National Science Foundation
Division of Polar Programs
Arlington, Virginia

DRAFT ENVIRONMENTAL DOCUMENT CONCURRENCE

Activity:
Study of the Role of the Central Scotia Sea and North Scotia Ridge in the Onset and Development of the Antarctic Circumpolar Current
[PGAN14XX.IEE]

I have read the attached document and concur with the findings and recommendation. I concur that the proposed activity can commence.

Proposals Covered, Collaborative Research: Role of the Central Scotia Sea Floor and North Scotia Ridge in the Onset and Development of the Antarctic Circumpolar Current, Dalziel 1246111

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Dr. Polly Penhale Date
Senior Advisor, Environment

National Science Foundation
Division of Polar Programs
Arlington, Virginia

DRAFT ENVIRONMENTAL DOCUMENT AND FINDING OF NO SIGNIFICANT AND NOT MORE THAN MINOR OR TRANSITORY ENVIRONMENTAL IMPACT

Study of the Role of the Central Scotia Sea and North Scotia Ridge in the Onset and Development of the Antarctic Circumpolar Current
NSF Tracking Number **[PGAN14XX.IEE]**

FINDING

The National Science Foundation (NSF) has prepared an Initial Environmental Evaluation (IEE)/Environmental Assessment (EA) to conduct marine-based studies in the Scotia Sea. Three Alternatives were evaluated:

Alternative A: Perform Geophysical Survey of the Scotia Sea North Scotia Ridge, and South Atlantic Ocean, and Collect Geodetic Measurements on the South Georgia microcontinent beginning in September 2014 with an Incidental Harassment Authorization

Alternative B: Perform Geophysical and Oceanographic Survey of the Scotia Sea, and North Scotia Ridge and South Atlantic Ocean at an alternate time with an Incidental Harassment Authorization

Alternative C: No Action and no Incidental Harassment Authorization

Based on the analyses in the environmental document (IEE/EA), I believe that implementation of Alternative (A) is the preferred alternative and is not a major federal action that would have a significant effect on the human environment, within the meaning of the National Environmental Policy Act (NEPA) of 1969, whose standards are expressly incorporated in section 2403a of the Antarctic Conservation Act of 1978, as amended, as specified therein. The proposed action involves marine-based activities onboard the R/V Nathaniel B. Palmer occurring in September through October 2014 and includes the use of a low-energy acoustic source for seismic surveying over a 2,950 km track, operation of transducer-based instruments (e.g., ADCP, sonar), collection of rock samples from the seafloor, and measurement of various geodetic measurements from land-based Global Navigation Satellite System (cGNSS) stations on the South Georgia microcontinent. Likewise, the action is also not one that would have more than a minor or transitory effect on the Antarctic environment, within the meaning of the Antarctic Conservation Act of 1978, as amended, and the Protocol on Environmental Protection to the Antarctic Treaty (1991). Therefore, a comprehensive environmental evaluation would not be prepared.

The time frame for Alternative A was chosen because this is the time of year with the most favorable conditions. A second alternative (Alternative B) was considered. This alternative would defer project initiation to January through March 2015. In general, potentially affected species would be more common in the area and this is the breeding period for several species.

The detailed elements of the proposed action for Alternative B would be identical to Alternative A.

The resulting impacts from Alternative B likely would be similar to those described in this environmental document. However, implementation of Alternative B potentially would result in a higher take of marine mammals during implementation of Alternative B. In addition, Alternative B may result in other science typically conducted during the austral summer season to be deferred or cancelled. Because of the potential increase of disturbance of marine mammals and potential impacts to other science projects, further analysis of Alternative B, beyond the details described herein is not warranted.

I recommend this activity proceed based on the implementation of Alternative A. This alternative provides for the use of field studies to collect data that would determine the dynamics of the Scotia Sea system and its role in climate change. The research activities are consistent with the NSF efforts to promote scientific investigations while protecting the Antarctic environment.

Recommending Official **Date**	**Recommending Official** **Date**
Scott Borg	Li Ling Hamady
Antarctic Sciences Section Head	Environmental Policy Specialist

DRAFT INITIAL ENVIRONMENTAL EVALUATION

National Science Foundation
Division of Polar Programs
Arlington, Virginia

Study of the Role of the Central Scotia Sea and North Scotia Ridge in the Onset and Development of the Antarctic Circumpolar Current
[PGAN1401.IEE]

1.0 PURPOSE AND NEED

Overview

In support of the United States Antarctic Program (USAP), the National Science Foundation (NSF) proposes to perform marine-based studies in the Scotia Sea, to include evaluation of the lithosphere adjacent to and beneath the Scotia Sea and South Atlantic Ocean (Figure 1). The two areas are proposed for study are the South Georgia (SG) microcontinent and the seafloor of the eastern portion of the central Scotia Sea (CSS), as shown in Figure 2.

The proposed research activities would include: 1) conducting a seismic survey along a 2,950-km track (Figure 2) using a two generator-injector airgun array (with a 'hot spare') 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) collecting GPS information through the temporary installation of three continuous Global Navigation Satellite Systems (cGNSS) on the SG microcontinent, and 4) collecting dredge samples within seamounts or magnetic anomalies to determine the nature and age of bathymetric highs near the eastern edge of the CSS. Incidental takes, if they were to occur, would be anticipated to result primarily from the proposed airgun activities.

The survey of SG will involve conducting single channel seismic reflection profiling across the northern central Scotia Sea along two lines that cross the seismically active and apparently compressive boundary between the South Georgia microcontinent and the NE Georgia Rise. The targeted geophysical surveys will occur in the unexplored zones of elevated crust in the eastern CSS and is designed to address several critical questions with respect to the tectonic nature of the northern and southern boundaries of the South Georgia microcontinent.

Opening of deep Southern Ocean gateways between Antarctica and South America and between Antarctica and Australia that permitted complete circum-Antarctic circulation, the Antarctic Circumpolar Current (ACC) is not well understood. The ACC may have been critical in the transition from a warm Earth in the early Cenozoic, to the subsequent much cooler conditions that persist to the present day. Opening of Drake Passage and the West Scotia Sea likely broke the final barrier formed by the Andes of Tierra del Fuego and the 'Antarctandes' of the Antarctic Peninsula. Once this deep gateway, usually referred to simply as the Drake Passage gateway (DPG), was created, the strong and persistent mid-latitude winds could generate one of the largest deep currents on Earth at ~135 Sverdrup [A Sverdrup (Sv) is a measure of average flow rate with 1 Sv equal to one million cubic meters of water per second]. This event is widely

believed to be closely associated in time with a major, abrupt drop in global temperatures and the rapid expansion of the Antarctic ice sheets at 33-34 million years from the present (Ma), the Eocene-Oligocene boundary.

The events leading to the complete opening of this gateway are very poorly known. The uncertainty is due to the complex tectonic history of the Scotia Sea and its enclosing Scotia Ridge, the eastward-closing, locally emergent submarine ridge that joins the southernmost Andes to the Antarctic Peninsula and deflects the ACC through gaps in its northern limb (Fig. 1).The critical keys to this problem are the enigmatic floor of the Central Scotia Sea (CSS) between the high relief South Georgia (~3000m) and the lower South Orkney islands (~1200m), emergent parts of microcontinental blocks on the North and South Scotia ridges respectively, and the North Scotia Ridge itself.

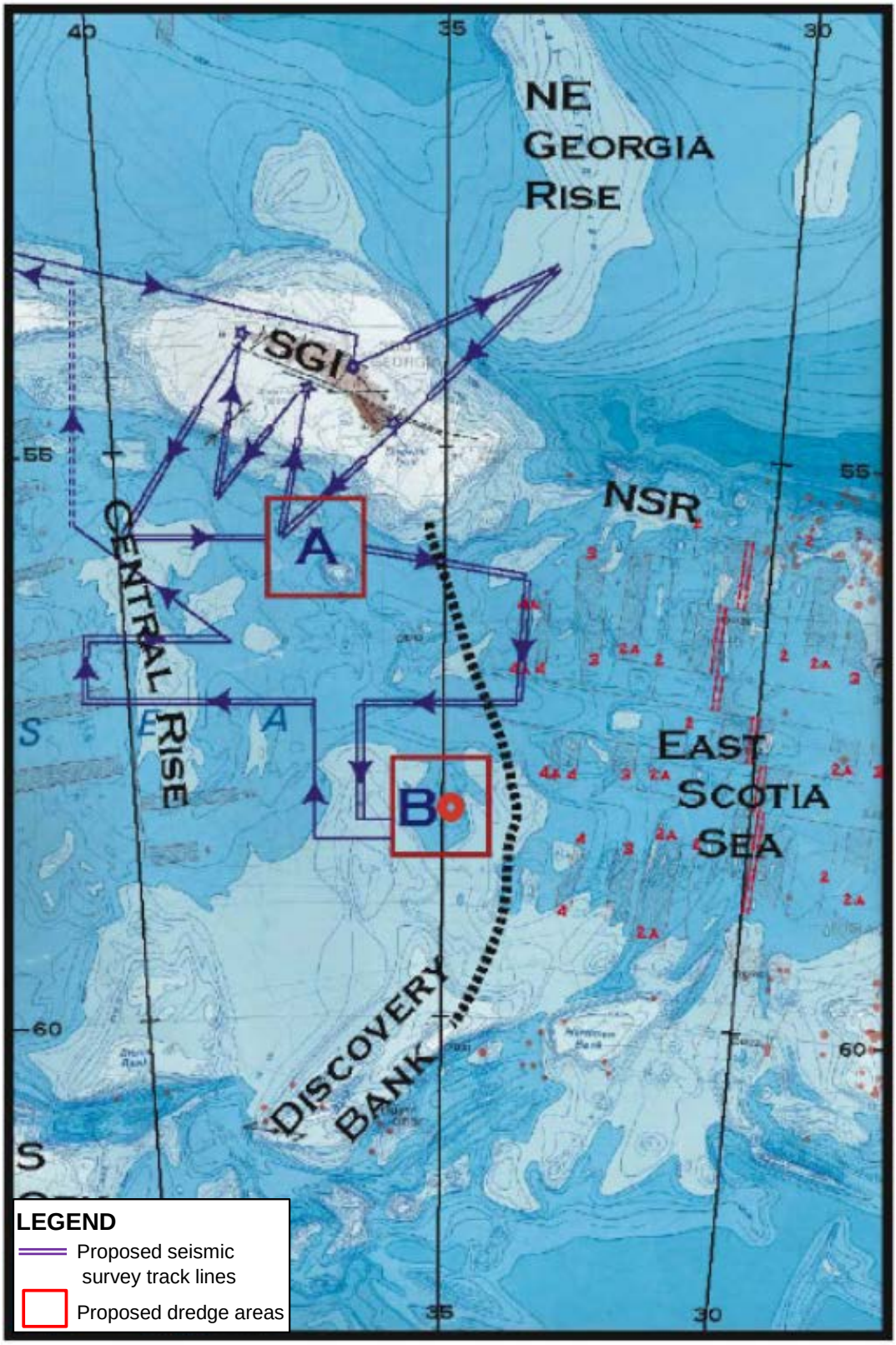
In 2008, an International Polar Year (IPY) research program was conducted using the RVIB Nathaniel B. Palmer (Cruise NBP 0805) that was designed to elucidate the structure and history of this area to help provide the constraints necessary for understanding of the initiation of the critical Drake Passage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

The results from the CSS are still fragmentary due to the limited time available during Cruise NBP 0805. Therefore, the extent, geometry and physiography of a submerged volcanic arc that may have delayed formation of a complete ACC until after the initiation of Antarctic glaciation are poorly defined, with direct dating limited to a few sites. To remedy these deficiencies, thereby further elucidating the role of the CSS in the onset and development of the ACC, the proposed targeted surveying and dredging will determine likely arc constructs in the eastern CSS. These will be combined with survey of the margins of the South Georgia microcontinent and installation of three continuous GPS stations on SG that will test the hypothesis regarding the evolution of the North Scotia Ridge, also an impediment to the present ACC.

Figure 1. Scotia Sea and South Atlantic Ocean Study Area

= Study Area

Figure 2. Scotia Sea Planned Cruise Track



Programmatic Environmental Analysis

The NSF prepared a Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) (hereafter called PEIS) for Marine Seismic Research funded by the National Science Foundation (NSF) or Conducted by the U.S. Geological Survey in compliance with the National Environmental Policy Act (NEPA); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA; NSF procedures for implementing NEPA and CEQ regulations (45 CFR 640); and Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal Actions. A Record of Decision (ROD) followed the publication of the Final PEIS in June 2012 and concluded the NEPA process.

The PEIS examined 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 Final PEIS to a number of representative or exemplary analysis areas. In this regard, 13 exemplary (representative) analysis areas were proposed for analysis within the Final PEIS, including 5 areas which were subject to detailed analysis [Detailed Analysis Areas (DAAs)] and 8 subject to qualitative analysis [Qualitative Analysis Areas (QAAs)]. One of the QAAs was designated the Sub-Antarctic (located east of New Zealand at 42° S, 145° W) and is particularly relevant to the proposed action described in this IEE with respect to biota that may be present in the Scotia Sea and South Atlantic Ocean during the early austral summer.

The PEIS set up a framework for streamlining the preparation of subsequent environmental documents where needed for individual cruises. Thus, while NSF-funded marine seismic research were reviewed in the PEIS, the analysis of site-specific impacts from future cruises such as the proposed action in the Scotia Sea and South Atlantic Ocean would be supplemented with additional analysis. Tiering this environmental document off of the PEIS increases its utility and meaning to the public, without duplicating previous paperwork and environmental analyses. Finally, the PEIS enabled the identification of an appropriate and prudent set of standard mitigation measures to be integrated into this and future NSF-funded cruises:

- Development of mitigating measures during the design and planning of research activities;
- Visual monitoring for marine mammals and turtles;
- Proposed safety radii or mitigation zone (MZ) (standard 328-ft (100-m) MZ for all research efforts with low-energy acoustic sources in water depths >100 m); and
- Mitigating measures to be implemented during operations, including: ramp-ups, shutdowns, and avoidance.

Functionally, this IEE/EA would use the environmental setting and impact assessment data presented in the PEIS for the Sub-Antarctic QAA as a basis for the evaluation and supplemented with available site-specific data for the subject regions of the Scotia Sea and South Atlantic

Ocean. Historical sightings data from previous cruises in the proposed study areas would be used to augment the Sub-Antarctic QAA data and provide semi-quantitative estimates of species population density.

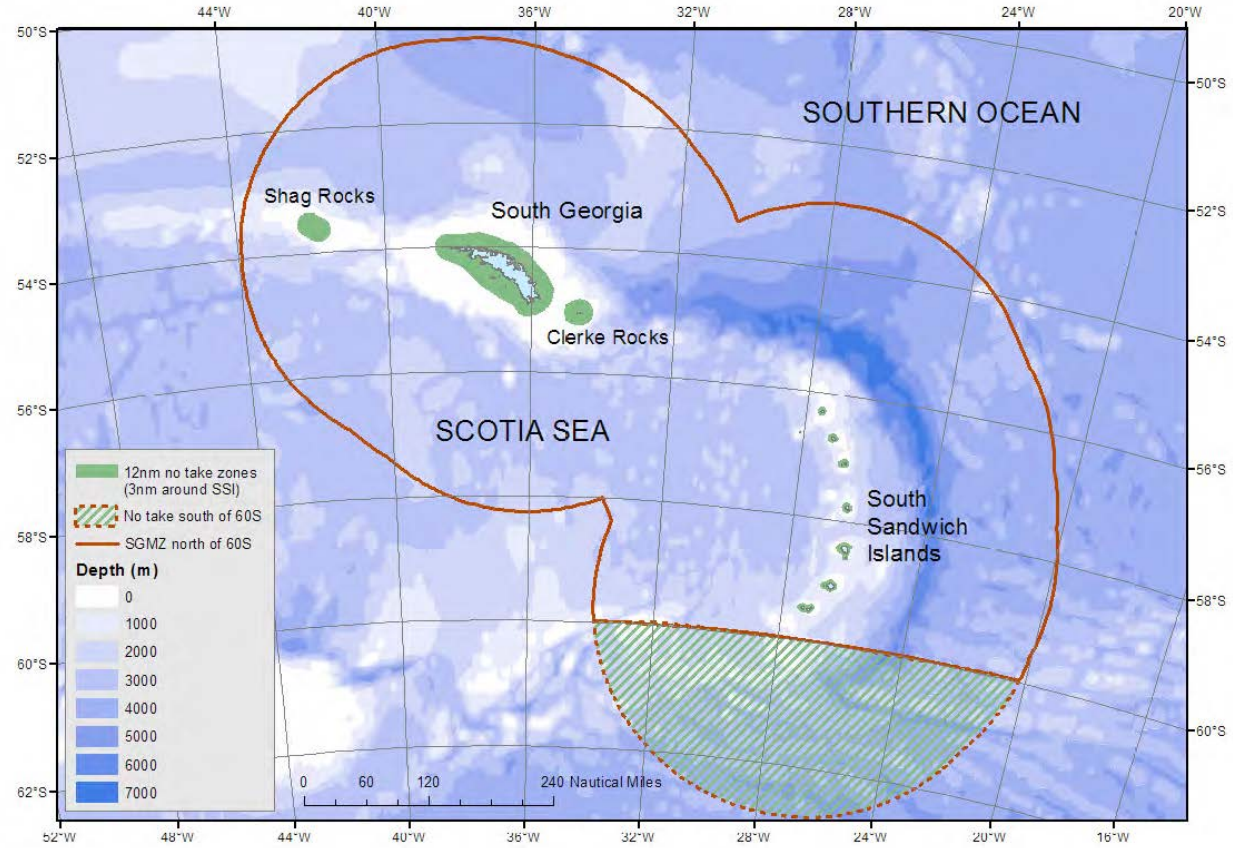
In addition, a significant portion of the environmental analysis for the effects to marine mammals was based on the PEIS and recently tiered environmental documents, including the Environmental Analysis of a Marine Geophysical Survey by the R/V Marcus G. Langseth on the mid-Atlantic Ridge, April–May 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).

2.0 PROPOSED ACTION

The proposed action would occur in selected regions of the Scotia Sea (located northeast of the Antarctic Peninsula) and South Atlantic Ocean and focus on two areas: 1) between the central rise of the Scotia Sea and the East Scotia Sea, and 2) the far South Atlantic Ocean immediately northeast of SG towards the NE Georgia Rise (both encompassing the region between 53°S and 58°S, and between 33°W and 40°W) as shown on Figure 2. The species present are expected to be the same in both locations. Figure 3 illustrates the general bathymetry of the study area and the border of the existing SG Maritime Zone (SGMZ), which also represents the Exclusive Economic Zone (EEZ) for the South Georgia and South Sandwich Islands.
Under Alternative A, the research would begin in September 2014 and span 30 days (including transit time to and from Punta Arenas, Chile) using the USAP research vessel icebreaker (RVIB) Nathaniel B. Palmer (NBP). The approximate departure date would be 20 September 2014 and the approximate arrival date would be 20 October 2014. The time frame for Alternative A was chosen because a vessel was available for use, there is generally favorable weather conditions, marine mammal densities generally are lower compared to the austral summer, and marine mammals are no longer breeding in the area.

A second alternative (Alternative B) was considered. This alternative would defer project initiation to January through March 2015. In general, potentially affected species would be more common in the area and this is the breeding period for several species. The detailed elements of the proposed action for Alternative B would be identical to Alternative A. The resulting impacts from Alternative B likely would be similar to those described in this environmental document. However, implementation of Alternative B potentially would result in a higher take of marine mammals during implementation of Alternative B. In addition, Alternative B may result in other science typically conducted during the austral summer season to be deferred or cancelled. Because of the potential increase of disturbance of marine mammals and potential impacts to other science projects, further analysis of Alternative B, beyond the details described herein is not warranted.

Figure 3. Scotia Sea Bathymetry and South Georgia Maritime Zone Boundary



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. 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 Compressor: Borsig-LMF Seismic Air Compressors, 1,200 cfm at 2000 psi
Accommodation Capacity: 22 crew plus 37 scientists

Specific details of the activities to be performed under Alternatives A or B are described below.

2.1 Seismic Survey

The proposed seismic survey would be performed in the Scotia Sea and South Atlantic Ocean along track lines totaling approximately 2,950 km and exclusively in water more than 1,000 m deep (Figure 2). The trackline distance includes equipment testing, start-up, line changes, repeat coverage of areas as needed, and equipment recovery. The proposed research activities including the seismic survey would bisect approximately 250,000 square kilometers (km^2) in the Scotia Sea region (see Figure 2). Seismic surveys would be conducted during the day and night, and for up to 40 hours of continuous operation.

The seismic surveys would be conducted within an area of approximately 3,953 km^2. This estimate is based on the maximum number of kilometers for the seismic survey (2,950 km) multiplied by the area ensonified around the planned seismic lines (0.675 km x 2). This ensonified area is based on the predicted RMS radii (m) presented in modeling data (Attachment A) assuming 100% use of 2 x 105 in^3 GI airguns in >1000 m water depths) which was calculated to be 675 m (0.675 km).

The seismic survey would involve the use of a low-energy acoustic source consisting of a two GI airgun array and either one or two 100-m solid-state hydrophone streamer towed behind the vessel. A third gun would serve as a "hot spare" to be used as a backup in the event that one of the two firing guns malfunctions. Detailed specifications, including dominant frequency and source output, for the airguns can be found in Attachment A. The airguns would be deployed in one string at a depth of approximately 3 to 4 m below the surface, spaced approximately 3 m apart and between 15 and 40 m astern. Each airgun would be configured to a displacement volume of 1,720 cubic centimeters (cm^3)(105 cubic inches) for both the generator and injector, and are considered a low-energy acoustic source as defined in the PEIS. The guns would fire the compressed air volume in unison in a harmonic mode and at an approximate firing pressure of 2,000 pounds per square inch (psi). 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).

Weather conditions permitting, it is anticipated that the seismic surveying **would not exceed 2,950 km in length and 325 hours of operation for the entire cruise** as summarized in Table 1. The long transit time between port (Punta Arenas, Chile) and the study site constrains how long the ship can be in the study area and limits the maximum amount of time the guns can operate.

Table 1. Proposed Seismic Survey Activities in the Scotia Sea

Survey Length (km)	Cumulative Duration [1] (hours)	Airgun Array Total Volume	Frequency Between Seismic Shots	Streamer Length
2,950	≤ 325	2 x 105 in^3 (2 x 1,720 cm^3)	5-10 seconds	100 m

Note: [1] Seismic operations are planned for no more than 40 continuous hours at a time.

During the seismic survey, the vessel would attempt to maintain a constant cruise speed of approximately 5 knots (9 km/hr). There would be between 360 and 720 shots per hour (distributed over the 9 kilometer distance), and the relative linear distance between shots would be between 15 and 30 m. The airguns would operate continuously for no more than 40 hours at a time and duration of continuous operation is dependent on operational constraints. The cumulative duration of airgun operation will not exceed 325 hrs. The operation hours and survey length would include equipment testing, ramp-up, line changes, and repeat coverage.

Weather and sea conditions would be closely monitored including conditions that could limit visibility. Pack ice is not anticipated to be encountered during the cruise and, therefore, no ice breaking is expected. 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.

Based on modeling data, the outputs from a pair of 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 2) and would be used accordingly to identify and report an event that could be interpreted as behavioral disturbance of marine mammals.

Table 2. Proposed MZ and 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 PEIS	
		190 dB	180 dB	160 dB	MZ (190/180 dB)	FMZ [1]
2 x 105 in^3 GI guns	>1000 m	20	69	670	100/100	670

Monitoring and 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 three Protected Species Observer (PSO) consistent with NMFS requirements, including a marine mammal expert familiar with species in the Southern Ocean to serve as the lead PSO.
- 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 minutes before the start of ramp ups through the duration of the ramp ups (and when possible at other times) during the day.
- Shutdowns when marine mammals are detected in or about to enter the designated MZ. Following a shutdown, airgun activity would not resume until the PSO has visually observed the marine mammal(s) exiting the mitigation zone and concluded that it is not likely to return or has not been seen within the mitigation 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 mitigation zone(s) - but probably not enough to allow continued one-airgun operations if a marine mammal came within the mitigation zone for two airguns.

To implement these measures, PSOs would monitor for the visual presence of cetaceans and pinnipeds prior to and during seismic survey operations. Monitoring procedures and resources are described in detail in Section 13. During seismic operations, three PSOs would be based aboard the NBP. The PSOs would be approved by NMFS and the lead PSO would be experienced with species in the Southern Ocean. The other PSOs would receive additional specialized training from the PSO to ensure that they can identify Southern Ocean species. During the majority of seismic operations, one PSO would monitor for marine mammals around the seismic vessel.

Seismic operations would be conducted during the day and night and up to 40 continuous hours during the survey. The PSOs would be on duty in 4-hour shifts and each PSO would not work more than two shifts per day; however during off hours, the resting PSO 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. 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.

For at least 30 minutes prior to the seismic survey, two PSOs 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.

A "ramp-up" procedure would be used when starting up at the beginning of seismic operations or any time after the entire array has been shut-down for more than 15 minutes, which means starting with a single GI airgun and adding a second GI airgun after five minutes. During ramp-up, the two PSOs shall monitor the mitigation zone, and if marine mammals are sighted, a shut-down shall be implemented as though the full array (both GI airguns) were operational. Therefore, initiation of ramp-up procedures from shut-down requires that the two PSOs be able to view the full mitigation zone.

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. If speed or course alteration is not safe or practicable, or if after alteration the marine mammal still appears likely to enter the mitigation zone, further mitigation measures, such as a shut-down, shall be taken.

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.

The airguns would be shut-down if a marine mammal is detected within, approaches, or enters the relevant mitigation zone (reference Table 2). A shut-down means all operating airguns are shut-down (i.e., turned off). Following a shut-down, airgun operations would not resume until the PSO(s) have visually observed the marine mammal(s) exiting the mitigation zone and is not likely to return, or has not been seen within the mitigation 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, including sperm, killer, and beaked whales).

The seismic surveys may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire relevant mitigation zones are visible and can be effectively monitored. No initiation of airgun array operations will occur from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the entire relevant mitigation zone cannot be effectively monitored by the PSO(s) on duty. To the maximum extent practicable, seismic operations (i.e., shooting airguns) will be scheduled during daylight hours.

2.2 Bathymetric Profiling, Magnetometry, and Imaging Surveys

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. During operations, when the vessel is not towing seismic equipment, its average speed would be 10.1 knots (18.8 km/hr). 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 characteristics of the Bathy 2000 are similar to the Knudsen 3260. Only one hull-mounted echo sounder can be operated at a time and the specific model to be used is expected to be selected by the scientific researchers. The Bathy 2000 was the preferred instrument for many previous surveys on the RVIB Palmer.

Multi-beam Sonar (Simrad EM120) – The hull-mounted multi-beam sonar would be operated continuously during the cruise. This instrument operates at a frequency of 12 kHz 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 millisecond (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. It would be continuously operated.

Acoustic Locator (Pinger) – A pinger would be deployed with certain instruments (e.g., camera) and equipment (e.g., dredges) so these devices can be located in the event they become detached from their lines. A pinger typically operates at a frequency of 12 kHz, generates a 5 ms pulse per second, and has an acoustical output of 162 dB re 1μPa (rms). A maximum total of six dredge samples would be obtain using these devices and require approximately 6 hours per sample. Therefore, the pinger would operate a total of 36 hours.

Passive Instruments – During the seismic survey in the Scotia Sea and South Atlantic Ocean, a precession magnetometer and Air-Sea gravity meter would be deployed. In addition, approximately 60 expendable bathythermographs (XBTs) would also be released over the course

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

2.3 Dredge Sampling

The primary sampling goals involve the acquisition of *in situ* rock samples from deep marine rises (escarpments) at 3,000 to 4,000 m depth to determine the composition and age of the seafloor. Underway multibeam and seismic data will be used to locate submarine outcrops. Dredging will be conducted upslope along the ledges. No dredging is planned along the top of any seamounts and the final selection of dredge sites will include review to ensure that the seamounts or corals in the area are avoided.

It is anticipated that researchers would survey and dredge two deep marine rises and one topographic high (see areas A and B in Figure 2). No more than three samples would be collected by dredge in each area (Table 3). The dredge buckets would be less than one meter across and each sample area to be dredged would be no longer than approximately 1,000 meters. Approximately 1,000 m^2 of seafloor would be disturbed by each deployment of the dredge at three different sites (resulting in a total of 6,000 m^2 of affected seafloor for the project).

Table 3. Proposed Dredging Activities in the Scotia Sea

Sampling Device	Area (Fig 2)	No. of Deployments
SIO style Deep Sea Rock Dredge	A	3
or		
USAP Improved Basket Dredge	B	3

[1] SIO means Scripps Institute of Oceanography

The Government of South Georgia and South Sandwich Islands (GSGSSI) has established a large sustainable use Marine Protected Area (MPA) covering over 1 million km^2 of the South Georgia and South Sandwich Islands (SGSSI) Maritime Zone. Activities conducted within the MPA are subject to the requirements of the current Management Plan (Attachment B). Research activities, including trawling and sampling of the seafloor, require application for permit issued by GSGSSI.

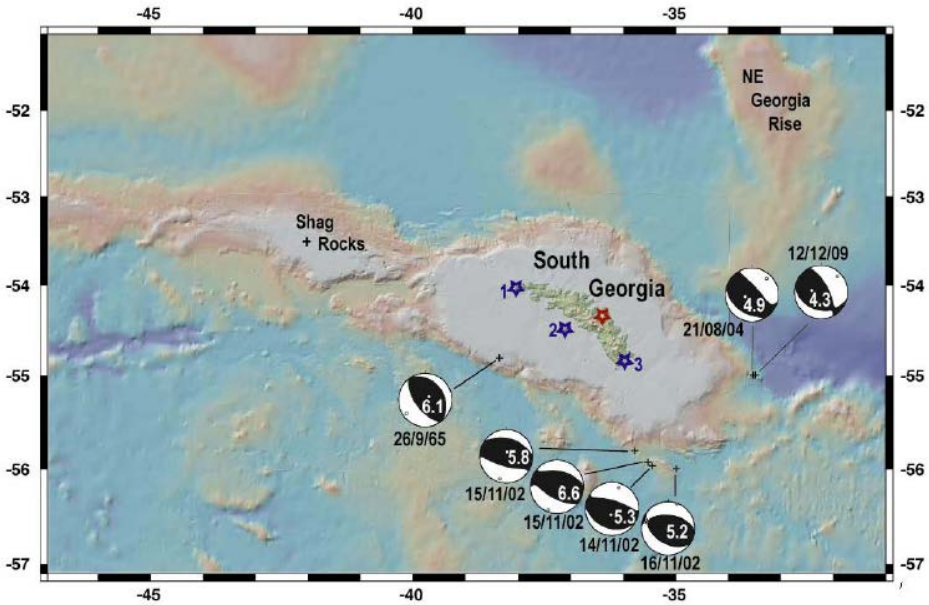
The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has adopted conservation measures (22-06, 22-07, and 22-09) to protect vulnerable marine ecosystems (VME). VME include seamounts, hydrothermal vents, cold water corals and sponge fields. These measures apply to the entire study area. Additionally, the area surrounding South Georgia Island was designated by CCALMR as an Integrated Study Area to assist with the collection and management of information relating to the CCAMLR Ecosystem Monitoring Program (CEMP).

Conservation measure 22-07 includes mitigation and reporting requirements if VME are encountered. The science team would follow these requirements (Attachment B) if VMEs are encountered while sampling the sea bottom; however, the specific intent of the dredging activities is to avoid obtaining material from the tops of seamounts.

2.4 Geodetic Measurements

Researchers would install three continuous Global Navigation Satellite System (cGNSS) stations on the South Georgia microcontinent (Figure 4). The cGNSS systems would collect GPS and meteorological data with daily data recovery using IRIDIUM-based communications. These stations would complement the cGNSS station installed at King Edward Point in Cumberland Bay on the northeastern side of the island (red star in Figure 4). A station would be installed near Cooper Bay on the southeastern extremity of the island (Figure 4; star 3). The second station would be installed on a reef or islet between Cooper Bay and Annenkov Island (Figure 4; star 2) and the third station would be installed on Bird Island (Figure 4; star 1). The stations would be removed after three years of operation.

Figure 4. **Location of cGNSS stations on the South Georgia Islands.**



Note: Star 1 = Bird Islet; Star 2 = Annenkov Island; Star 3 = Cooper Bay

The GPS antenna occupies a circle of 0.4 m diameter and is 1.5 m in height. It is joined by a cable of maximum length 30m (but as short as possible) to an upright frame no larger than 4 m2 and attached equipment box 1.32m x 0.71m x 0.61m . Each GPS/meteorological unit would include a solar power system (e.g., batteries, cables, and panels), short antennas (<0.5m) for the GPS transmitter/receiver and meteorology sensors, and a data receiver-transmission system The antennas would be anchored into the rock using a metal anchor plate and rock bolts. A small amount of epoxy may be required to ensure that the bolts are secured within the rock.

3.0 AFFECTED ENVIRONMENT

The description of the affected environment in the PEIS, Chapter 3, focuses only on those resources potentially subject to impacts. Accordingly, the discussion of the affected environment (and associated analyses) has focused mainly on those related to marine biological resources, as the proposed short-term activities have the potential to impact marine biological resources within

the project area. These resources are identified in Section 3.0, whereas the potential impacts to these resources are discussed in Section 4.0. Initial review and analysis of the proposed project actions determined that the following resource areas did not require further analysis in this IEE/EA:

- *Transportation* — Only the NPB would be used during the marine seismic survey. Therefore, projected increases in vessel traffic attributable to implementation of the proposed activities would constitute only a negligible portion of the total existing vessel traffic in the analysis area;
- *Air Quality/Greenhouse Gases* — Project vessel emissions would result from the proposed activities, however these short-term emissions would not result in any exceedance of Federal Clean Air standards. Emissions would be expected to have a negligible impact on the air quality within the survey area;
- *Land Use* — All activities are proposed to occur in the marine environment. Therefore, no changes to current land uses or activities within the project area would result from the proposed actions;
- *Safety and Hazardous Materials and Management* — No hazardous materials would be generated or used during proposed activities. All project-related wastes would be disposed of in accordance with Federal and international requirements including the Protocol on Environmental Protection to the Antarctic Treaty;
- *Geological Resources (Topography, Geology and Soil)* — The proposed actions would result in only short-term displacement of soil and seafloor sediments through dredging the seafloor. Proposed activities would not adversely affect geologic resources as only minor impacts would occur;
- *Water Resources* — No discharges to the marine environment are proposed within the project area that would adversely affect marine water quality. While research activities would include water sampling via CTDs, this would not be anticipated to have an impact on water resources;
- *Socioeconomic and Environmental Justice* — Due to the extremely remote location of the proposed activities, no environmental justice or socioeconomic impacts (including to commercial fishing or tourism activities) would be anticipated as result of the proposed activities;
- *Visual Resources* — No visual resources would be anticipated to be negatively impacted as a result of the location of the proposed activities; and
- *Cultural Resources* — there are no known cultural resources in the proposed project area. Therefore, no impacts to cultural resources would be anticipated.

The proposed action would occur in selected regions of the Scotia Sea (located northeast of the Antarctic Peninsula), and South Atlantic Ocean, encompassing the region between 53°S and 58°S, and between 33°W and 40°W. The proposed action would focus between the central rise of the Scotia Sea and the East Scotia Sea, and 2) northeast of SG towards the NE Georgia Rise. The study site is within the Sub-Antarctic QAA described in the PEIS.

The description of the environment of the Scotia Sea and region is presented below and derived primarily from the *South Georgia and the South Sandwich Islands Marine Protected Area Management Plan* (GSGSSI, 2013) included as Attachment B.

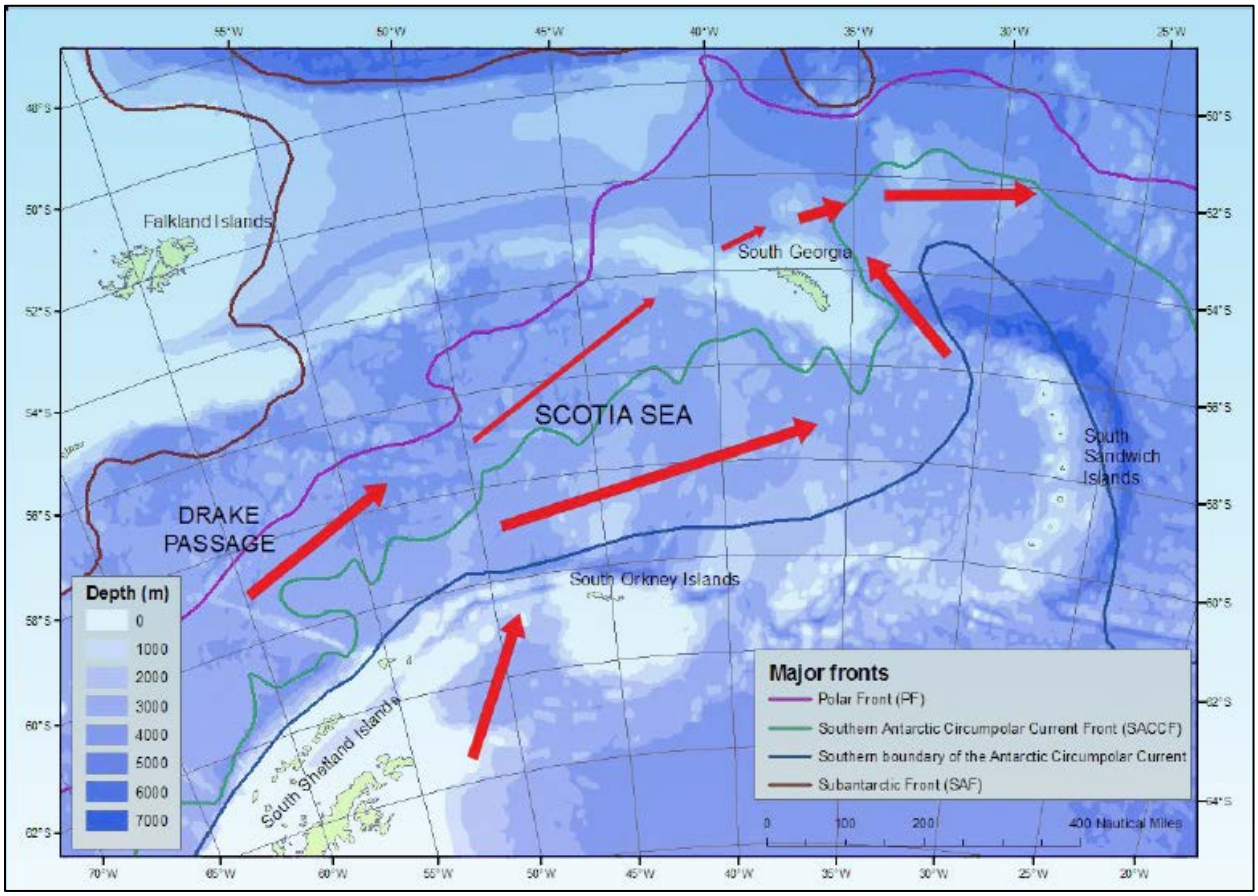
3.1 Physical Conditions

The Scotia Sea is influenced by the Antarctic Circumpolar Current (ACC), which includes high velocity currents (see Figure 5) and is highly constrained as it flows through the Drake Passage, after which it is able to meander more freely as it crosses the Scotia Sea.

The Sub-Antarctic Front (SAF) separates the ACC from temperate waters to the north. The Southern Antarctic Circumpolar Current Front (SACCF) crosses the central Scotia Sea and wraps around the eastern end of South Georgia, before retroflecting to the north and east of the island.

The Polar Front (PF) lies between the SACCF and SAF and separates waters with a subsurface temperature minimum to the south from warmer waters to the north. Further south the SB maintains a mostly eastward course through the Scotia Sea, but has a northward topographically induced loop in the vicinity of the South Sandwich Island arc. Within this area of complex oceanography, different water masses may be characterized by different flora and fauna, with fronts potentially providing elevated productivity and putative barriers to stenothermal (temperature sensitive) fauna.

Figure 5. Scotia Sea Area Bathymetry and Currents



Source: *South Georgia and the South Sandwich Islands Marine Protected Area Management Plan* (GSGSSI, 2013).

South Georgia lies to the south of the Polar Front and hence the seas surrounding the island are cold throughout the year, ranging from 0°C in August to 4°C in late summer. Tidal ranges are generally small (< 1 m).

The waters around the South Sandwich Islands, which are south of the SB, are cooler than the waters around South Georgia, reaching 1.5oC in the northern area in summer. The southern islands are usually in the seasonal sea-ice zone, which often encompasses the whole island chain between August and October.

3.2 Acoustic Environment

The PEIS describes ambient noise conditions common throughout the world's oceans, including noise generated by wind and waves, precipitation, geological sources, sea ice, and biological sources. The PEIS further described the factors that affect sound propagation in the marine environment, such as geology, bottom topography, temperature, and salinity.

The area of the South Sandwich Islands (southwest Atlantic) is tectonically the most active zone in the Antarctic (Miller, et al., 2004), as a segment of the South American-Atlantic Plate is being subducted under the Sandwich Plate at the Scotia Sea Trench with an active seafloor spreading ridge just to the west of it. Several earthquakes per day occur in this region.

3.3 Biota

The Scotia Sea and South Atlantic region is biologically active and diverse with krill populations, whales returning to feed from breeding areas in the north, as well as seal colonies, fish, and flying seabirds. The seafloor in the Scotia Sea is also known to contain diverse benthic communities. ESA listed species are identified in section 3.3.7 and listed in Table 10.

The marine habitats of the Scotia Sea and South Atlantic region can be divided into the pelagic and the benthic realms. The pelagic system is relatively uniform with similar species throughout, but with some depth stratification.

Benthic habitats are considerably more diverse extending from the inter-tidal through the shallows to 8,000 m in the depths of the trenches near the South Sandwich Islands. Hogg et al. (2011) recently highlighted the tremendous faunal diversity in the waters of South Georgia, much of which was in the benthos.

As described in Section 2, this IEE/EA would use the environmental setting and impact assessment data presented in the PEIS for the Sub-Antarctic QAA as a basis for the evaluation of the proposed action. The following presents descriptions of the biological communities that may be present in the study areas. A cross-reference of species names used in this document to their common names appears in Attachment C.

3.3.1 Marine Invertebrates

Various species of decapods and 35 squid, 10 octopus, and 4 cuttlefish species are listed in the PEIS as occurring in the sub-Antarctic area (Table 4). The cephalopods (squid and octopi) comprise an important part of the diet of a number of predator species, including penguins and other sea birds, seals and whales. It is noted that some of the species listed in the PEIS are not expected to occur in the proposed study area.

Table 4. Potential Occurrence of Decapod Crustaceans and Cephalopod Mollusks Identified in the PEIS Sub-Antarctic Area

Group	Potential Occurrence
Decapods	
Lobsters	B F E a
Crabs	B F E a
Shrimps	B F c
Cephalopods	
Octopuses	B F c
Squids	B F E M a
Cuttlefishes	B F c
Nautiluses	-

Notes: B = breeds within the area; **E** = economically important fishery within the area; **F** = feeds within the area; M = migrates through the area but unlikely to breed there. **a** = Abundant: the species group 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 group 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; **-** = species group does not occur there. Table reproduced from the PEIS
Source: NSF 2011

3.3.2 Fish

Higher group fish species that potentially occur within the sub-Antarctic area as cited in the PEIS are listed in Table 5. There are no ESA-, IUCN-, or CITES-listed fish species identified for this analysis area.

Table 5. Potential Occurrence of Higher Fish Groups Identified in the PEIS Sub-Antarctic Area

Higher Fish Group	Potential Occurrence (Jan-Feb)
Hagfishes & Lampreys	-
Sharks, Skates, Rays, & Chimeras	B F M
Sturgeons	-
Herring-likes	-
Salmon, Smelts, etc.	-
Cod-likes	B E F M
Pipefishes & Seahorses	-
Scorpionfishes	B F M
Perch-likes	B E F M
Tuna & Billfishes	B F M
Flatfishes	B E F M
Coelacanths	-

Notes: B = breeds within the area; **E** = economically important fishery within the area; **F** = feeds within the area; **M** = migrates through the area. Table reproduced from the PEIS.
Source: NSF 2011.

The dominant family in the pelagic fish in the Scotia Sea region is the *Myctophidae* or lantern fish, which includes 20 species. The myctophids are small planktivorous fish that live from the surface layers down to the bathypelagic (> 1000 m). The most abundant species in South Georgia waters are from the genera *Electrona*, *Protomyctophum* and *Gymnoscopelus*. The other important family is the *Bathylagidae* or deep-sea smelts, which are abundant at depths greater than 400 m.

The demersal ichthyofauna of the continental shelf in the Scotia Sea region is dominated by fish of the sub-order Notothenioidei, including 28 species in 5 families (Nototheniidae, Channichthyidae, Bathydraconidae, Artedidraconidae and Harpagiferidae), which are endemic to the Southern Ocean. The demersal fauna includes the marbled rock cod (*Notothenia rossii*) and the yellow-tailed notothen (*Patagonotothen guntheri*) as well as the currently fished mackerel icefish (*Champsocephalus gunnari*) and Patagonian toothfish (*Dissostichus eleginoides*).

Based on CCAMLR reports, fisheries in the Scotia Sea region reported catches of 172,657 metric tonnes during the 2010/11 reporting period, comprising primarily (99 percent) of krill (Euphausiidae), with the remainder of the catch being from, Channichthyidae, Moridae, Nototheniidae, and Rajidae.

3.3.3 Sea Turtles

Five species of sea turtles have been observed in the sub-Antarctic (Table 6) and are considered uncommon to common. No sea turtle nesting occurs in the region. The species' occurrences in the proposed study areas are not expected.

Table 6. Potential Occurrence of Sea Turtles Identified in the PEIS Sub-Antarctic Area

Species	Potential Occurrence (winter)
Green Turtle	cM
Hawksbill	cM
Loggerhead	u? M
Olive ridley	cMF
Kemp's ridley	-
Leatherback	u? MF
Flatback	-

Notes: F = known to feed within the area, **M** = known to migrate through the area; **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 assuming many visits to the area; **-** = species does not occur; **?** = uncertain. Table reproduced from the PEIS.
Source: NSF 2011.

3.3.4 Seabirds

Seabirds are considered species that nest on land but spend all or a considerable portion of their lives in marine environments and surface- or plunge-dive below the water surface in search of prey. Six seabird families may potentially occur within the sub-Antarctic area and are listed in Table 7.

Table 7. Potential Occurrence of Seabirds Identified in the PEIS Sub-Antarctic Area

Group	Potential Occurrence (Jan-Feb)
Albatrosses	FM a
Petrels/Shearwaters	FM a
Diving-petrels	F a
Gannets/Boobies	FM u
Gulls	M r
Terns/Noddies	FM c

Notes: F = known to feed within the area; **M** = known to migrate or disperse through the area; **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 few10s, **u** = uncommon: the species is expected to be encountered at most a few times a year assuming many visits to the area, **r** = rare: the species is not expected to be encountered more than once in several years. Table reproduced from the PEIS.
Source: NSF 2011.

South Georgia is home to 28 species of breeding seabirds, with a further species (Antarctic fulmar) breeding only on the South Sandwich Islands (Attachment B). The islands and waters of South Georgia and the South Sandwich Islands are regularly visited by a large number of vagrants and non-breeding species.

Four species of albatross breed on South Georgia: wandering (*Diomedea exulans*), black-browed (*Thalassarche melanophris)*, grey-headed (*Thalassarche chrysostoma)* and light-mantled sooty albatross (*Phoebetria palpebrata*).

3.3.5 Penguins

Penguins may be found in open water throughout the region as they forage from numerous established colonies on nearby land masses. Five species of penguin: king (*Aptenodytes patagonicus*), gentoo (*Pygoscelis papua*), macaroni (*Eudyptes chrysolophus*), Adélie (*Pygoscelis adeliae*) and chinstrap (*Pygoscelis antarctica*) breed on both South Georgia and the South Sandwich Islands. The largest of these species is the king penguin, which forms large densely packed colonies typically near sandy beaches and glacial melt water streams. King penguin

numbers have been increasing on South Georgia, with an estimated 450,000 breeding pairs, the majority of which are in the colonies at St Andrews Bay and Salisbury Plain.

Although the proposed seismic survey would be conducted more than 100 km from the nearest land mass, the research activities are within a penguin's maximum foraging range of 550 km from one of these colonies. The proposed survey would take place within the austral summer breeding period for these species (October-March).

3.3.6 Marine Mammals

The Scotia Sea and South Atlantic Ocean is a feeding ground for a variety of marine mammals, including cetaceans (whales), both baleen (mysticetes) and toothed whales (odontocetes) and pinnipeds (seals). Attachment B contains description of the marine mammal species that are regularly encountered in South Georgia waters.

Population data and marine mammal sightings data and density data specific to the Scotia Sea and South Atlantic region were reviewed and compiled to characterize marine mammals expected to be present in the Scotia Sea and South Atlantic Ocean. The listing of the data sources, observational characteristics associated with sightings data, species observed within the data sets, correction factors, and population density estimates by data source for cetacean and pinniped species that would be present in the proposed study area are summarized in Attachment D. Historical sightings data and estimated densities from previous cruises and other research specific to the Scotia Sea and South Atlantic region were reviewed and compiled to provide a more accurate representation of the species that may be encountered in the Scotia Sea during the proposed action and provide quantitative estimates of species population density. Based on this review, Table 8 identifies the species expected to be present in the Scotia Sea and South Atlantic. The species observed and observational characteristics associated with sightings data and the estimated densities are presented in Attachment D.

Table 8. Projected Number of Cetacean and Pinnipeds Expected to be Encountered During the Proposed Seismic Survey

Common Name	Areal Density (No. /km^2)	Estimated Number of Animals [Note 1]
Mysticetes		
Blue whale	0.0000510	1
Fin whale	0.0182040	72
Humpback whale	0.0006610	3
Minke whale	0.1557920	616
Dwarf minke whale	0.1557920	616
Sei whale	0.0063590	25
Southern right whale	0.0079652	31
Odontocetes		
Arnoux's beaked whale	0.0113790	45

Table 8. Projected Number of Cetacean and Pinnipeds Expected to be Encountered During the Proposed Seismic Survey

Common Name	Areal Density (No. /km^2)	Estimated Number of Animals [Note 1]
Cuvier's beaked whale	0.000548	3
Gray's beaked whale	0.0018850	7
Hourglass dolphin	0.0154477	61
Killer whale	0.0153800	61
Layard's beaked whale	0.0007716	3
Long-finned pilot whale	0.2145570	848
Peale's dolphin	0.0026551	10
Shepherd's beaked whale	0.0092690	37
Southern bottlenose whale	0.0089307	35
Southern right whale dolphin [Note 2]	0.0061610	24
Spectacled porpoise	0.0015000	6
Sperm whale	0.0020690	8
Pinnipeds		
Antarctic fur seal	0.5103608	2,017
Sub-Antarctic fur seal	0.5103608	2,017
Crabeater seal	0.0185313	73
Elephant seal	0.0003000	1
Leopard seal	0.115194	46
Ross seal	0.0000000	0
Weddell seal	0.0027447	11

Notes:
[1] Estimated number of animals is estimated density multiplied by the 3,953 km^2 area ensonified to 160 dB (rms) around the planned seismic lines (670 m x 2 x 2,950 km).
[2] Southern right whale dolphins are known to congregate in large groups which may be a greater number of animals than projected using estimated areal density.

3.3.7 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. No fish or benthic invertebrates in the Southern Ocean are considered endangered in the IUCN Red List. Table 9 identifies the status of penguin and marine mammal species in the Southern Ocean. Three marine mammal species are identified as endangered by IUCN are blue, fin, and sei whales.

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, Subantarctic 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
Cuvier's beaked whale	LC ver 3.1 (2008)	
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)	

Notes: 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 the 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

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				

NOTES: 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. NSF consulted the published FWS listing of foreign species and noted that no species are on the list.
http://ecos.fws.gov/tess_public/SpeciesReport.do?lead=10&listingType=L
Source: NOAA Fisheries, March 2014
The request for 'take' under the Endangered Species Act is located in Table 22

3.4 Protected Area Status

The entire Scotia Sea is a designated sustainable use Marine Protected Area (MPA) by the Government of South Georgia and South Sandwich Islands (GSGSSI). The MPA (IUCN Category VI) covers over 1 million km^2 of the South Georgia and South Sandwich Islands (SGSSI) Maritime Zone. Activities conducted within the MPA are subject to the requirements of

the Management Plan (Attachment B). The area was designated as an MPA to ensure the protection and conservation of the resources and biodiversity and support important ecosystem roles, such as feeding areas for marine mammals, penguins and other seabirds.

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has adopted conservation measures (22-06, 22-07, and 22-09) to protect vulnerable marine ecosystems (VME). VME include seamounts, hydrothermal vents, cold water corals and sponge fields. These VMEs are generally slow growing and recovery from disturbance could take decades. The CCAMLR measures apply to the entire study area. Additionally, the area surrounding South Georgia Island was designated by CCALMR as an Integrated Study Area to assist with the collection and management of information relating to the CCAMLR Ecosystem Monitoring Program (CEMP).

Conservation measure 22-07 includes mitigation and reporting requirements if VME are encountered. The science team would follow these requirements if VMEs are encountered while sampling the sea bottom; however, the specific intent of the dredging activities is to avoid obtaining material from the tops of seamounts.

4.0 ENVIRONMENTAL ANALYSIS

This section of the IEE/EA identifies the potential environmental effects resulting from the proposed activities in Alternatives A. Potential environmental effects resulting from Alternative B would likely be similar to Alternative A since fewer animals would be in the area. The direct effects of the proposed actions include interactions with the environment such as physical changes or entities imposed on or released to the environment. The proposed actions involve the use of an acoustic source for seismic surveying, operation of transducer-based instruments (e.g., ADCP, sonar), and collection of rock samples from the seafloor. These activities would result in the release of acoustical energy to the underwater environment, physical disturbance of the seafloor, and the irretrievable deployment of certain devices and equipment.

The PEIS defined the preferred alternative as the use of low-energy acoustic sources with generic mitigation measures and sets up a framework for the preparation of subsequent environmental documents. Thus, the analysis of site-specific impacts from the proposed action and relevant mitigating measures is presented in this IEE/EA and is described below.

4.1 Acoustic Outputs

During the seismic and bathymetric surveys, multiple acoustic sources would be operating simultaneously and emitting sound energy to the marine environment. Acoustical energy released by the airguns would attenuate with distance from the source. Transducer-based instruments release pulsed and highly directional acoustic energy that is significantly less intense outside the focus of the beams. Although sounds emitted underwater from multiple sources are additive, the logarithm scale which characterizes sound energy causes the most intense sound source to be dominant while less intense sources contribute little to the overall sound energy received by a receptor.

The acoustic outputs from the airguns and the transducer-based instruments emit sufficient energy to be detected by many marine organisms including marine mammals a considerable distance from the source. If exposed to high sound levels, potential adverse effects to marine organisms may include behavioral disturbance, masking of natural sounds, injury and under extreme conditions to marine mammals, temporary or permanent hearing impairment.

A description of potential impacts to each type of biological community that may result from acoustic outputs during seismic studies is presented below.

4.1.1 Marine Invertebrates

There are currently no quantitative data indicating the effects of the proposed action would adversely affect a population of marine invertebrates. Extrapolation from several studies suggests that a small number of some species or developmental stages of individual invertebrates could theoretically sustain injurious effects if they are within several meters of an operating source; however, the number of invertebrates potentially disturbed in this way would not be expected to exceed the number disturbed under natural conditions.

4.1.2 Fish

Fish in proximity to the proposed activities may potentially be affected by acoustical outputs. Generally, physiological damage or mortality in fish would only be realized if an organism was extremely close to one of the acoustic sources.

Based on the available information, fish populations expected in the survey area would include a number of families, including Nototheniiformes. The potential impacts of scientific research using seismic surveys on marine fish populations in Antarctica are not predicted to be significant (NSF, 2011). Potential impacts as a result of exposure to airgun acoustic releases primarily include short-term behavioral or possibly physiological impacts to small numbers of individuals. The small number of individual fish that could potentially experience injurious or mortal impacts when within a few meters of a high-energy acoustic source is considered insignificant on a population scale.

Short-term behavioral effects such as localized displacement or disturbance of individual fish are the most likely effects expected. It is unlikely that fish individuals would remain sufficiently near an acoustic source to be exposed to a harmful noise level. Avoidance reactions are to be considered reversible and the organisms are expected to return to the area after the vessel departs. Overall, effects on fish are expected to be minor and transitory.

4.1.3 Sea Turtles

Because sea turtles are not expected to be present in the study area, no impacts to any of their populations are expected. However, they may be observed during the transit to and from Hobart, Australia.

4.1.4 Seabirds

There are no scientific data indicating or suggesting that seabirds are adversely affected by seismic airguns or other sound sources used during typical seismic surveys. Moreover, thousands of hours of observational data by observers during numerous seismic surveys throughout the world suggest that seabirds do not remain in the water near airgun acoustic sources where they would be at potential risk of injury. Therefore, acoustic impacts of airguns on seabirds would be limited to temporary displacement of individuals (avoidance response), and no significant impacts are expected at the population level for all seabird species.

4.1.5 Penguins

There is very little information available to suggest that the underwater sounds at the intensity level expected during the proposed seismic and bathymetric surveys would have an adverse impact on penguins. It is likely that the vessel could encounter penguins during the seismic survey since this area lies within the 550-km foraging range that penguins travel from established colonies (SCAR, 2002). If encountered, it is likely that penguins would be diving and foraging for food. Similar to impacts to seabirds, there would be no significant impacts to individual penguins or their populations expected from the proposed seismic surveys (NSF, 2011). Impacts to penguins, if any, would be limited to avoidance responses and would not likely result in exposure to harmful sound levels. Overall, the impact to penguins from acoustic outputs is considered to be minor and transitory.

4.1.6 Marine Mammals

Current NMSF Guidelines

If exposed to high sound levels, potential adverse effects to marine mammal species may include behavioral disturbance, masking of natural sounds, physiological stress and, under extreme conditions, temporary or permanent hearing impairment resulting in injury or mortality. Under the U.S. Marine Mammal Protection Act (MMPA), a “take” is defined as any action to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. The term “harassment” was further defined in the 1994 amendments to the MMPA as any act of pursuit, torment, or annoyance, at two distinct levels:

- Level A Harassment – potential to injure a marine mammal or marine mammal stock in the wild.

- Level B Harassment – potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavior patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

Based on current NMFS guidelines, the threshold for received pulse levels that may result in injury or hearing impairment to marine mammals (i.e., Level A Harassment) is defined as ≥ 180 dB re 1 μPa (rms) for cetaceans and ≥ 190 dB re 1 μPa (rms) for pinnipeds. The threshold sound level that is expected to cause marine mammals to display avoidance reactions (behavioral disturbance, i.e., Level B harassment) is defined by NMFS as ≥ 160 dB re 1 μPa (rms). The

NMFS guidelines were incorporated into the mitigating measures in the PEIS to prevent marine organism exposure to sound levels that may potentially result in physiological damage or hearing impairment (i.e., Level A harassment).

Pending NMFS Guideline Revisions

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.)

Effects of the Proposed Action

No adverse effects to the marine mammals such as physiological damage or hearing impairment are expected to occur during the proposed action due to the implementation of monitoring and mitigation measures consistent with NMFS guidelines and the PEIS. During seismic and bathymetric surveying, effects on marine mammals are expected to be limited to short-term behavioral disturbance reactions exhibited by animals avoiding or being temporary displaced by acoustical sources such as the airgun array and narrowly focused transducer beams on the

moving vessel (Level B Harassment). The acoustic outputs from the airguns and transducer-based equipment are not expected to mask underwater sounds used by marine mammals due to the short duration of the acoustic pulses even though some frequencies used may overlap with those used by certain cetaceans (SCAR, 2002).

The PEIS analysis determined that with implementation of the proposed monitoring and mitigation measures, impacts to cetaceans are expected to be limited to behavioral disturbance and localized avoidance in the area near the active airguns. This is expected to have negligible short- and long-term impacts on individual odontocetes, their habitats, and regional populations.

The PEIS found in Sections 3.6.4.3 and 3.7.4.3 that operation of Multibeam Echosounders (MBES) and Sub-bottom Profilers (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.

A report on the effects of marine acoustics in the Southern Ocean by the SCAR concluded that airgun seismic surveys and transducer-based equipment are not considered a threat to marine mammal populations (SCAR, 2006). The SCAR report also documented that while acoustic outputs from transducer-based sources may create temporary behavioral changes and displace a small number of animals, their use is not considered a risk. Therefore, the effects of the proposed activities to marine mammals that may be encountered in the study area are expected to be minor and transitory. Overall, the disturbances that may result from the study activities are considered reversible and the animals are expected to return to the area after the vessel departs.

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 dredging.

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).

Further details pertaining to potential effects from acoustic sources on different classes of marine mammals including cetaceans and pinnipeds are described below. Table 11 provides an estimate of the density and number of marine mammals that may be encountered during the 2,950-km seismic survey, based on sightings data (Attachment D).

Table 11. Projected Number of Cetacean and Pinniped Takes in the Proposed Study Areas

Common Name	Areal Density (No. /km^2)	Estimated Level B Harassment/Take (No. of animals) [Note 1]
Mysticetes		
Blue whale	0.0000510	1
Fin whale	0.0182040	72
Humpback whale	0.0006610	3
Minke whale	0.1557920	616
Dwarf minke whale	0.1557920	616
Sei whale	0.0063590	25
Southern right whale	0.0079652	31
Odontocetes		
Arnoux's beaked whale	0.0113790	45
Cuvier's beaked whale	0.000548	3
Gray's beaked whale	0.0018850	7
Hourglass dolphin	0.0154477	61
Killer whale	0.0153800	61
Layard's beaked whale	0.0007716	3
Long-finned pilot whale	0.2145570	848
Peale's dolphin	0.0026551	10
Shepherd's beaked whale	0.0092690	37
Southern bottlenose whale	0.0089307	35
Southern right whale dolphin [Note 2]	0.0061610	24
Spectacled porpoise	0.0015000	6
Sperm whale	0.0020690	8
Pinnipeds		
Antarctic fur seal	0.5103608	2,017
Sub-Antarctic fur seal	0.5103608	2,017
Crabeater seal	0.0185313	73
Elephant seal	0.0003000	1
Leopard seal	0.0115194	46
Ross seal	0.000000	0
Weddell seal	0.0027447	11

Notes:

[1] Calculated take is estimated density multiplied by the 3,953 km^2 area ensonified to 160 dB (rms) around the planned seismic lines (670 m x 2 x 2,950 km).

[2] Southern right whale dolphins are known to congregate in large groups which may be a greater number of animals than projected using estimated areal density.

Cetaceans

Mysticetes

Because mysticetes feed at high latitudes in summer, several species are expected to be in the area during the seismic survey, including blue, sei, minke, and humpback whales. As summarized for the sub-Antarctic region in the PEIS and separately corroborated by actual sightings data, some mysticetes are expected to be in the study area during the proposed action. Table 11 includes an estimate of the density and number of mysticetes that may be encountered during the 2,950-km seismic survey.

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

Operation of MBESs, SBPs, and pingers is not likely to impact mysticetes. The intermittent and narrow downward-directed nature of the MBES and SBP acoustic sources would result in no more than one or two brief ping exposures to an individual mysticete given the movement and speed of the vessel and organism; such brief exposure to this sound is not expected to cause injury or PTS based on results of limited studies of some odontocete species (PEIS Appendix E, NSF 2011).

Odontocetes

Odontocetes are highly mobile and often move seasonally, traveling to high latitudes for summer feeding. Table 11 includes an estimate of the density and number of mysticetes that may be encountered during the 2,950-km seismic survey.

The proposed airguns for the seismic survey have dominant frequency components of 2-188 Hz. This frequency range somewhat 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, although at progressively lower levels with increasing frequency. These frequencies overlap most, if not all, frequencies produced by odontocetes. 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.

Odontocetes 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. Similar to mysticetes, potential injuries (Level A exposures) are not likely due to behavioral avoidance.

Pinnipeds

The six species of seals that may be present in the study area during the proposed action are expected to be mostly found near pack ice or coastal areas and not prevalent in open sea areas where the seismic survey would be conducted. Based on sightings data and population density

estimates (see Attachment C), Table 11 includes an estimate of the density and number of pinnipeds that may be encountered during the 2,950-km seismic survey.

With implementation of the proposed monitoring and mitigation measures, impacts of proposed seismic surveys to pinnipeds are expected to be limited to behavioral disturbance and, in some cases, localized avoidance of the area near the active airguns.

These effects of the proposed action are expected to have negligible short- or long-term effects on individuals, habitats, and regional populations of pinnipeds. Because of prominent avoidance reactions, pinnipeds are not expected to be exposed to potentially harmful sound levels above 190 dB re 1 μPa (rms) during the seismic survey. If an individual pinniped experiences temporary hearing impairment, full recovery of hearing is anticipated once the organism is no longer exposed. No serious injury or mortality of pinnipeds is expected.

There are currently no data on the potential disturbance effects of echosounders or sub-bottom profilers on pinnipeds. Based on observed pinniped responses to underwater sounds and the narrowly focused nature of transducer produced acoustic releases, effects, if any, to pinnipeds are expected to be short-term or momentary startle responses of no lasting consequence to the organisms.

Request for Take under the Endangered Species Act

The authors request non-lethal 'take' of odontocetes and mysticetes protected under the Endangered Species Act that may be in the area where proposed activities may occur during the cruise. The estimated 'take' is listed in Table 12 and is based on the data provided in Table 11.

Table 12. Take Request for Species Protected Under the Endangered Species Act Encounters in the Study Area

Common Name	Expected Sightings during the 2,950-km Seismic Survey	Potential Take Expected in the Study Area
Blue whale	1	1
Fin whale	72	72
Humpback whale	3	3
Sei whale	25	25
Southern right whale	31	31
Sperm whale	8	8

4.2 Physical Disturbances

Impacts resulting from dredging activities would occur due to the inherent physical disturbance of the seafloor during rock sampling activities. In addition, there is a possibility that benthic organisms may be displaced or killed, if present. It is anticipated that the dredge used to collect

sediment in the Scotia Sea region may extract up to 1,000 m^2 of material from the seafloor at each of six sampling locations (1-m wide dredge along a 1,000 m track). Therefore a total area 6,000 m^2 along 6,000 m of dredge line would be disturbed during the project.

During the proposed rock dredging activities, it is anticipated that the resulting voids in the seafloor would quickly fill with sediment as the disturbed areas collapse and native material is redistributed by bottom currents. Dredge sites would be carefully selected to avoid sensitive environments such as seamounts or corals (see also section 5.6). Impacts resulting from rock sampling activities are expected to be minor and transitory.

When the rock samples are retrieved from the seafloor, material may fall from the sampling device causing a temporary turbidity plume in the water column. Impacts resulting from the dispersal of sediment in the water column and deposition on the seafloor would be localized and would not significantly alter water quality or adversely impact benthic organisms.

Although VMEs would be avoided, there is a chance that VME indicator organisms may be collected. VMEs indicator organisms (e.g., sponges, corals) are generally slow growing and recovery from disturbance could take decades. To minimize the potential impacts to VMEs, the research team would review underway multibeam and seismic data to avoid submarine rises and seamount tops where VME indicator organisms may concentrate. See also Section 4.5 for additional mitigations.

4.3 Accidental Releases

Potential releases to the environment may include accidental spills or leaks of fuel or other hazardous materials (oil, glycol) and the unexpected loss of equipment. Since accidental releases are not planned, their frequency, magnitude, composition, and resulting environmental effects cannot be projected in advance.

Accidental spills of fuel, oil, or other substances from vessel operations are possible but very unlikely based on previous experience. Over 10 years of operation the NBP has only experienced five spills, all of which have involved hydraulic fluid, as documented in the *USAP Master Permit* Annual Report for the years when these events occurred. Each spill incident represented the release of a small quantity of liquid ($\leq$ 12 liters). Should an accidental release occur during the proposed surveys, specific resources would be available to minimize the migration of the material, facilitate cleanup, and remediate affected media. Should a spill or loss of equipment occur, the event would be documented and reported consistent with the requirements of 45 CFR §671 and the *USAP Master Permit.*

4.4 Endangered Species

No adverse impacts to endangered species are expected to occur during the proposed action. Endangered or threatened marine mammal species would not be exposed to harmful sound levels during the seismic survey that would result in injury or hearing impairment (Level A

Harassment). Additionally, mitigating measures would be taken during seismic survey activities to immediately shut down the airguns if marine mammals (including endangered species) is observed in, or entering, the MZ (that would result in a Level A exposure). In the event an endangered species enters the FMZ, it may experience short-term behavioral disturbance (Level B Harassment).

4.5 Protected Areas

No adverse impacts to populations of benthic organisms in the two proposed MPAs located in the Scotia Sea are expected. The dredge would disturb marine sediments in a 1,000 m^2 area at each of six sampling locations and any disturbed benthic habitats would be re-established through infaunal mixing.

A total area of 6,000 m^2 along 6,000 m of dredge line would be disturbed during the project. Because the dredge sampling is intended to focus on seamounts, mitigation and reporting requirements contained in CCAMLR conservation measures 22-06b and 22-07 (Attachment B) would be followed.

Mitigations include that if three or more VME indicator units are recovered at any one of the three sites, then no additional dredging would be conducted at that site within 1 nm radius of the dredges conducted, and the grantee would contact NSF. In addition, NSF would urge the grantee to contact the Southwest Science Center of the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) to provide the CCAMLR representative with information as stipulated in 22-06b.

4.6 Cumulative Impacts

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. For example, the combined acoustic outputs from the seismic surveying activities along with the simultaneous use of transducer-based equipment (multi-beam sonar, sub-bottom profiler, ADCP) could be more significant than any of these sources operating individually.

Background underwater acoustic sources in Antarctic waters include the movement and grinding of ice floes, grounding of icebergs, wind, waves, precipitation, and earthquakes (SCAR, 2004). Furthermore, several earthquakes per day occur in the area near the South Sandwich Islands. The proposed studies represent short-term events and would not incrementally increase background noise levels in the Scotia Sea.

Potential biological receptors (including marine mammals, invertebrates, and fish) are expected to detect sounds emitted from the ship during the proposed survey activities and exhibit avoidance reactions before being exposed to sounds from multiple sources. The infrequent performance of seismic surveys in the area reduces the risk that individual animals may be cumulatively exposed to potentially disruptive or harmful sound levels. Cumulative impacts to seabirds including penguins would be negligible.

As described in the PEIS (NSF, 2011), impacts to marine mammals from low-energy seismic source surveys are expected to be limited to localized and short-term behavioral changes and no impacts are anticipated at the regional population level. Thus, the proposed seismic survey would not cause chronic disruption of normal behavioral patterns or yield long-term displacement of marine mammals from preferred feeding or breeding areas. Furthermore, human-related activities in the Scotia Sea and nearby Southern Ocean are comparatively limited when considered in the context of the global scale, and the few, relatively short, localized research cruises by the USAP or other nations (see Attachment E) would not have more than a negligible cumulative effect on marine mammals at the individual or population level. Planned monitoring and mitigation measures, which include visual monitoring and the use of mitigation zones, would serve to reduce the level of impact and the likelihood of cumulative effects.

It is possible that a long-migrating animal or population exposed during the proposed cruise could be exposed to anthropogenic sounds during migration to another location or region; seasonal migration patterns of some cetaceans and pinnipeds involve long distances. However, such exposures would be considered a series of short-term behavioral changes. There is no evidence that such short-term effects, whether considered alone or in succession, result in long-term adverse impacts to individuals or populations assuming important habitats or activities are not disturbed. Additionally, migrating marine mammals have been exposed to many anthropogenic underwater sound activities for decades in all ocean basins. Some of these populations continue to grow despite certain anthropogenic marine activities that have been shown to result in behavioral disturbances to some individuals. In summary, cumulative impacts to mysticetes, odontocetes, and pinnipeds are expected to be negligible and insignificant.

The collection of rocky materials in the Scotia Sea would be limited to six 1,000-m long tracks using a dredge with a 0.5 to 1.5 m wide opening. These types of dredge samples typically recover glacial cobbles and stones with some epifaunal encrustations but would not otherwise severely disturb the bottom habitats. The cumulative effects of these sampling efforts are expected to be less than minor.

No cumulative impacts are expected to result from regular deployment of up to 60 expendable instruments (XBTs) during the proposed activities. These devices would be released at various locations and would either sink to the seafloor or eventually wash ashore resulting in less than minor impact.

The Scotia Sea and South Atlantic region has been studied by several National Antarctic Programs and numerous research cruises have been conducted by Chilean, Argentine, British, and U.S. Antarctic research teams. Within the larger region of the marine environment commercial fishing and tourism also occur and if these types of vessels are encountered it is unlikely that the proposed research would impact them. Efforts will be made to identify such cruises and coordinate with them to reduce potential impacts.

4.7 Impact Assessment Summary

The potential environmental impacts associated with the proposed action in Alternative A to perform marine-based studies in the Scotia Sea and South Atlantic Ocean have been identified

and evaluated in this IEE/EA. Table 13 summarizes the potential environmental impacts and their significance. The potential environmental impacts associated with the proposed action under Alternative B would be similar to those identified with Alternative A.

The findings of this assessment indicate that the outputs associated with the proposed research activities would have minor and transitory effects on the marine environment in the Scotia Sea and South Atlantic Ocean. The underwater release of acoustic energy from the two-airgun array and transducer-based equipment has the potential to cause transient behavioral changes in sensitive marine receptors. While the acoustic sources are not expected to cause physiological damage to the biota, some organisms may experience short-term behavioral changes such as avoidance reactions. Short-term behavioral disturbances defined by NMFS as Level B Harassment of marine mammals are expected. These responses are likely to disappear either once the vessel leaves the area or the affected organism migrates outside the study area. Additionally, the short-term duration of the seismic survey and its relatively limited extent within the context of the Scotia Sea would minimize the risk of causing significant adverse effects to a population of marine organisms inhabiting the region. Considering these factors, it is not expected that marine organisms would be exposed to noise of sufficient intensity and duration to cause injury or permanent behavioral changes.

The No Action Alternative (Alternative C) would preclude the collection of the proposed seismic and bathymetric survey data and hinder the geophysical and physical oceanographic investigation of the Scotia Sea. Data related the tectonic nature of the northern and southern boundaries of the South Georgia microcontinent would not be collected and would not be available to the science community. Loss of these data would be significant.

Table 13. Summary of Potential Impacts from Geophysical Studies in the Scotia Sea and South Atlantic Ocean

Activity	Output	Environmental Impacts[1]					
		Affected Environment	**Duration**	**Extent**	**Intensity**	**Probability**	**Environmental Rating**
Conduct Seismic Survey	Acoustic Releases (2-airgun array)	Cetaceans, Penguins, Pinnipeds, Fish	Short-term (≤ 325 hours)	3,953 km^2	Low (reversible)	Likely [2]	2
		Benthos				Unlikely	0
Conduct Bathymetric Surveys	Acoustic Releases (single-beam echo sounder, multi-beam sonar, ADCP)	Cetaceans, Penguins, Pinnipeds, Fish	Short-term (≤ 30 days)	2 areas (CSS and South Atlantic Ocean) + transit	Low (reversible)	Possible	1
		Benthos				Unlikely	0
Collect Rock Dredge Samples	Physical Disturbances	Seafloor (hard substrates)	Long-term	Localized ≤ 6 locations (6,000 m^2 total)	Moderate	Certain	3
		Benthos				Likely	1
	Acoustic Releases (pinger)	Cetaceans, Penguins, Pinnipeds, Fish	Short-term	Localized ≤ 6 locations	Low (reversible)	Unlikely	0
Deploy XBTs	Material Releases	Scotia Sea, South Atlantic Ocean	Long-term	~60	Low	Unlikely	0
Operate the NBP in Study Areas	Operational Outputs (acoustic, air emissions, wastewater, mechanical)	Scotia Sea, South Atlantic Ocean	Short-term (≤ 30 days)	Localized	Low	Unlikely	0
	Accidental Releases/Spills	Scotia Sea, South Atlantic Ocean	Long-term	Localized	Low-Moderate	Highly Unlikely	0
Deploy cGNSS) stations	Physical Disturbances	South Georgia	Short-term (≤ 3 years)	Localized 3 locations	Low	Likely	0
	Material Releases	South Georgia	Long-term		Low	Likely	0

Table 13 Notes:
CSS = Central Scotia Sea
[1] The potential environmental impacts associated with the proposed action under Alternative B would be similar to those identified with Alternative A.
[2] Total length of survey; up to 325 hours of operation; individual receptors are not likely to be exposed over the entire survey.
Environmental Rating:
+ = environmental improvement
0 = no substantial effect or highly unlikely
1 = minor, short-term effect
2 = minor effect that continues for a limited period of time after the activity is completed
3 = minor, localized long-term effect
4 = environmental effects may be substantial or long-term

5.0 COORDINATION WITH OTHER AGENCIES

This document will be used as supporting documentation for an IHA application submitted by NSF to NMFS, under the U.S. MMPA, for "taking by harassment" (disturbance) of small numbers of marine mammals during this proposed seismic survey. Potential impacts to endangered species and critical habitat have also been assessed in the document; therefore, it will be used to support the ESA Section 7 consultation process with NMFS and USFWS.

NSF will coordinate the planned marine mammal monitoring program associated with the seismic survey with any parties that express interest in this survey activity. USGS have coordinated, and will continue to coordinate, with other applicable Federal agencies as required, and will comply with their requirements.

NSF is also coordinating proposed activities with the GSGSSI and has applied for a permit for research activities, including dredging and sampling of the seafloor, consistent with the requirements of the MPA.

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