180 dB distances were obtained due to clipping of arrivals at short distances but the data is compatible with estimates of 294 m for 190 dB and 511 m for 180 dB. Comparison between these shallow-water values and the deep-water L-DEO model results provided correction factors of 14.7 for the 190 dB rms distance, 7.40 for the 180 dB rms distance and 2.94 for the 160 dB rms distance, which in turn are used to derive mitigation radii for GI guns of other sizes, as is done here for the 2 x 45-in^3 GI gun source. The only empirical measurements obtained for intermediate water depths (100–1000 m) during either survey were for the 36-aigun array in 2007–2008 (PEIS Appendix H [Diebold et al. 2010]). Following results obtained at this site (PEIS Appendix H [Diebold et al., 2010]; their Fig. 16) and earlier practice, a correction factor of 1.5, irrespective of distance to the array, is used to derive intermediate-water radii from modeled deep-water radii for all array configurations.

Based on the modeling and applications of appropriate correction factors, estimates of the maximum distances from the GI guns where sound levels of 190, 180 and 160 dB re 1 μPa (rms) are

predicted to be received in deep (>1000-m) and intermediate (100–1000 m) water are shown in Table 1. Specifically, we have compiled the L-DEO model results for both sources (2 x 45 and 2 x 105 in^3 based on modeling of G guns) in deep water as well as shallow-water estimates from the 2003 survey for the 2 x 105-in^3 GI gun source, and we have derived intermediate-water distances using a correction factor of 1.5, and shallow-water distances for the 2 x 45 in^3 source using correction factors of 14.7 (190 dB), 7.40 (180 dB) and 2.94 (160 dB) calculated from the 2 x 105-in^3 GI gun source.

The PEIS defined a low-energy source as any towed acoustic source whose received level is ≤180 dB at 100 m, including any single or any two GI airguns and a single pair of clustered airguns with individual volumes of ≤250 in^3. In § 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applied a 100-m mitigation zone (MZ) for all low-energy acoustic sources in water depths >100 m. Consistent with the PEIS, that approach is used here for the pair of 45-in^3 GI airguns and pair of 105-in^3 GI airguns. A fixed full mitigation zone (FMZ), or 160 dB "Safety Zone" was not defined in the PEIS for the same suite of low-energy sources, therefore, L-DEO model results for 45-in^3 G Guns and 105-in^3 GI airguns are used here to determine the 160 dB radius.

The 180-dB re 1 μPa_{rms} distance is the safety criterion as specified by NMFS (2000) for cetaceans and 190-dB re 1 μPa_{rms} for pinnipeds. The 180-dB distance would also be used as the MZ for sea turtles, as required by NMFS in other seismic projects (e.g., Smultea et al. 2004; Holst et al. 2005a,b; Holst and Beland 2008; Holst and Smultea 2008; Hauser et al. 2008). If marine mammals or sea turtles are detected within or about to enter the appropriate MZ, the airguns would be shut down immediately.

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. NSF would be prepared to revise its procedures for estimating numbers of mammals should NMFS implement new acoustic criteria guidelines. However, currently the procedures are based on best practices noted by Pierson et al. (1998) and Weir and Dolman (2007).

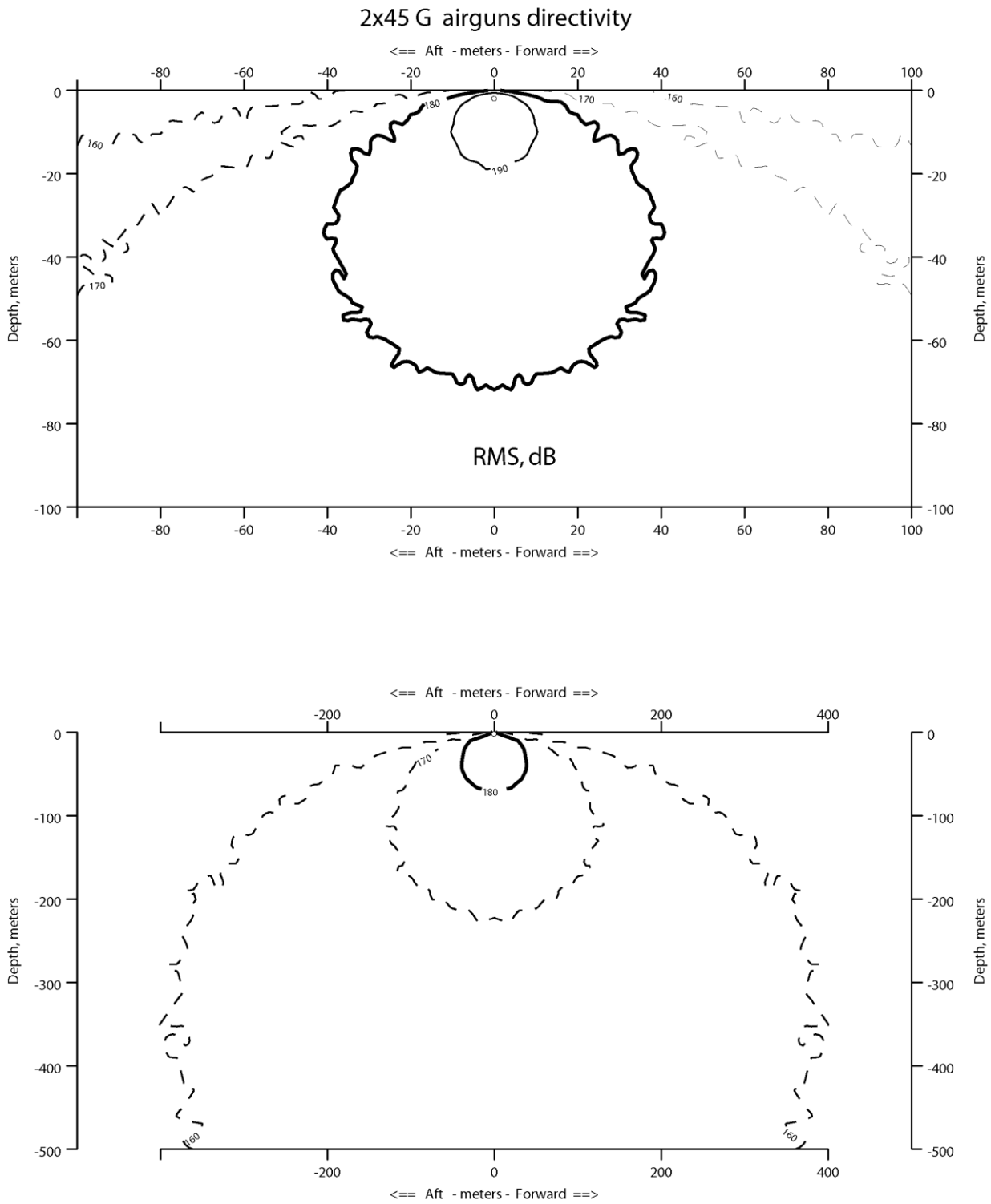

Figure 2. Modeled received sound levels from two 45-in^3 G guns, similar to the two 45-in^3 GI airguns that would be used during the seismic surveys in the Dumont d'Urville Sea Ocean in February 2014. Model results provided by L-DEO.

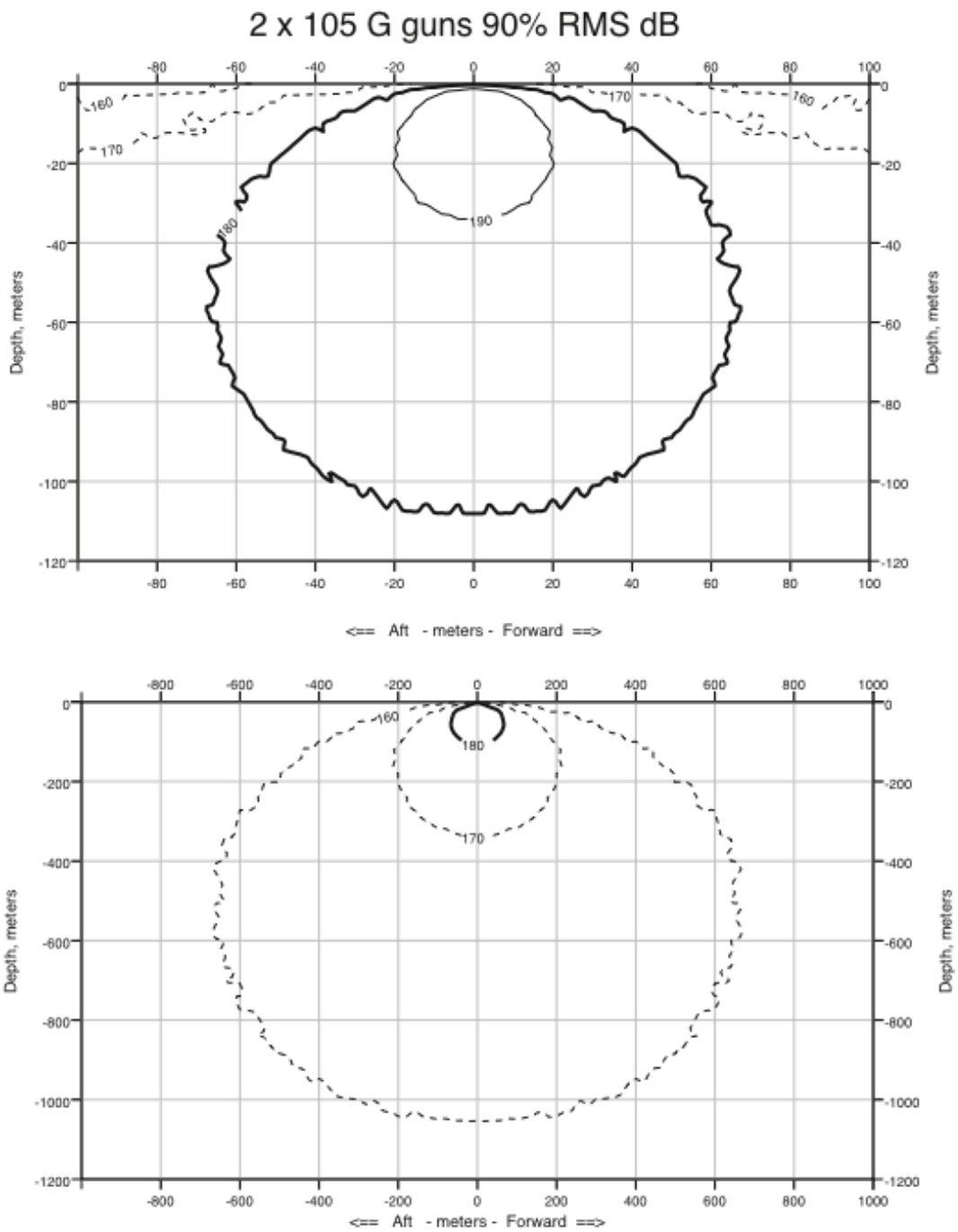

Figure 3. Modeled received sound levels from two 105-in^3 G guns, similar to the two 105-in^3 GI airguns that would be used during the seismic surveys in the Dumont d'Urville Sea in February 2014. Model results provided by L-DEO.

Table 1. Predicted distances to which sound levels of 190, 180 and 160 dB re 1 μPa (rms) might be received from two 45-in^3 G guns or two 105-in^3 G guns, similar to the two 45-in^3 GI guns or two 105-in^3 GI guns that would be used during the seismic surveys in the Dumont d'Urville Sea in February 2014. Distances are based on model results provided by L-DEO (presented in Fig. 2 and 3) and empirical measurements acquired during the 2003 calibration survey in the Gulf of Mexico. The Mitigation Zones (MZs) and Full Mitigation Zone (FMZs) proposed for this survey are provided below and are based on model/empirical measurements and standard MZs established in the PEIS for low energy sources.

Source and volume	Water depth	Predicted RMS radii (m) based on modelling and empirical measurements			Proposed MZ and FMZ based on modelling/empirical measurements and PEIS	
		190 dB	180 dB	160 dB	MZ (190/180 dB)	FMZ
2 x 45 in^3 GI guns	>1000 m	10	40	400	100/100	400
	100–1000 m	15	60	600	100/100	600
	<100 m [Note]	147	296	1176	147/296	1176
2 x 105 in^3 GI guns	>1000 m	20	69	670	100/100	670
	100-1000 m	30	104	1005	100/100	1005
	<100 m [Note]	294	511	1970	294/511	1970

Note: The proposed seismic survey in the Dumont d'Urville Sea will be conducted in waters between 100 m and 1,000 m deep; predicted RMS radii and proposed MZ and FMZ are included for reference purposes only.

Attachment C
CCAMLR Protection Measures

CONSERVATION MEASURE 22-06 (2012)[1,2]
Bottom fishing in the Convention Area

Species	all
Area	see paragraphs 1, 2
Season	all
Gear	bottom fishing

The Commission,

Recognising the commitment made by Members to implement the CCAMLR precautionary and ecosystem approaches to fisheries management by embracing principles of conservation as stated in Article II of the Convention,

Conscious of the urgent need to protect vulnerable marine ecosystems (VMEs) from bottom fishing activities that have significant adverse impacts on such ecosystems,

Noting that United Nations General Assembly Resolution 61/105, adopted on 8 December 2006, calls on regional fisheries management organisations or arrangements with the competence to regulate bottom fisheries to adopt and implement measures to prevent significant adverse impacts of bottom fisheries on VMEs, and noting further that all CCAMLR Members joined in the consensus by which this resolution was adopted,

Noting also the importance of Article IX of the Convention, including the use of the best scientific evidence available,

Aware of the steps already taken by CCAMLR to address the impacts of deep-sea gillnetting and bottom trawling in the Convention Area, through the implementation of Conservation Measures 22-04 and 22-05 respectively,

Recognising that CCAMLR has responsibilities for the conservation of Antarctic marine living resources, part of which include the attributes of a regional fisheries management organisation,

Noting that all CCAMLR conservation measures are published on the CCAMLR website,

hereby adopts the following conservation measure in accordance with Article IX of the Convention:

Management of bottom fishing

1. This conservation measure applies to areas in the Convention Area south of 60°S, and to the rest of the Convention Area with the exception of subareas and divisions where an established fishery was in place in 2006/07 with a catch limit greater than zero.

2. This conservation measure also applies to the area of Statistical Division 58.4.1 north of 60°S.

3. For the purposes of this measure, the term ‘vulnerable marine ecosystems’ in the context of CCAMLR includes seamounts, hydrothermal vents, cold water corals and sponge fields.

4. For the purposes of this measure, the term ‘bottom fishing activities’ includes the use of any gear that interacts with the bottom.

5. Contracting Parties whose vessels wish to engage in any bottom fishing activities shall follow the procedures described in paragraphs 7 to 11 below.

6. Contracting Parties shall not authorise vessels flying their flag to participate in bottom fishing activities, except in accordance with the provisions of this conservation measure and Conservation Measure 10-02. Specifically, notwithstanding a timely notification of intention to participate in a new fishery in accordance with Conservation Measure 21-01 or to participate in an exploratory fishery under Conservation Measure 21-02, Contracting Parties shall not authorise, under Conservation Measure 10-02, vessels flying their flag to participate in bottom fishing activities if:

   (i) a preliminary assessment was not submitted to the Scientific Committee and the Commission at least three months prior to the annual meeting of the Commission, in accordance with paragraph 7(i); or

   (ii) the Commission determines, based upon advice and recommendations from the Scientific Committee and pursuant to paragraph 7(ii), that the proposed bottom fishing activities should not proceed.

Assessment of bottom fishing

7. All bottom fishing activities shall be subject to assessment by the Scientific Committee, based on the best available scientific information, to determine if such activities, taking account of the history of bottom fishing in the areas proposed, would contribute to having significant adverse impacts on VMEs, and to ensure that if it is determined that these activities would make such contributions, that they are managed to prevent such impacts or are not authorised to proceed. The assessments shall include the following procedures:

   (i) Each Contracting Party proposing to participate in bottom fishing activities shall submit to the Scientific Committee and Commission information and a preliminary assessment based on the pro forma in Annex 22-06/A, with the best available data, of the known and anticipated impacts of its bottom fishing activities on VMEs, including benthos and benthic communities, not less than three months prior to the annual meeting of the Commission. These submissions shall also include the mitigation measures proposed by the Contracting Party to prevent such impacts.

   (ii) The Scientific Committee shall undertake an assessment, according to procedures and standards it develops, and provide advice to the Commission as to whether the proposed bottom fishing activities would contribute to having significant adverse impacts on VMEs and, if so, whether the proposed or additional mitigation measures would prevent such impacts. In its assessment, the Scientific Committee may use additional information available to it, including information from other fisheries in the region or similar fisheries elsewhere. The Scientific Committee will not consider, or provide advice on, preliminary assessments provided after the deadline for submission of preliminary assessments set forth in paragraph 7(i).

(iii) The Commission shall, taking account of advice and recommendations provided by the Scientific Committee concerning bottom fishing activities, including data and information arising from reports pursuant to paragraph 7, adopt conservation measures to prevent significant adverse impacts on VMEs, that as appropriate:

(a) allow, prohibit or restrict bottom fishing activities within particular areas;
(b) require specific mitigation measures for bottom fishing activities;
(c) allow, prohibit or restrict bottom fishing with certain gear types; and/or
(d) contain any other relevant requirements or restrictions to prevent significant adverse impacts to VMEs.

Encounters with VMEs

8. Annex 22-06/B provides guidelines specifying categories of information to be included in the notification to be submitted to the Secretariat by Contracting Parties when evidence of VMEs has been encountered, and has not otherwise been reported under Conservation Measure 22-07.

9. Contracting Parties, in the absence of site-specific or other conservation measures to prevent significant adverse impact on VMEs, shall require vessels flying their flag to cease bottom fishing activities in any location where evidence of a VME is encountered in the course of fishing activities, and to report the encounter to the Secretariat in accordance with the schedule of the Catch and Effort Reporting System (Conservation Measures 23-01, 23-02, 23-03 or 23-07, whichever is applicable), so that appropriate conservation measures can be adopted in respect of the relevant site.

10. The Scientific Committee shall provide advice to the Commission on the known and anticipated impacts of bottom fishing activities on VMEs and recommend practices, including ceasing fishing activities if needed, when evidence of a VME is encountered in the course of bottom fishing activities. Taking account of this advice, the Commission shall adopt conservation measures to be applied when evidence of a VME is encountered in the course of bottom fishing activities.

Monitoring and control of bottom fishing activities

11. Notwithstanding Members' obligations pursuant to Conservation Measure 21-02, all Contracting Parties whose vessels participate in bottom fishing activities shall:

(i) ensure that their vessels are equipped and configured so that they can comply with all relevant conservation measures;

(ii) ensure that each vessel carries at least one CCAMLR-designated scientific observer to collect data in accordance with this and other conservation measures;

(iii) submit data pursuant to Data Collection Plans for bottom fisheries to be developed by the Scientific Committee and included in conservation measures;

(iv) be prohibited from continuing participation in the relevant bottom fishery if data arising from conservation measures relevant to that bottom fishery have not been submitted to CCAMLR pursuant to paragraph 11(iii) for the most recent season in

which fishing occurred, until the relevant data have been submitted to CCAMLR and the Scientific Committee has been allowed an opportunity to review the data.

12. The Secretariat shall annually compile a list of vessels authorised to fish pursuant to this conservation measure and shall make this list publicly available on CCAMLR's website.

Data collection and sharing and scientific research

13. The Scientific Committee shall, based on the best available scientific information, advise the Commission on where VMEs are known to occur or are likely to occur, and advise on potential mitigation measures. Contracting Parties shall provide the Scientific Committee with all relevant information to assist in this work. The Secretariat shall maintain an inventory including digital maps of all known VMEs in the Convention Area for circulation to all Contracting Parties and other relevant bodies.

14. Scientific bottom fishing research activities notified under Conservation Measure 24-01, paragraph 2, shall proceed according to Conservation Measure 24-01 and shall be undertaken with due regard to potential impacts on VMEs. Scientific bottom fishing research activities notified under Conservation Measure 24-01, paragraph 3, shall be treated in accordance with all aspects of paragraph 9 of this conservation measure, notwithstanding the procedures in Conservation Measure 24-01. Consistent with existing reporting requirements in Conservation Measure 24-01, paragraph 4, information regarding the location and the type of any VME encountered, in the course of scientific bottom fishing research activities, shall be reported to the Secretariat.

Review

15. This conservation measure will be reviewed at the next regular meeting of the Commission, based on the findings of the Scientific Committee. In addition, beginning in 2009 and biennially thereafter, the Commission will examine the effectiveness of relevant conservation measures in protecting VMEs from significant adverse impacts, based on advice from the Scientific Committee.

[1] Except for waters adjacent to the Kerguelen and Crozet Islands
[2] Except for waters adjacent to the Prince Edward Islands

PRO FORMA FOR SUBMITTING PRELIMINARY ASSESSMENTS OF THE POTENTIAL FOR PROPOSED BOTTOM FISHING ACTIVITIES TO HAVE SIGNIFICANT ADVERSE IMPACTS ON VULNERABLE MARINE ECOSYSTEMS (VMEs)

Preliminary assessment of bottom fishing activities – Required Information

1. Scope

1.1 Fishing method(s) notified
Longline type (e.g. Spanish, auto, trotline), pots etc.

1.2 Subarea/division where fishing has been notified
e.g. Subareas 88.1 and 88.2

1.3 Period of notification
Fishing season

1.4 Names of fishing vessels
Please provide the name of all vessels notified to fish

2. Proposed fishing activity – *please complete separately for each fishing gear method*

2.1 Fishing gear details
– refer to CCAMLR fishing gear library for examples noted below.

(i) Fishing gear configuration
Provide a detailed description of each fishing gear type and its deployment process including diagrams of the different components of the gear and their dimensions – include line type, weight, anchors, size, spacing, material properties (e.g. breaking strain), sink rates in water etc. – so that the fishing footprint can be estimated separately for each gear component. This description can simply cross reference gear descriptions included in the CCAMLR fishing gear library (see examples or the diagrams available in the CCAMLR observer logbooks).

(ii) Expected behaviour of fishing gear
Provide a detailed description of the fishing process and the known or expected interaction of the gear with the seafloor, including gear movement (e.g. movement in contact with the seafloor) during the setting, soaking and hauling processes. This description can reference other gear performance descriptions in documents previously adopted and available in the CCAMLR fishing gear library.

(iii) Estimated footprint associated with possible unusual fishing events
Provide a description of other fishing gear deployment events (e.g. line breakage, gear loss) that can be expected to have a footprint size or impact level associated with fishing activity, with estimates of how frequently such events occur and their associated footprint as in (ii) above. This estimate may reference other gear performance description documents previously adopted and available in the CCAMLR fishing gear library.

(iv) Estimated footprint index (km^2 per unit of fishing effort)
Using the description of fishing gear configuration (i) and the expected behaviour of the fishing gear (ii), provide an estimate of the footprint index – i.e. the estimated maximum area within which contact with the seafloor may occur per unit of fishing effort (e.g. km^2 impacted per km mainline deployed or other unit defined in the fishing gear configuration description, or see examples). Describe uncertainties used in estimating the fishing gear footprint (e.g. extent of gear movement in contact with the seafloor). This estimate may reference other footprint estimation documents previously adopted and available in the CCAMLR fishing gear library.

(v) Estimated 'impact index'
Estimate the impact index per standard unit of fishing gear (i.e. the footprint index multiplied by the composite mortality rate expected within the footprint, see examples).

2.2 Scale of proposed fishing activity
Please provide proposed estimated effort within each subarea/division in which activities have been notified, including the expected depth range of fishing activities (e.g. expected effort in units used in (iv) – total km of mainline).

3. Methods used to avoid significant impacts on VMEs

Please provide details of modifications (if any) to gear configuration or methods of deployment aimed at preventing or reducing significant impacts on VMEs during the course of fishing.

GUIDELINES FOR THE PREPARATION AND SUBMISSION OF NOTIFICATIONS OF ENCOUNTERS WITH VULNERABLE MARINE ECOSYSTEMS (VMEs)

1. General information

Include contact information, nationality, vessel name(s) and dates of data collection.

Preferably, the notification should be prepared as a proposal, using these guidelines and submitted as a meeting document to WG-EMM for review.

2. VME location

Start and end positions of all gear deployments and/or observations.

Maps of sampling locations, underlying bathymetry or habitat and spatial scale of sampling.

Depth(s) sampled.

3. Sampling gear

Indicate sampling gears used at each location.

4. Additional data collected

Indicate additional data collected at or near the locations sampled.

Data such as multibeam bathymetry, oceanographic data such as CTD profiles, current profiles, water chemistry, substrate types recorded at or near those locations, other fauna observed, video recordings, acoustic profiles etc.

5. Supporting evidence

Provide supporting evidence, rationale, analysis, and justification to classify the indicated areas as vulnerable marine ecosystems.

6. VME taxa

For each station sampled, provide details of all the VME taxa observed, including their relative density, absolute density, or number of organisms if possible.

CONSERVATION MEASURE 22-07 (2010)[1,2]
Interim measure for bottom fishing activities subject to Conservation Measure 22-06 encountering potential vulnerable marine ecosystems in the Convention Area

Species	all
Area	see CM 22-06
Season	all
Gear	bottom fishing

The Commission,

Noting the commitment made by Members to avoid significant adverse impacts on vulnerable marine ecosystems (VMEs) from bottom fishing activities,

Acknowledging the current prohibitions on bottom trawling in Conservation Measure 22-05 and on deep-sea gillnetting in Conservation Measure 22-04 in the high-seas areas of the Convention Area,

Agreeing on the need to implement the precautionary approach for managing bottom fisheries with respect to VMEs due to the difficulty in acquiring data on their location, extent and risk of significant adverse impacts,

Further noting the need to acquire additional data to contribute to assessments and advice on a long-term precautionary approach to avoiding significant adverse impacts on VMEs,

hereby adopts the following conservation measure in accordance with Article IX of the Convention and Conservation Measure 22-06:

Area

1. This conservation measure applies to the same area as Conservation Measure 22-06.

Definitions

2. The following definitions apply to this conservation measure:

   (i) Those contained in paragraphs 3 and 4 in Conservation Measure 22-06 relating to 'vulnerable marine ecosystems' (VMEs) and 'bottom fishing activities'.

   (ii) 'VME indicator organism' means any benthic organism listed in the CCAMLR VME Taxa Classification Guide[3].

   (iii) 'VME indicator unit' means either one litre of those VME indicator organisms that can be placed in a 10-litre container, or one kilogram of those VME indicator organisms that do not fit into a 10-litre container.

   (iv) 'Line segment' means a 1 000-hook section of line or a 1 200 m section of line, whichever is the shorter, and for pot lines a 1 200 m section.

   (v) 'Risk Area' means an area where 10 or more VME indicator units are recovered within a single line segment. A Risk Area has a radius of 1 n mile from the midpoint[4] of the line segment from which the VME indicator units are recovered. However, Members may require their vessels to observe a larger Risk Area in accordance with their domestic laws.

Vessel requirements

3. Members shall require their vessels to clearly mark fishing lines into line segments and collect segment-specific data on the number of VME indicator units.

4. Members shall require their vessels, if 10 or more VME indicator units are recovered in one line segment, to complete hauling any lines intersecting with the Risk Area without delay and not to set any further lines intersecting with the Risk Area. The vessel shall immediately communicate to the Secretariat and to its Flag State the location of the midpoint of the line segment from which those VME indicator units were recovered along with the number of VME indicator units recovered.

5. Members shall require their vessels, if five or more VME indicator units are recovered within one line segment, to immediately communicate to the Secretariat[5] and to their Flag State the location of the midpoint of the line segment from which those VME indicator units were recovered along with the number of VME indicator units recovered.

Management

6. On receipt of a notification under paragraph 4, the Secretariat shall:

   (i) record the location of the Risk Area;

   (ii) within one working day of receipt, notify all fishing vessels in the relevant fishery and their Flag States that the Risk Area is closed; and that, as in paragraph 4, all vessels shall immediately cease setting any further lines intersecting with the Risk Area.

7. On receipt of five notifications under paragraph 5 within a single fine-scale rectangle[6], the Secretariat shall, within one working day of receiving the fifth notification, notify all fishing vessels in the relevant fishery and their Flag States of the coordinates of the fine-scale rectangle, indicating that VMEs may occur within that area. Vessels may continue to fish in the area consistent with paragraphs 4 and 5.

Data

8. Vessels shall report in accordance with Conservation Measure 23-01 total benthos recovered in a five-day period. To the extent possible, VME indicator units for each line segment and the midpoint of each line segment on all lines, including zero catches, should be reported in the fine-scale data.

Review

9. A Risk Area shall remain closed for any fishery until reviewed by the Scientific Committee and management actions are determined by the Commission. Scientific research shall be allowed in Risk Areas as agreed by the Scientific Committee.

10. The Commission will review this conservation measure in 2012, in light of observer, vessel and other data collected, the results of the deliberations of the Working Group on Ecosystem Monitoring and Management (WG-EMM) and the Working Group on Fish

Stock Assessment (WG-FSA), and in accordance with the advice of the Scientific Committee.

[1] Except for waters adjacent to the Kerguelen and Crozet Islands
[2] Except for waters adjacent to the Prince Edward Islands
[3] Available from the CCAMLR Secretariat and on the CCAMLR website.
[4] In latitude and longitude
[5] This may be through the Flag State or directly to the Secretariat, whichever is the most practicable.
[6] A fine-scale rectangle is defined as an area of 0.5° latitude by 1° longitude with respect to the northwest corner of the statistical subarea or division. The identification of each rectangle is by the latitude of its northernmost boundary and the longitude of the boundary closest to 0°.