Draft Environmental Analysis of a Marine Geophysical Survey by the R/V *Marcus G. Langseth* on the mid-Atlantic Ridge, April–May 2013

Prepared for

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ABSTRACT

Lamont-Doherty Earth Observatory (L-DEO), with funding from the U.S. National Science Foundation (NSF), plans to conduct a high-energy, 2-D seismic survey on the Mid-Atlantic Ridge in April–May 2013. The seismic survey would use a towed array of 36 airguns with a total discharge volume of ~6600 in^3. The seismic survey would take place in International Waters in water depths ~900–3000 m.

NSF, as the funding and action agency, has a mission to "promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…". The proposed seismic survey would collect data in support of a research proposal that has been reviewed under the NSF merit review process and identified as NSF program priorities. It would provide data necessary to investigate the tectono/magmatic setting of the Rainbow hydrothermal field, located within a non-transform discontinuity of the Mid-Atlantic Ridge.

The Draft Environmental Analysis (EA) in this document addresses NSF's requirements under Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions", for the proposed NSF federal action. L-DEO is requesting an Incidental Harassment Authorization (IHA) from the U.S. National Marine Fisheries Service (NMFS) to authorize the incidental, i.e., not intentional, harassment of small numbers of marine mammals should this occur during the seismic survey. The analysis in this document also supports the IHA application process and provides information on marine species that are not addressed by the IHA application, including seabirds and sea turtles that are listed under the U.S. Endangered Species Act (ESA), including candidate species. As analysis on endangered/threatened species was included, this document will be used to support ESA Section 7 consultations with NMFS and U.S. Fish and Wildlife Service (USFWS). Alternatives addressed in this Draft EA consist of a corresponding program at a different time with issuance of an associated IHA and the no action alternative, with no IHA and no seismic survey. This document tiers to the Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey (June 2011) and Record of Decision (June 2012), referred to herein as PEIS.

In addition, an Environmental Assessment was prepared pursuant to the National Environmental Policy Act (NEPA) for an NSF-funded seismic survey conducted by the R/V *Ewing*, a seismic vessel formerly owned by NSF and operated on NSF's behalf by L-DEO, at a nearby site in the Mid-Atlantic Ocean (26°N, 45°W) during 30 October–5 November 2003. Although the airgun configuration and source levels were different in the survey conducted by the R/V *Ewing* than those currently proposed, analysis conclusions are similar in that no significant impacts are anticipated by the proposed activities. No marine mammals were observed during the seismic operations or during transit to and from the survey sites, which appeared to confirm anticipated low densities of species in the survey area and limited impacts, if any, of the activities. The Environmental Assessment prepared for that survey is incorporated into this analysis by reference as if fully set forth herein.

Numerous species of marine mammals inhabit the mid-Atlantic Ocean. Several of these species are listed as ***endangered*** under the U.S. Endangered Species Act (ESA): the sperm, North Atlantic right, humpback, sei, fin, and blue whales. Other ESA-listed species that could occur in the area are the ***endangered*** Bermuda petrel, leatherback, hawksbill, green, and Kemp's ridley turtles, and the ***threatened*** loggerhead turtle and roseate tern.

Potential impacts of the seismic survey on the environment would be primarily a result of the operation of the airgun array. A multibeam echosounder and a sub-bottom profiler would also be operated. Impacts would be associated with increased underwater noise, which may result in avoidance behavior by marine mammals, sea turtles, seabirds, and fish, and other forms of disturbance. An integral part of the planned survey is a monitoring and mitigation program designed to minimize potential impacts of the proposed activities on marine animals present during the proposed research, and to document as much as possible the nature and extent of any effects. Injurious impacts to marine mammals, sea turtles, and seabirds have not been proven to occur near airgun arrays, and also are not likely to be caused by the other types of sound sources to be used. However, given the high levels of sound emitted by a large array of airguns, a precautionary approach is warranted. The planned monitoring and mitigation measures would reduce the possibility of injurious effects.

Protection measures designed to mitigate the potential environmental impacts to marine mammals and sea turtles would include the following: ramp ups; typically two, but a minimum of one dedicated observer maintaining a visual watch during all daytime airgun operations; two observers 30 min before and during ramp ups during the day and at night; no start ups during poor visibility or at night unless at least one airgun has been operating; passive acoustic monitoring (PAM) via towed hydrophones during both day and night to complement visual monitoring (unless the system and back-up systems are damaged during operations); and power downs (or if necessary shut downs) when marine mammals or sea turtles are detected in or about to enter designated exclusion zones. L-DEO and its contractors are committed to applying these measures in order to minimize effects on marine mammals and sea turtles and other environmental impacts. The relatively wide shot spacing, in time and space, to be used during part of the survey, is an inherent mitigation measure relative to more typical seismic surveys with closer shot points.

With the planned monitoring and mitigation measures, unavoidable impacts to each species of marine mammal and turtle that could be encountered would be expected to be limited to short-term, localized changes in behavior and distribution near the seismic vessel. At most, effects on marine mammals may be interpreted as falling within the U.S. Marine Mammal Protection Act (MMPA) definition of “Level B Harassment” for those species managed by NMFS. No long-term or significant effects would be expected on individual marine mammals, sea turtles, seabirds, the populations to which they belong, or their habitats.

LIST OF ACRONYMS

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AMVER	Automated Mutual-Assistance Vessel Rescue
CEQ	Council on Environmental Quality
CTAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
CITES	Convention on International Trade in Endangered Species
dB	decibel
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	(U.S.) Endangered Species Act
EZ	Exclusion Zone
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information System
h	hour
hp	horsepower
ICES	International Council for the Exploration of the Sea
IHA	Incidental Harassment Authorization (under MMPA)
in	inch
IOC	Intergovernmental Oceanographic Commission of UNESCO
IODP	Integrated Ocean Drilling Program
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
kHz	kilohertz
km	kilometer
kt	knot
L-DEO	Lamont-Doherty Earth Observatory
m	meter
MAR	Mid-Atlantic Ridge
MBES	Multibeam echosounder
MCS	Multichannel seismic
min	minute
MMPA	(U.S.) Marine Mammal Protection Act
MPA	Marine Protected Area
ms	millisecond
n.mi.	nautical mile
NAMMCO	North Atlantic Marine Mammal Commission
NAST	North Atlantic Subtropical Gyral Province
NEPA	(U.S.) National Environmental Policy Act
NMFS	(U.S.) National Marine Fisheries Service
NRC	(U.S.) National Research Council
NSF	National Science Foundation
OBIS	Ocean Biogeographic Information System

OBS	Ocean Bottom Seismometer
OEIS	Overseas Environmental Impact Statement
p or pk	peak
PAM	Passive Acoustic Monitoring
PEIS	Programmatic Environmental Impact Statement
PI	Principal Investigator
POPA	Azores Fisheries Observer Programme
PTS	Permanent Threshold Shift
PSO	Protected Species Observer
QAA	Qualitative analysis area
RL	Received level
rms	root-mean-square
s	second
SBP	Sub-bottom profiler
SIO	Scripps Institution of Oceanography
TTS	Temporary Threshold Shift
UNEP	United Nations Environment Programme
U.S.	United States of America
USC	United States Code
USGS	U. S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
μPa	microPascal
vs.	versus
WCMC	World Conservation Monitoring Centre
WHOI	Woods Hole Oceanographic Institution

I. PURPOSE AND NEED

The purpose of this Draft Environmental Analysis (EA) is to provide the information needed to assess the potential environmental impacts associated with the use of a 36-airgun array during the proposed seismic survey. The Draft EA was prepared under Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions". This Draft EA tiers to the Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (June 2011) and Record of Decision (June 2012), referred to herein as PEIS. The Draft EA addresses potential impacts of the proposed seismic survey on marine mammals, as well as other species of concern in the area, including sea turtles, seabirds, fish, and invertebrates. The Draft EA will also be used in support of an application for an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS) and Section 7 consultations under the Endangered Species Act (ESA) with NMFS and U.S. Fish and Wildlife Service (USFWS). The requested IHA would, if issued, allow the non-intentional, non-injurious "take by harassment" of small numbers of marine mammals during the proposed seismic survey by L-DEO on the Mid-Atlantic Ridge (MAR) during April–May 2013.

To be eligible for an IHA under the U.S. Marine Mammal Protection Act (MMPA), the proposed "taking" (with mitigation measures in place) must not cause serious physical injury or death of marine mammals, must have negligible impacts on the species and stocks, must "take" no more than small numbers of those species or stocks, and must not have an unmitigable adverse impact on the availability of the species or stocks for legitimate subsistence uses.

In addition, an EA was prepared for an NSF-funded seismic survey conducted by the R/V *Ewing*, a seismic vessel formerly owned by NSF and operated on NSF's behalf by L-DEO, at a nearby site in the Mid-Atlantic Ocean (26ºN, 45ºW) during 30 October–5 November 2003. Although the airgun configuration and source levels were different in the survey conducted by the R/V *Ewing* than those currently proposed, analysis conclusions are similar in that no significant impacts are anticipated by the proposed activities. During the 2003 survey, no marine mammals were observed during the seismic operations or during transit to and from the survey site, which appeared to confirm anticipated low densities of species in the survey area and limited impacts, if any, of the activities. The EA prepared for that survey is incorporated into this analysis by reference as if fully set forth herein.

Mission of NSF

NSF was established by Congress with the National Science Foundation Act of 1950 (Public Law 810507, as amended) and is the only federal agency dedicated to the support of fundamental research and education in all scientific and engineering disciplines. Further details on the mission of NSF are described in § 1.2 of the PEIS.

Purpose of and Need for the Proposed Action

As noted in the PEIS, §1.3, NSF has a continuing need to fund seismic surveys that enable scientists to collect data essential to understanding the complex Earth processes beneath the ocean floor. The purpose of the proposed action is to fund the investigation of the tectono/magmatic setting of the Rainbow massif and associated hydrothermal field, located within a non-transform discontinuity of the MAR at ~36.2°N. The main goals would be (1) to determine the characteristics of the magma body that supplies heat to the Rainbow hydrothermal field; (2) to determine the distribution of the different rock types that form the Rainbow massif that hosts the hydrothermal field; and (3) to image large- and small-scale faults in the vicinity of the Rainbow massif and investigate their role in controlling hydrothermal fluid discharge. The proposed activities would continue to meet NSF's critical need to foster a better understanding of Earth processes.

Background of NSF-funded Marine Seismic Research

The background of NSF-funded marine seismic research is described in § 1.5 of the PEIS.

Regulatory Setting

The regulatory setting of this Draft EA is described in § 1.8 of the PEIS, including

- Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions";
- Marine Mammal Protection Act (MMPA); and
- Endangered Species Act (ESA).

II. Alternatives Including Proposed Action

In this Draft EA, three alternatives are evaluated: (1) the proposed seismic survey and issuance of an associated IHA, (2) a corresponding seismic survey at an alternative time, along with issuance of an associated IHA, and (3) no action alternative. Additionally, two Alternatives were considered but were eliminated from further analysis. A summary table of the proposed action, alternatives, and alternatives eliminated from further analysis is provided at the end of this section.

Proposed Action

The project objectives and context, activities, and mitigation measures for the planned seismic survey are described in the following subsections.

(1) Project Objectives and Context

L-DEO plans to conduct a seismic survey at the Rainbow massif and associated hydrothermal field, located within a non-transform discontinuity of the MAR at ~36°N, ~34°W (Fig. 1). As noted previously, the goals of the proposed research would be to conduct a multi-scale seismic investigation of the tectono/magmatic setting of the Rainbow massif, specifically to (1) determine the characteristics of the magma body that supplies heat to the Rainbow hydrothermal field; (2) determine the distribution of the different rock types that form the Rainbow massif; and (3) image large- and small-scale faults in the vicinity of the Rainbow massif, and investigate their role in controlling hydrothermal fluid discharge. To achieve these goals, the Principal Investigators (PIs), Drs. J.P. Canales, R. Dunn, and R. Sohn have proposed to (1) build a three-dimensional model of the structure of the Rainbow massif using 3-D seismic tomography methods and data recorded by 46 ocean bottom seismometers (OBSs); (2) acquire 2-D seismic reflection profiles to image crustal faulting; and (3) monitor local natural microseismicity in the area for a period of 6 months using 15 OBSs.

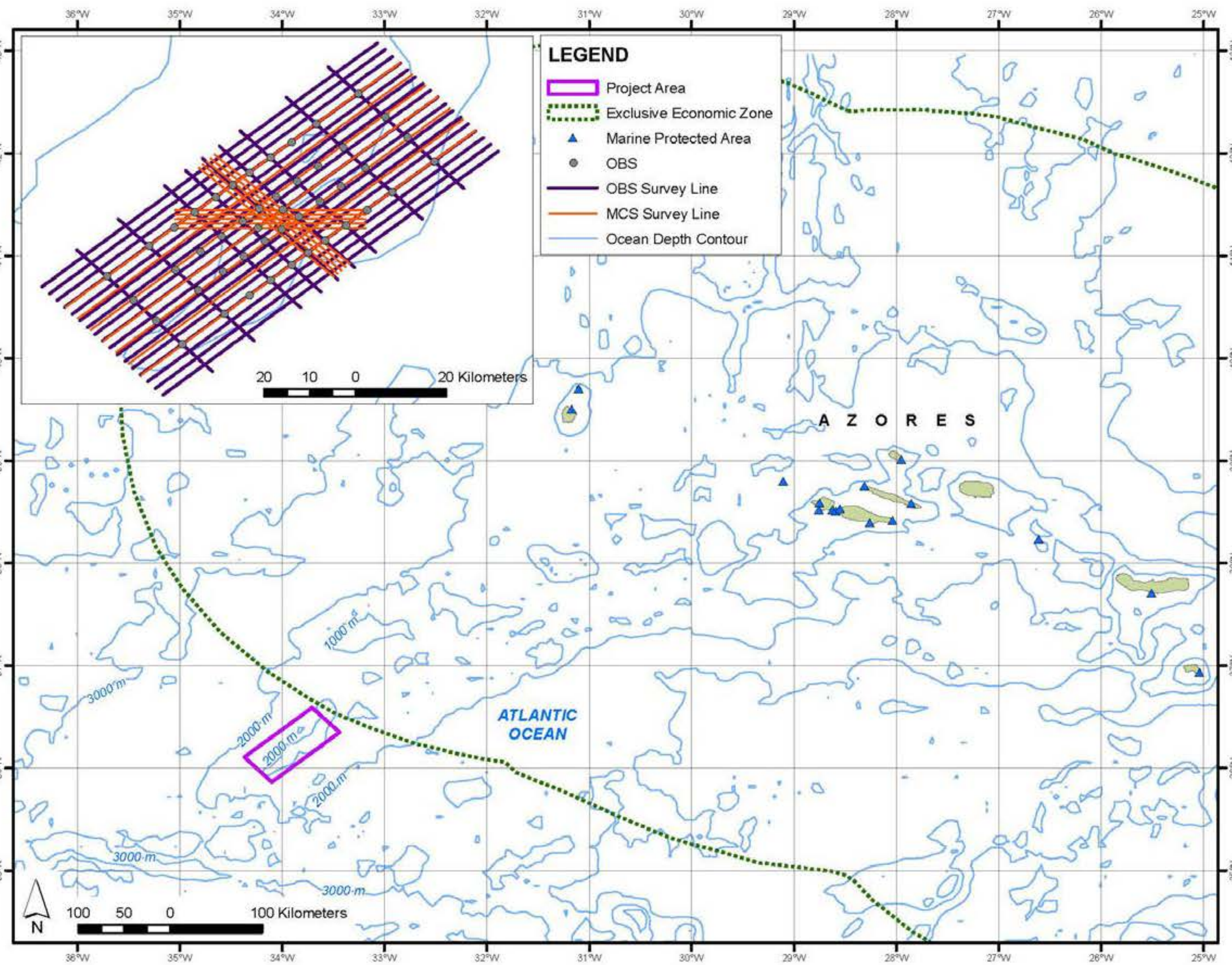


Figure 1. Location of the proposed seismic survey and OBSs at the proposed study site on the Mid-Atlantic Ridge during April–May 2013, and marine protected areas in the Azores.

(2) Proposed Activities

(a) Location of the Activities

The survey activities would encompass the area ~35.5–36.5°N, ~33.5–34.5°W on the MAR (Fig. 1). Water depths in the survey area range from ~900 m to ~3000 m. The seismic survey would be conducted in International Waters, and would be scheduled to occur for ~16–20 days during 8 April–13 May 2013. Some minor deviation from these dates would be possible, depending on logistics and weather.

(b) Description of the Activities

The procedures to be used for the survey would be similar to those used during previous seismic surveys by L-DEO and would use conventional seismic methodology. The survey would involve one source vessel, the R/V *Marcus G. Langseth*. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of ~6600 in^3. The receiving system would consist of a hydrophone streamer and/or 46 ocean bottom seismometers (OBSs). As the airgun array is towed along the survey lines, the hydrophone streamer would receive the returning acoustic signals and transfer the data to the on-board processing system. The OBSs record the returning acoustic signals internally for later analysis.

At the survey area, 46 OBSs would be deployed and a total of ~1680 km of survey lines would be shot in a grid pattern (Fig. 1). The OBSs would then be retrieved, and ~900 km of 2-D survey lines would be shot in multichannel seismic (MCS) mode using an 8-km streamer as the receiver (Fig. 1). All but ~17 km would be in water depths >1000 m. After the MCS survey, 15 OBSs would be deployed and left in place for 6 months. The total seismic survey effort would consist of ~2580 km of transect lines. There would be additional seismic operations in the survey area associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. In our calculations (see § IV(3)), 25% has been added for those additional operations.

In addition to the operations of the airgun array, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) would also be operated from the R/V *Langseth* continuously throughout the survey. All planned geophysical data acquisition activities would be conducted by L-DEO with on-board assistance by the scientists who have proposed the study. The Principal Investigators (PIs) are Drs. J.P. Canales and R. Sohn of Woods Hole Oceanographic Institution (WHOI) and Dr. R. Dunn of the University of Hawaii. The vessel would be self-contained, and the crew would live aboard the vessel for the entire cruise.

(c) Schedule

The *Langseth* would depart from St George's, Bermuda, on 8 April 2013 and spend ~6 days in transit to the proposed survey area. Deployment of the short-term OBSs would take ~ 2.5 days, the seismic survey ~16–20 days, OBS retrieval ~5 days, and deployment of long-term OBSs ~1.5 days. The Langseth would then transit for ~2 days to arrive at Ponta Delgada, Azores, on 13 May 2013.

(d) Source Vessel Specifications

The R/V *Marcus G. Langseth* is described in § 2.2.2.1 of the PEIS. The vessel speed during seismic operations would be 4.5 kt (~8.3 km/h).

(e) Airgun Description

During the survey, the airgun array to be used would consist of 36 airguns (plus 4 spares), with a total volume of ~6600 in^3. The airgun array is described in § 2.2.3.1 of the PEIS, and the airgun configuration is illustrated in the PEIS Figure 2.11. It would be towed at a depth of 12 m for the OBS and MCS lines of the survey. Shot intervals would be 3.25 min (~450 m) during OBS seismic, and ~16 s (37.5 m) during MCS seismic.

(f) OBS Description and Deployment

For the study, 46 OBSs would be deployed by the R/V *Langseth* before the OBS survey and retrieved after the OBS survey. Once the MCS survey has been completed, 15 long-term OBSs would be deployed and left in place for 6 months.

The OBSs that would be used during the cruise are Scripps Institution of Oceanography (SIO) OBSs, which have a height of ~1 m and a maximum diameter of 97 cm. The anchors are 45-kg iron grates with dimensions 7×91×91.5 cm.

Once an OBS is ready to be retrieved, an acoustic release transponder interrogates the instrument at a frequency of 9–11 kHz, and a response is received at a frequency of 9–13 kHz. The burn-wire release assembly is then activated, and the instrument is released from the anchor to float to the surface.

(g) Multibeam Echosounder and Sub-bottom Profilers

Along with the airgun operations, two additional acoustical data acquisition systems would be operated during the survey. The ocean floor would be mapped with the Kongsberg EM 122 MBES and a Knudsen Chirp 3260 SBP. These sources are described in § 2.2.3.1 of the PEIS.

(3) Monitoring and Mitigation Measures

Marine mammals and sea turtles are known to occur in the proposed survey area. However, the number of individual animals expected to be approached closely during the proposed activities would be relatively small in relation to regional population sizes. With the proposed monitoring and mitigation provisions, potential effects on most if not all individuals are expected to be limited to minor behavioral disturbance. Those potential effects are expected to have negligible impacts both on individual marine mammals and on the associated species and stocks.

To minimize the likelihood that potential impacts could occur to the species and stocks, airgun operations would be conducted in accordance with all applicable U.S. federal regulations and IHA requirements.

L-DEO's mitigation measures are described in § 2.4.4.1 of the PEIS. Included are

- mitigation during planning phases;
- monitoring by protected species visual observers (PSVOs) for marine mammals and sea turtles;
- passive acoustic monitoring (PAM);
- PSVO data and documentation; and
- mitigation during operations (speed or course alteration; power-down, shut-down, and ramp-up procedures; and special mitigation measures for rare species, species concentrations, and sensitive habitats).

Although it is very unlikely that a North Atlantic right whale would be encountered, the airgun array would be shut down if one is sighted at any distance from the vessel because of its rarity and conservation status. It is unlikely that concentrations of large whales would be encountered, but if so, they would be avoided.

Planning Phase

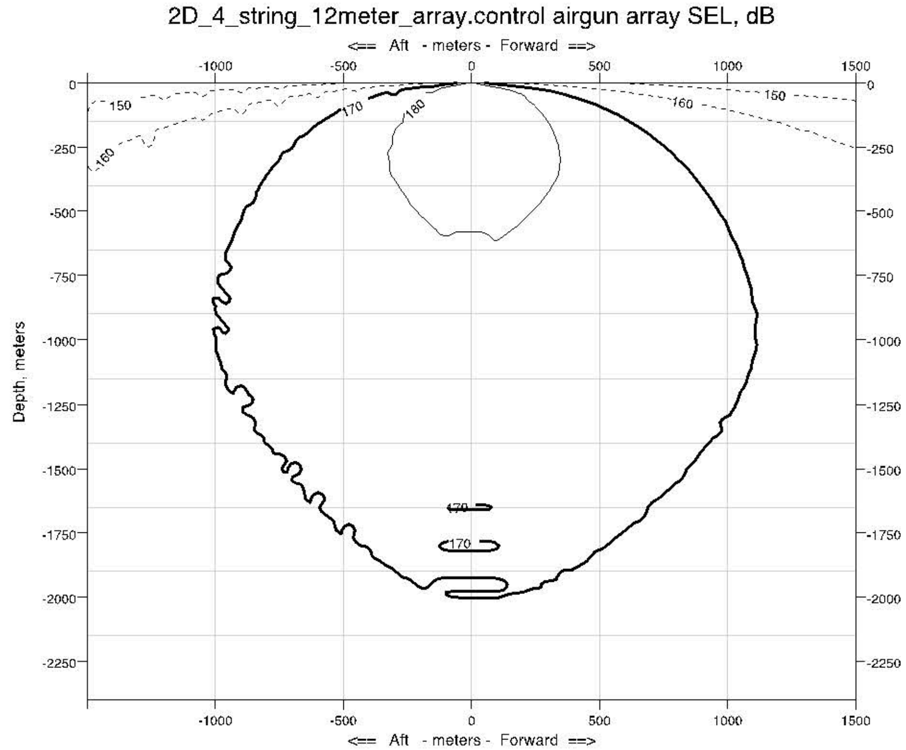
As discussed in §2.4.1.1 of the PEIS, mitigation of potential impacts from the proposed activities begins during the planning phases of the proposed activities. After considering what energy source level was necessary to achieve the research goals, the PIs determined the use of the 36-airgun array with a total volume of ~6600 in^3 would be required. Given the research goals, this energy source level is viewed as appropriate. The PIs worked with L-DEO and NSF to identify potential time periods to carry out the survey taking into consideration key factors such as environmental conditions (i.e., the seasonal presence of marine mammals, sea turtles, and seabirds), weather conditions, equipment, and optimal timing for other proposed seismic surveys using the R/V *Langseth*. Most marine mammal species are expected to occur in the area year-round, so altering the timing of the proposed project likely would result in no net benefits for those species.

Proposed Exclusion Zones

Received sound levels have been predicted by L-DEO's model (Diebold et al. 2010; see also Appendix H of the PEIS) as a function of distance from the airguns for the 36-airgun array and for a single 1900LL 40-in^3 airgun, which would be used during power downs (Figs. 2 and 3). This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the 36-airgun array have been reported in ~1600 m water depth (deep water), 50 m depth (shallow water), and a slope site (intermediate water depth) in the Gulf of Mexico (GoM) in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010).

For deep and intermediate-water cases, these field measurements cannot be used readily to derive mitigation radii, because at those sites the calibration hydrophone was located at a roughly constant depth of 350–500 m, which may not intersect all the isopleths at their widest point from the sea surface down to the maximum relevant water depth for marine mammals of ~2000 m. Figures 2 and 3 in Diebold et al. (2010) show how the values along the maximum SPL line that joins the points where the isopleths attain their maximum width (providing the maximum distance associated with each sound level) can differ from values obtained along a constant depth line. At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data recorded at the deep and slope sites are suited for comparison with modeled levels at the depth of the calibration hydrophone. At longer ranges, the comparison with the mitigation model—constructed from the maximum SPL through the entire water column at varying distances from the airgun array—is the most relevant. The results are summarized below.

Comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and modeled results for the same array tow depth are in good agreement (Figs. 12 and 14 in Diebold et al. [2010]). As a consequence, isopleths falling within this domain can be predicted reliably by the L-DEO model, even if they would be sampled imperfectly by measurements obtained at a single depth. At longer distances, the calibration data show that seafloor reflected and sub-seafloor refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent (Figs. 11, 12 and 16 in



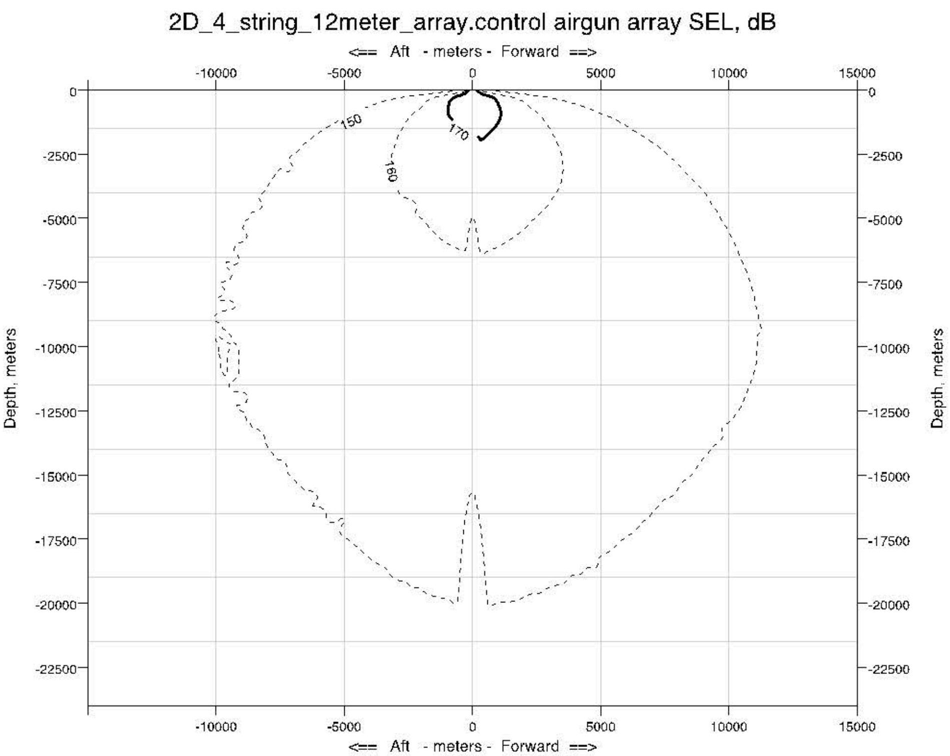
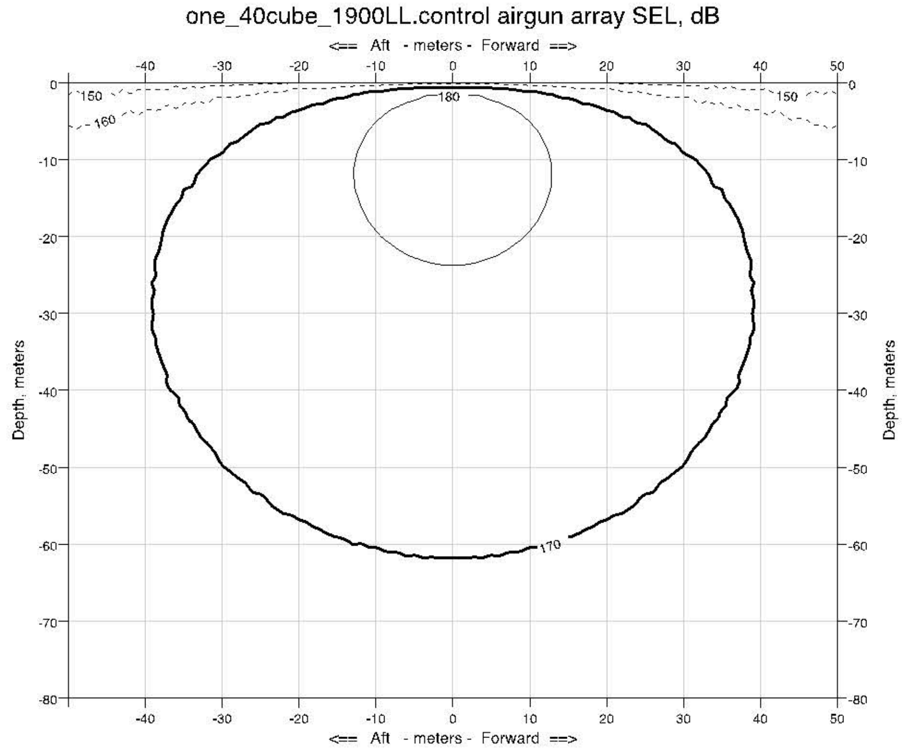


Figure 2. Modeled received sound levels (SELs) from the 36-airgun array planned for use during the proposed survey on the Mid-Atlantic Ridge during April–May 2013, at a 12-m tow depth. Received RMS levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides radius to the 170-dB SEL isopleths as a proxy for the 180-dB RMS isopleths and the plot at the bottom provides radius to the 150-dB SEL isopleth as a proxy for the 160-dB RMS isopleth. A maximum depth of 2000 m is considered.



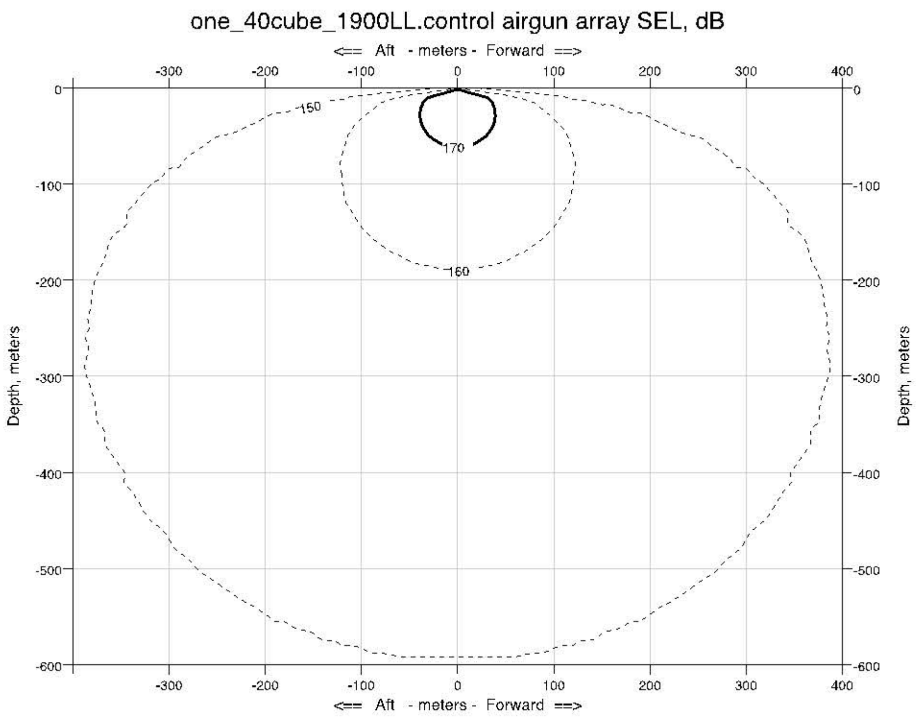


Figure 3. Modeled received sound levels (SELs) from a single 40-in^3 airgun operating in deep water, which is planned for use as a mitigation gun during the proposed survey on the Mid-Atlantic Ridge during April–May 2013. Received RMS levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides radius to the 170-dB SEL isopleths as a proxy for the 180-dB RMS isopleths and the plot at the bottom provides radius to the 150-dB SEL isopleth as a proxy for the 160-dB RMS isopleth.

Diebold et al. [2010]). Aside from local topography effects, the region around the critical distance (~5 km in Figs. 11 & 12, and ~4 km in Fig. 16 in Diebold et al. [2010]) is where the observed levels rise very close to the mitigation model curve. However, the observed sound levels are found to fall almost entirely below the mitigation model curve (Figs. 11, 12 and 16 in Diebold et al. [2010]). Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for estimating mitigation radii.

Here we use for the 36-airgun array the deep-water radii obtained from modeled levels in deep water down to a maximum depth of 2000 m. The intermediate-water radii are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (Fig. 16 in Diebold et al. [2010]).

Measurements have not been reported for the single 40-in^3 airgun. The PEIS defines a low-energy source as any towed acoustic source whose received level is ≤180 dB at 100 m, including any single airgun with a volume ≤425 in^3. In § 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applies a 100-m exclusion zone (EZ) for all low-energy acoustic sources in water depths >100 m. That approach is adopted here for the single Bolt 1900LL 40-in^3 airgun that would be used during power downs. No fixed, full 160-dB zone has been defined yet for the same suite of low-energy sources, therefore, L-DEO model results are used here to determine the 160 dB radius for the 40-in^3 airgun.

Table 1 shows the 180-dB EZ for the single airgun from the PEIS and, using the modeled measurements for the 36-airgun array and the 160-dB EZ for the single airgun, the distances at which the rms sound levels are expected to be received. The 180-dB re 1 μPa_{rms} distance is the safety criterion as specified by NMFS (2000) for cetaceans. The 180-dB distance would also be used as the exclusion zone for sea turtles, as required by NMFS in most other recent seismic projects (e.g., Smultea et al. 2004; Holst et al. 2005a,b; Holst and Beland 2008; Holst and Smultea 2008; Hauser et al. 2008; Holst 2009; Antochiw et al. n.d.). If marine mammals or sea turtles were detected within or about to enter the appropriate exclusion zone, the airguns would be immediately powered down (or shut down if necessary).

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

Alternative 1: Alternative Survey Timing

An alternative to issuing the IHA for the period requested and to conducting the project then would be to conduct the project at an alternative time, implementing the same monitoring and mitigation measures as under the Proposed Action, and requesting an IHA to be issued for that alternative time. The proposed time for the cruise in April–May 2013 is the most suitable time logistically for the R/V *Langseth* and the participating scientists. If the IHA is issued for another period, it could result in significant delay and disruption not only of this cruise, but also of additional studies that are planned on the R/V *Langseth* for 2013 and beyond. An evaluation of the effects of this Alternative Action is given in § IV.

TABLE 1. Predicted distances from the airgun array to which sound levels ≥180 and 160 dB re 1 μPa_{rms} are expected to be received during the proposed survey on the Mid-Atlantic Ridge, 8 April–13 May 2013. Radii for the full airgun array and for the 160-dB radii for the single mitigation gun are based on L-DEO model results. The 180-dB exclusion zone (EZ) for the single mitigation airgun is the conservative EZ for all low-energy acoustic sources in water depths >100 m defined in the PEIS.

Source and Volume	Water Depth (m)	Predicted RMS Radii (m)	
		180 dB	160 dB
Single Bolt airgun, 40 in^3	>1000 m	100	388
	100–1000 m	100	582
36 airguns, 6600 in^3	>1000 m	1116	6908
	100–1000 m	1674	10,362

Alternative 2: No Action Alternative

An alternative to conducting the proposed activities is the "No Action" alternative, i.e., do not issue an IHA and do not conduct the research operations. If the research was not conducted, the "No Action" alternative would result in no disturbance to marine mammals due to the proposed activities.

The goal of the proposed research is to conduct a multi-scale seismic investigation of the tectono/magmatic setting of the Rainbow massif, specifically to (1) to determine the characteristics of the magma body that supplies heat to the Rainbow hydrothermal field; (2) to determine the distribution of the different rock types that form the Rainbow massif; and (3) to image large- and small-scale faults in the vicinity of the Rainbow massif, and investigate their role in controlling hydrothermal fluid discharge. The methodology to achieve this goal would be to conduct a multi-scale seismic investigation of the tectono/magmatic setting of the Rainbow massif using the R/V *Langseth*.

The "No Action" alternative could also, in some circumstances, result in significant delay of other studies that would be planned on the R/V *Langseth* for 2013 and beyond, depending on the timing of the decision. Not conducting this cruise (no action) would result in less data and support for the academic institutions involved. Data collection would be an essential first step for a much greater effort to analyze and report information for the significant topics indicated. The field effort provides material for years of analyses involving multiple professors, students, and technicians. The lost opportunity to collect valuable scientific information would be compounded by lost opportunities for support of research infrastructure, training, and professional career growth. An evaluation of the effects of this Alternative Action is given in § IV.

Alternatives Considered but Eliminated from Further Analysis

(1) Alternative E1: Alternative Location

The Rainbow Hydrothermal Field is unique because it represents an end-member within the family of Mid-Atlantic Ridge hydrothermal systems: it vents fluids at very high temperatures (up to 365°C) and it is hosted in mantle (ultramafic) rocks. No other known system in this area meets these characteristics. Observations from water-column surveys indicate that there are probably other systems similar to Rainbow in the area; however Rainbow is to date the only system accurately located and scientifically sampled.

Since the inception of this proposal, similar systems have been discovered and described in the Central and South Atlantic (Logatchev, 14°45'N; Semeynov, 13°30'N; Ashadze, 13°N; Nibelungen, 8°18'S). However, none of these systems is located within a non-transform discontinuity as Rainbow is, and most importantly, none of them have been geologically surveyed and sampled with the detail that Rainbow has. Having detailed geological information is paramount for interpreting our geophysical observations.

For those reasons, Rainbow is the only site where the main scientific research questions posed could be addressed: What are the relationships between magmatism, faulting, substrate lithology, and hydrothermal circulation at a high-temperature, ultramafic-hosted hydrothermal field? Furthermore, the proposed research underwent the NSF merit review process, and the science, including the site location, was determined to be meritorious.

(2) Alternative E2: Use of Alternative Technologies

As described in § 2.6 of the PEIS, alternative technologies to the use of airguns were investigated to conduct high-energy seismic surveys. At the present time, these technologies are still not feasible, commercially viable, or appropriate to meet the Purpose and Need. NSF currently owns the R/V *Langseth*, and its primary capability is to conduct high-energy seismic surveys.

Table 2 provides a summary of the proposed action, alternatives, and alternatives eliminated from further analysis.

III. Affected Environment

As described in the PEIS, Chapter 3, the description of the affected environment 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 III, whereas the potential impacts to these resources are discussed in Section IV. Initial review and analysis of the proposed Project activities determined that the following resource areas did not require further analysis in this Environmental Assessment:

- *Transportation*—Only the R/V *Langseth* 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 Project;
- *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;

Table 2. Summary of Proposed Action, Alternatives Considered, and Alternatives Eliminated

Proposed Action	Description/Analysis
Proposed Action: Conduct a marine geophysical survey and associated activities on the Mid-Atlantic Ridge	Under this action, the following activities are proposed (1) to conduct 3-D seismic tomography methods and data recorded by 46 ocean bottom seismometers (OBSs); (2) to acquire 2-D seismic reflection profiles; and (3) to monitor local natural microseismicity for a period of 6 months using 15 OBSs. When considering mobilization, demobilization, refueling, equipment maintenance, weather, marine mammal activity, and other contingencies, the proposed activities would be expected to be completed in ~16–20 days. The affected environment, environmental consequences, and cumulative impacts of the proposed activities are described in Sections 3.0, 4.0, and 5.0, respectively. All necessary permits and authorizations, including an IHA, would be requested from regulatory bodies.
Alternatives	Description/Analysis
Alternative 1: Alternative Survey Timing	Under this Alternative, LDEO would conduct survey operations at a different time of the year to reduce impacts on marine resources and users, and improve monitoring capabilities. However, most marine mammal species are probably year-round residents in the survey area, so altering the timing of the proposed project likely would result in no net benefits for those species. Further, consideration would be needed for constraints for vessel operations and availability of equipment (including the vessel) and personnel. Limitations on scheduling the vessel include the additional research studies planned on the vessel for 2013 and beyond. The proposed monitoring and mitigation measures described in detail in this document (Section II (3)), would apply to survey activities conducted during an alternative survey time period, along with any additional requirements identified by regulating agencies as a result of the change. All necessary permits and authorizations, including an IHA, would be requested from regulatory bodies.
Alternative 2: No Action	Under this Alternative, no proposed activities would be conducted and seismic data would not be collected. Whereas this alternative would avoid impacts to marine resources, it would not meet the purpose and need for the proposed action. Geological data of scientific value and relevance increasing our understanding of Earth processes and the tectono/magmatic setting of the Rainbow field would not be collected. The collection of new data, interpretation of these data, and introduction of new results into the greater scientific community and applicability of this data to other similar settings would not be achieved. No permits and authorizations, including an IHA, would be requested from regulatory bodies as the proposed action would not be conducted.
Alternatives Eliminated from Further Analysis	Description
Alternative E1: Alternative Location	The survey location has been specifically identified because of the geological features under investigation. While alternative survey locations may be possible, Rainbow is the only site where the main scientific research questions posed could be addressed: What are the relationships between magmatism, faulting, substrate lithology, and hydrothermal circulation at a high-temperature, ultramafic-hosted hydrothermal field? Furthermore, the proposed science underwent the NSF merit review process, and the science, including the site location, was determined to be meritorious.
Alternative E2: Alternative Survey Techniques	Under this alternative, LDEO would use alternative survey techniques, such as marine vibroseis, that could potentially reduce impacts on the marine environment. Alternative technologies were evaluated in the PEIS, § 2.6. At the present time, however, these technologies are still not feasible, commercially viable, or appropriate to meet the Purpose and Need. NSF currently owns the R/V *Langseth*, and its primary capability is to conduct high-energy seismic surveys.

- *Geological Resources (Topography, Geology and Soil)*—The proposed Project would result in only short-term displacement of soil and seafloor sediments through the placement of OBSs on 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. Therefore, there would be no impacts to water resources resulting from the proposed Project activities;
- *Terrestrial Biological Resources*—All proposed Project activities would occur in the marine environment and would not impact terrestrial biological resources;
- *Socioeconomic and Environmental Justice*—Implementation of the proposed Project would not affect, beneficially or adversely, socioeconomic resources, environmental justice, or the protection of children. No changes in the population or additional need for housing or schools would occur; human activities in the area around the survey vessel would be limited to commercial fishing activities, however because of the distance from local ports and the short duration of the proposed activities (<1 month), fishing activity is expected to be very limited, and no significant impacts on fishing would be anticipated. Fishing and potential impacts to fishing are described in further detail in Sections III and IV, respectively. No other socioeconomic impacts would be anticipated as result of the proposed activities;
- *Visual Resources*—No visual resources would be anticipated to be negatively impacted as the area of operation is significantly outside of the land and coastal view shed; and
- *Cultural Resources*—There are no known cultural resources in the proposed Project area. Therefore, no impacts to cultural resources would be anticipated.

One of the qualitative analysis areas (QAAs) defined in the PEIS is on the MAR, at 26ºN, 40ºW, ~1100 km from the proposed survey area. The PEIS MAR QAA provided a qualitative assessment for a 2-D reflection seismic survey with a 36-airgun array. The affected environment and environmental consequences for that survey scenario were described in the PEIS in Chapter 3. The PEIS MAR QAA survey, and associated affected environment and potential environmental consequences, is similar to the survey currently proposed. This Draft EA, however, provides further detail and analysis for this specific survey and survey location.

Oceanography

The Atlantic Ocean is divided by the MAR, one of the largest underwater mountain ranges with a length of ~16,000 km, extending from the Arctic Ocean to the southern tip of Africa. It lies along the north-south axis of the Atlantic Ocean in the central part of the basin between abyssal plains. The proposed survey area consists of a hydrothermal field on the MAR at ~36°N, 34°W.

The proposed survey area is in the North Atlantic Subtropical Gyral Province (NAST), which is bounded to the west and northwest by the Gulf Stream, to the northeast at ~40–42ºN by the bifurcation of the flow between the Azores Current and the North Atlantic Current, and to the south at ~25–30ºN by the Subtropical Convergence (Longhurst 2007). Because of density differences between the water masses, most of the region has a complex vertical stratification pattern (Skov et al. 2008). The NAST can contain both errant cold-core eddies originating in the Gulf Stream and cyclonic, warm-core eddies created by isolated seamounts (Longhurst 2007). At the proposed survey area, the Azores Current flows to the east in summer and winter (Santos et al. 1995).

A spring phytoplankton bloom occurs in the North Atlantic Ocean because of increasing light conditions and nutrient availability. The bloom starts at a latitude of ~35ºN in December–January and then develops across the North Atlantic during spring and summer, moving north to arctic waters in June. At the same time, stratified nutrient-depleted waters of the North Atlantic Subtropical Gyre also extend north, reaching the latitudes of the Azores in late spring to early summer. In the Azorean archipelago, situated on the MAR ~400 km northeast of the proposed survey area, peak chlorophyll *a* concentrations (0.3−0.64 mg/m^3) during 2004−2007 were measured in February−April, and the lowest concentrations (0.07−0.10 mg/m^3) were measured in June−October (Visser et al. 2011). The spring phytoplankton bloom could temporarily produce high zooplankton densities, particularly in areas where the spring bloom combines with physical factors, e.g., upwelling areas, fronts, and seamounts, to concentrate zooplankton.

Protected Areas

There are a number of marine protected areas in the Azores, the nearest of which is >400 km from the proposed survey area. The areas are shown in Figure 1.

Marine Mammals

Forty-four species of marine mammals, including 30 odontocetes, 7 mysticetes, and 7 pinnipeds, are known to occur in the North Atlantic Ocean. Of those, 28 cetacean species (7 mysticetes and 21 odontocetes) could occur near the proposed survey site (Table 3). Six of the 28 species are listed under the U.S. Endangered Species Act (ESA) as ***Endangered***: the North Atlantic right, humpback, blue, fin, sei, and sperm whales. Seven cetacean species, although present in the wider North Atlantic Ocean, likely would not be found near the proposed survey area at ~36–36.5°N because their ranges generally do not extend south of ~40°N in pelagic mid-Atlantic waters (the Atlantic white-sided dolphin *Lagenorhynchus acutus*, white-beaked dolphin *Lagenorhynchus albirostris*, and harbor porpoise *Phocoena phocoena*), or their ranges in the North Atlantic Ocean generally do not extend north of ~20°N (the Clymene dolphin *Stenella clymene*), 30°N (Fraser's dolphin *Lagenodelphis hosei*), 34°N (the spinner dolphin *Stenella longirostris*), or 35°N (the melon-headed whale *Peponocephala electra*). Two additional species, the Atlantic humpback dolphin (*Souza teuszii*) found in coastal waters of western Africa, and the long-beaked common dolphin (*Delphinus capensis*) found in coastal waters of South America and of western Africa do not occur in deep offshore waters. No pinniped species is known to occur in the deep waters of the MAR.

General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of mysticetes and odontocetes are given in § 3.6.1 and § 3.7.1, respectively, of the PEIS. The general distribution of mysticetes and odontocetes in the North Atlantic and on the MAR is discussed in § 3.6.3.4 and § 3.7.3.4 of the PEIS, respectively. The rest of this section deals specifically with their distribution near the proposed survey area.

The main sources of information used here are a multidisciplinary survey conducted during 4 June–2 July along the MAR from Iceland to the Azores (Waring et al. 2008) and the Ocean Biogeographic Information System (OBIS) database hosted by Rutgers and Duke University (Read et al. 2009), in particular cetacean sightings reported by the Azores Fisheries Observer Programme (POPA), which covered the Azores, Madeira, and Canary islands during 1998–2009 (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). POPA observers are on the Azorean tuna fleet, and the fishery occurs between May and November (POPA 2012). Other relevant OBIS data used here are unclassified incidental sightings of

Table 3. The habitat, regional abundance, and conservation status of marine mammals that could occur in or near the proposed survey site.

Species	Occurrence near survey location	Habitat	Abundance in the North Atlantic	ESA[1]	IUCN[2]	CITES[3]
Mysticetes North Atlantic right whale	Rare	Coastal and shelf waters	396[4]	EN	EN	I
Humpback whale	Common-Uncommon	Mainly nearshore waters and banks	11,570[5]	EN	LC	I
Common minke whale	Common-Uncommon	Coastal, offshore	121,000[6]	NL	LC	I
Bryde's whale	Uncommon	Coastal, offshore	N.A.	NL	DD	I
Sei whale	Common-Uncommon	Mostly pelagic	12-13,000[7]	EN	EN	I
Fin whale	Common-Uncommon	Slope, mostly pelagic	24,887[8]	EN	EN	I
Blue whale	Common-Uncommon	Coastal, shelf and pelagic	937[9]	EN	EN	I
Odontocetes Sperm whale	Common-Uncommon	Usually deep pelagic, steep topography	13,190[10]	EN	VU	I
Pygmy sperm whale	Rare	Deep waters off shelf	395[4,11]	NL	DD	II
Dwarf sperm whale	Rare	Deep waters off shelf		NL	DD	II
Cuvier's beaked whale	Common-Uncommon	Slope and pelagic	3513[4,12]	NL	LC	II
Northern bottlenose whale	Common-Uncommon	Pelagic	~40,000[13]	NL	DD	I
True's beaked whale	Rare	Pelagic	3513[4,12]	NL	DD	II
Gervais beaked whale	Uncommon	Pelagic	3513[4,12]	NL	DD	II
Sowerby's beaked whale	Uncommon	Pelagic	3513[4,12]	NL	DD	II
Blainville's beaked whale	Uncommon	Pelagic	3513[4,12]	NL	DD	II
Rough-toothed dolphin	Rare	Mostly pelagic	N.A.	NL	LC	II
Common bottlenose dolphin	Common-Uncommon	Coastal, shelf, pelagic	81,588[14]	NL	LC	II
Pantropical spotted dolphin	Rare	Shelf, slope and oceanic	4,439[4]	NL	LC	II
Atlantic spotted dolphin	Common-Uncommon	Shelf, offshore	50,978[4]	NL	DD	II
Striped dolphin	Common-Uncommon	Off continental shelf	94,462[4]	NL	LC	II
Short-beaked common dolphin	Common-Uncommon	Shelf, pelagic, high relief	120,743[4]	NL	LC	II
Risso's dolphin	Common-Uncommon	Shelf, slope, seamounts	20,479[4]	NL	LC	II
Pygmy killer whale	Rare	Pelagic	N.A.	NL	DD	II
False killer whale	Common-Uncommon	Pelagic	N.A.	NL	DD	II
Killer whale	Common-Uncommon	Coastal, widely distributed	N.A.	NL	DD	II
Long-finned pilot whale	Rare	Mostly pelagic	12,619[4]; 780,000[15]	NL	DD	II
Short-finned pilot whale	Common-Uncommon	Mostly pelagic, high-relief	24,674[4]; 780,000[15]	NL	DD	II

N.A. Not available or not assessed.
[1] U.S. Endangered Species Act: EN = Endangered, NL = Not listed (ECOS 2012)
[2] Codes for IUCN classifications: EN = Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient. Classifications are from the IUCN Red List of Threatened Species (IUCN 2012).
[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2012); Appendix I = Threatened with extinction; Appendix II = not necessarily now threatened with extinction but may become so unless trade is closely controlled.
[4] Western North Atlantic, in U.S. and southern Canadian waters (Waring et al. 2012)
[5] Likely negatively biased (Stevick et al. 2003)
[6] Central and Northeast Atlantic (IWC 2012)
[7] North Atlantic (Cattanach et al. 1993)
[8] Central and Northeast Atlantic (Víkingsson et al. 2009)
[9] Central and Northeast Atlantic (Pike et al. 2009).
[10] For the northeast Atlantic, Faroes-Iceland, and the U.S. east coast (Whitehead 2002).
[11] Both *Kogia* species
[12] *Ziphius* and *Mesoplodon* spp. combined
[13] Eastern North Atlantic (NAMMCO 1995)
[14] Offshore, Western North Atlantic (Waring et al. 2012)
[15] *Globicephala sp*. combined, Central and Eastern North Atlantic (IWC 2012)

cetaceans from U.K. Royal Navy ships during operations in remote areas in all seasons during 1947–2003 (Maughan 2003). During an L-DEO seismic survey conducted on the R/V *Ewing* between 31 October and 5 November 2003 on the MAR at ~26ºN, 45ºW, no marine mammals were sighted during ~43 h and 475 km of survey effort (Holst 2004).

(1) Mysticetes

North Atlantic Right Whale (*Eubalaena glacialis*)

The North Atlantic right whale occurred historically off southeast Greenland (Knowlton et al. 1992), and has recently been detected there visually and acoustically (Mellinger et al. 2011). There was also a recent sighting in the Azores during winter (Silva et al. 2012), and there is an OBIS record of a right whale near Madeira (Smith 2002), suggesting that there could be a remaining central or eastern sub-population. Right whales were not sighted during the survey along the MAR north of the Azores (Waring et al. 2008).

Humpback Whale (*Megaptera novaeangliae*)

Humpback whales are most abundant in the Azores in April–May, following the phytoplankton spring bloom, where they forage en route towards their northern feeding grounds (Villa et al. 2011; Visser et al. 2011). They are not observed in the Azores during their southward migration in autumn, when chlorophyll concentrations are low (Visser et al. 2011). There are 25 OBIS sightings of the humpback whale around the Azores, during April–August (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009) and one other sighting near the survey area, at ~35ºN, 32ºW in water ~3000 m deep (Maughan 2003). Whaling records also show some humpback whale sightings along the MAR near the survey area during spring (Reeves et al. 2004). Humpback whales were not sighted in the region north of the Azores during the survey along the MAR north of the Azores (Waring et al. 2008).

Common Minke Whale (*Balaenoptera acutorostrata*)

There are 96 OBIS sightings of the minke whale around the Azores, during May–October, the nearest ~300 km from the proposed survey area (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). One minke whales was sighted at ~53ºN during the survey along the MAR north of the Azores (Waring et al. 2008). An autonomous hydrophone moored at a depth of ~925 m on the MAR, ~450 km southwest of the survey area, from February 1999 to March 2001 recorded minke whale calls primarily from October to April (Nieukirk et al. 2004).

Bryde's Whale (*Balaenoptera edeni/brydei*)

Bryde's whales in the Azores have been observed feeding during their northward spring migration (Villa et al. 2011). Elsewhere in the North Atlantic, the seasonal distribution of Bryde's whales is not well known (Reilly et al. 2008). There are 20 OBIS sightings of Bryde's whale around the Azores, all during July and August 2004, the nearest ~520 km from the proposed survey area (Steiner et al. 2007; Skov et al. 2008). There was one Bryde's whale sighting at ~40ºN during the survey along the MAR north of the Azores (Waring et al. 2008).

Sei Whale (*Balaenoptera borealis*)

Sei whales are regularly sighted near the Azores during spring (Víkingsson et al. 2010). Sei whales were the most commonly sighted species during the survey along the MAR from north of the Azores, all north of ~52ºN and with the highest number of sightings clustered at the Charlie Gibb Fracture Zone at ~52°N (Waring et al. 2008). Seven sei whales satellite-tagged in the Azores during May–June 2008 and 2009 crossed the North Atlantic, traveling to the Labrador Sea west and southwest of Greenland, and one sei whale tagged in the Azores in September 2009 moved southeastward towards West Africa (Prieto et al. 2010).

There are over 200 OBIS sightings of the sei whale around the Azores, during May–September (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009), and one other OBIS sighting that is ~380 km to the southwest of the survey site, at 34ºN, 37.4ºW, recorded opportunistically in April 1994 (Maughan 2003).

Fin Whale (*Balaenoptera physalus*)

Fin whales in the Azores have been observed feeding on krill during their northward spring migration (Villa et al. 2011). Abundant fin/blue whale-like vocalizations were recorded during deployment of ocean-bottom passive seismometers around the MAR at ~37°N, more in winter than in summer (Chauhan et al. 2009). An autonomous hydrophone moored at a depth of ~925 m on the MAR ~450 km to the southwest of the survey area from February 1999 to March 2001 recorded fin whale calls primarily from October to April (Nieukirk et al. 2004).

There are over 230 OBIS sightings of the fin whale around the Azores, during May–August, the nearest ~400 km from the proposed survey area, and one other sighting ~565 km to the southeast of the survey area, at 37.9ºN, 30.1ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). There were seven fin whale sightings between ~40°N and 53°N during the survey along the MAR from north of the Azores (Waring et al. 2008).

Blue Whale (*Balaenoptera musculus*)

Blue whales in the Azores have been observed feeding during their northward spring migration (Villa et al. 2011). Abundant fin/blue whale-like vocalizations were recorded during deployment of ocean-bottom passive seismometers around the MAR at ~37°N, more in winter than in summer (Chauhan et al. 2009). An autonomous hydrophone moored at a depth of ~925 m on the MAR ~450 km southwest of the survey area from February 1999 to March 2001 recorded blue whale calls primarily from November to February (Nieukirk et al. 2004).

There are ~75 OBIS sightings of the blue whale around the Azores, during May–August, the nearest ~400 km from the proposed survey site, and one other sighting ~675 km southeast of the survey area, at 31ºN, 29.8ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). There were four blue whale sightings between ~41°N and 44°N during the survey along the MAR north of the Azores (Waring et al. 2008).

(2) Odontocetes

Sperm Whale (*Physeter macrocephalus*)

Sperm whales were the second most commonly sighted cetacean species (n = 48) during the survey along the MAR north of the Azores (Waring et al. 2008). Most sightings were north of ~52°N; 8 sightings were between ~41°N and 47°N. In the Azores, sperm whales were heavily hunted, especially in the mid-20th century. In Flores, 1904 sperm whales were captured between 1864 and 1977, and in Santa Maria, 867 were captured between 1896 and 1966 (Carvalho and Brito 2009). Sperm whale use the Azores as both a feeding and breeding grounds (Clark 1956 *in* Matthews et al. 2001). Individuals observed in the Azores belong to a single population (Pinela et al. 2009).

There are over 3500 OBIS sightings of the sperm whale around the Azores (IOC 2012), with the POPA sightings during May–October, virtually the entire tuna fishing season, and three other sightings near the survey area, one southwest on the MAR at 34ºN, 37.5ºW, ~390 km from the proposed survey area (Maughan 2003) and two northeast on the MAR at ~37ºN, ~200 km from the proposed survey area (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009).

Pygmy and Dwarf Sperm Whales (*Kogia breviceps* and *K. sima*)

There are no OBIS sightings of pygmy or dwarf sperm whales around the Azores (IOC 2012). One group of 12 pygmy sperm whales was sighted by the U.K. Royal Navy ~875 km southwest of the survey area, at 32.2ºN, 42.3ºW, in April 1972 (Maughan 2003). *Kogia* species were not sighted during the survey along the MAR north of the Azores (Waring et al. 2008).

Cuvier's Beaked Whale (*Ziphius cavirostris*)

There are 62 OBIS sightings of Cuvier's beaked whale around the Azores, during May–August, the nearest ~280 km from the proposed survey area at 37.9ºN, 31.9ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). Cuvier's beaked whales were not sighted during the survey along the MAR north of the Azores (Waring et al. 2008).

Northern bottlenose whale (*Hyperoodon ampullatus*)

There are >200 OBIS sightings of the northern bottlenose whale around the Azores during May–September, the nearest ~260 km from the proposed survey area at 37.9ºN, 32.2ºW, and three additional sightings southeast of the survey area, the nearest ~585 km from the proposed survey area at 34.4ºN, 27.8ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). Northern bottlenose whales were not sighted during the survey along the MAR north of the Azores (Waring et al. 2008).

True's Beaked Whale (*Mesoplodon mirus*)

There are no OBIS sightings of True's beaked whale near the proposed survey area (IOC 2012). It was not observed during the survey along the MAR north of the Azores, although there were 8 sightings of *Mesoplodon* spp., the nearest ~200 km north of the Azores (Waring et al. 2008).

Gervais' Beaked Whale (*Mesoplodon europaeus*)

There are eight OBIS of sightings of Gervais' beaked whale around the Azores, the nearest ~625 km from the proposed survey area at 39.2ºN, 28.1ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). Gervais' beaked whale was not sighted during the survey along the MAR north of the Azores, although there were 8 sightings of *Mesoplodon* spp., the nearest ~200 km north of the Azores (Waring et al. 2008).

Sowerby's Beaked Whale (*Mesoplodon bidens*)

There are 16 OBIS sightings of Sowerby's beaked whale around the Azores, the nearest ~350 km from the proposed survey area at 38.3ºN, 31.2ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). During 2002–2009, 10 Sowerby's beaked whales stranded in the central group of islands in the Azores, all during July (Pereira et al. 2011). The species was not sighted during the survey along the

MAR north of the Azores, although there were 8 sightings of *Mesoplodon* spp., the nearest ~200 km north of the Azores (Waring et al. 2008).

Blainville's Beaked Whale (*Mesoplodon densirostris*)

There are two OBIS sightings of Blainville's beaked whale near the Azores, the nearest ~675 km from the proposed survey area at 39ºN, 27.3ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). Blainville's beaked whale was not sighted during the survey along the MAR north of the Azores, although there were 8 sightings of *Mesoplodon* spp., the nearest ~200 km north of the Azores (Waring et al. 2008).

Rough-toothed Dolphin (*Steno bredanensis*)

There are no OBIS sightings of the rough-toothed dolphin near the proposed survey area (IOC 2012), and none were observed during the survey along the MAR north of the Azores (Waring et al. 2008).

Common Bottlenose Dolphin (*Tursiops truncatus*)

There are over 1500 OBIS sightings of the common bottlenose dolphin around the Azores during March–November, the nearest ~140 km from the proposed survey area at ~37.3ºN, 34.0ºW (Maughan 2003; Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). The bottlenose dolphin was not sighted during the survey along the MAR north of the Azores (Waring et al. 2008).

Pantropical Spotted Dolphin (*Stenella attenuata*)

There are no OBIS sightings of the pantropical spotted dolphin near the proposed survey area (IOC 2012), and none were sighted during the survey along the MAR north of the Azores (Waring et al. 2008).

Atlantic Spotted Dolphin (*Stenella frontalis*)

There are over 3500 OBIS sightings of the Atlantic spotted dolphin around the Azores, the nearest ~230 km from the proposed survey area at ~37.3ºN, 31.9ºW (Stone et al. 1995; Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). The Atlantic spotted dolphin was not sighted during the survey along the MAR north of the Azores (Waring et al. 2008).

Striped Dolphin (*Stenella coeruleoalba*)

There are over 250 OBIS sightings of the striped dolphin around the Azores, during May–October, the nearest ~360 km from the proposed survey at ~38ºN, 30.8ºW (Maughan 2003; Machete and Santos 2007; Morato et al. 2008; Skov et al. 2008; Amorin et al. 2009). There were 12 striped dolphin sightings and another 14 common/striped dolphin sightings during the survey along the MAR north of the Azores, between ~41ºN and 50ºN (Waring et al. 2008).

Short-beaked Common Dolphin (*Delphinus delphis*)

In the Azores, short-beaked common dolphins are associated with seamounts of <400 m depth (Morato et al. 2008). Along the MAR between Iceland and the Azores, dolphins tended to aggregate in areas of steep slopes; bottom depth was less important (Doksæter et al. 2008). There are over 8500 OBIS sightings of the common dolphin around the Azores, the nearest ~140 km from the proposed survey area at ~36.5ºN, 32.5ºW (CTAP 1982; Maughan 2003; Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). There were 26 short-beaked common dolphin sightings and another 14 common/striped dolphin sightings during the survey along the MAR north of the Azores, between ~41ºN and 50ºN (Waring et al. 2008).

Risso's Dolphin (*Grampus griseus*)

There are over 700 OBIS sightings of Risso's' dolphin around the Azores, during May–October, the nearest ~250 km from the proposed survey area at ~37.1ºN, 31.5ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). Risso's dolphin was not sighted during the survey along the MAR north of the Azores (Waring et al. 2008).

Pygmy Killer Whale (*Feresa attenuata*)

There are no OBIS sightings of the pygmy killer whale near the proposed survey area (IOC 2012), and none were observed during the survey along the MAR north of the Azores (Waring et al. 2008).

False Killer Whale (*Pseudorca crassidens*)

There are 177 OBIS sightings of the false killer whale around the Azores, during May–October, the nearest ~290 km from the proposed survey area at ~37.9ºN, 31.7ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). The false killer whale was not sighted during the survey along the MAR north of the Azores (Waring et al. 2008).

Killer Whale (*Orcinus orca*)

There are 55 OBIS sightings of the killer whale around the Azores, the nearest ~325 km from the proposed survey area at ~38.2ºN, 31.5ºW (Maughan 2003; Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). One group of five killer whales was sighted during the survey along the MAR north of the Azores, at ~56ºN (Waring et al. 2008).

Long-finned Pilot Whale (*Globicephala melas*)

There are no OBIS sightings of the long-finned pilot whale near the proposed survey area (IOC 2012). There were 13 pilot whale sightings during the survey along the mid MAR north of the Azores, most identified as long-finned pilot whales, all north of 45ºN (Waring et al. 2008).

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

There are over 300 OBIS sightings of the short-finned pilot whale around the Azores, the nearest ~265 km from the proposed survey area at ~37.2ºN, 31.4ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). There were 13 pilot whale sightings during the survey along the MAR north of the Azores, most identified as long-finned pilot whales, all north of 45ºN (Waring et al. 2008).

Sea Turtles

Six species of sea turtles, all of which are considered under the ESA to be ***endangered*** or ***threatened***, could occur in or near the proposed survey area on the Mid-Atlantic Ridge. General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of sea turtles are given in § 3.4.1 of the PEIS. The general distribution of sea turtles in the North Atlantic and on the MAR is discussed in § 3.4.3.4 of the PEIS. The rest of this section deals specifically with their distribution near the proposed survey area. The main source of information used in this section is the OBIS database (see above). During an L-DEO seismic survey conducted between 31 October and 5

November 2003 on the MAR at ~26ºN, 45ºW, no sea turtles were sighted during ~43 h and 475 km of survey effort (Holst 2004).

(1) Leatherback Turtle (*Dermochelys coriacea*)

There are 85 OBIS sightings of the leatherback turtle around the Azores, the nearest ~390 km from the proposed survey area at ~38.3ºN, 30.7ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). There are another three sightings in the OBIS database, >600 km south of the proposed survey location, from September to December 2002 (SEFSC 2002). Of nine leatherback turtles tracked using satellite relayed data loggers from June 2002 to September 2004, two were observed traveling close to the survey site (Hays et al. 2006). Three leatherback turtles were reported as bycatch from the swordfish fisheries in the Azores from May to December 2008 (Ferreira et al. 2008).

(2) Green Turtle (*Chelonia mydas*)

There are six OBIS sightings of the green turtle around the Azores, during May–August, the nearest ~365 km from the proposed survey area at ~38.4ºN, 31.1ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). There is another OBIS sighting >1200 km southwest of the proposed survey area in November 2003 (Coyne and Godley 2005).

(3) Loggerhead Turtle (*Caretta caretta*)

There are ~2500 OBIS sightings of the loggerhead turtle near the proposed survey area and around the Azores, the nearest ~75 km from the proposed survey at ~35.5ºN, 34.5ºW (Coyne and Godley 2005; Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009). Sixty loggerhead turtles were reported as bycatch from the swordfish fisheries in the Azores during May–December 2008 (Ferreira et al. 2008). Bolten et al. (1993) suggested that small (10–82 cm curved carapace length) loggerhead turtles found in the Azores are recruited annually, possibly from the southeastern U.S., and leave the Azores before reaching breeding size.

(4) Hawksbill Turtle (*Eretmochelys imbricata*)

There is one OBIS sighting of the hawksbill turtle around the Azores, in June 1998, ~630 km from the proposed survey area at ~39.4ºN, 28.2ºW (Machete and Santos 2007; Morato et al. 2008; Amorin et al. 2009).

(5) Olive and Kemp’s Ridley Turtles (*Lepidochelys olivacea* and *L. kempii*)

In the Atlantic Ocean, olive ridley turtles inhabit the west coast of Africa and northeastern coast of South America; a few are present in the West Indies, but they do not occur in most of the North Atlantic Ocean (Spotila 2004). There are a few sightings of Kemp’s ridley turtle from the Azores and Madeira (Brongersma 1995), and they have been captured occasionally in waters near there (Bolton and Martins 1990). There are no OBIS sightings of olive or Kemp’s ridley turtles near the proposed survey area (IOC 2012).

Seabirds

Two ESA-listed seabird species could occur in or near the project area: the ***Endangered*** Bermuda petrel and the ***Threatened*** roseate tern. General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of seabird families is given in § 3.5.1 of the PEIS.

(1) Bermuda Petrel (*Pterodroma cahow*)

The Bermuda petrel is listed as ***Endangered*** under the ESA (USFWS 2012a) and ***Endangered*** on the 2012 IUCN Red List of Threatened Species (IUCN 2012). The Bermuda petrel was exploited for food and was thought to be extinct by the 17th century. It was only rediscovered in 1951, at which time the population consisted of 18 pairs (del Hoyo et al. 1992). The population has been the subject of an ongoing recovery effort and by 2008 was up to 85 breeding pairs (Maderios et al. 2012). This population is now increasing slowly, but remains vulnerable to storm damage, erosion, and predation (BirdLife International 2012a; Maderios et al. 2012).

Currently, all known breeding pairs breed on islets in Castle Harbour, Bermuda (Maderios et al. 2012). Petrels return to the colony in mid-October and remain until June. During the non-breeding season (mid June–mid October), Bermuda petrels are strictly pelagic and likely follow the Gulf Stream. During the non-breeding season, they have been found as far as the Grand Banks and southwest of Ireland (BirdLife International 2012a). In 2002, a Bermuda petrel was captured in a burrow on an offshore islet in the Azores (Bried and Magalhaes 2004). The same bird was present in 2003 and again in 2006 (Demey 2007). The Bermuda petrel could be encountered in very small numbers in the survey area.

(2) Roseate Tern (*Sterna dougallii*)

The Roseate tern is listed as ***Endangered*** under the ESA on the Atlantic Coast south to North Carolina and ***Threatened*** in all other areas of the Western Hemisphere (USFWS 2012b), and is listed as ***Least Concern*** on the 2012 IUCN Red List of Threatened Species (IUCN 2012). Three-quarters of the European population (1000 pairs) nests on the Azores (BirdLife International 2012b). Populations in the Azores are threatened by disturbance of breeding colonies and predation by introduced mammals such as rats and ferrets (Avery et al. 1995).

Breeding habitat includes sandy or rocky offshore islands and barrier beaches (Gochfeld et al. 1998). European populations winter in West Africa, between Guinea and Gabon (del Hoyo et al. 1996). During the breeding season, roseate terns are strictly coastal, whereas during the non-breeding season, they migrate well offshore and may be primarily pelagic. Roseate terns feed primarily on small marine fish taken over sandbars or shoals, or over schools of pelagic predatory fish (Gochfeld et al. 1998).

Fish, Essential Fish Habitat, and Habitat Areas of Particular Concern

There are no ESA-listed fish species in or near the proposed survey area on the Mid-Atlantic Ridge. There is one species that is a candidate for ESA listing that could occur there, the scalloped hammerhead shark *Sphyrna lewini*, a coastal pelagic species that also occurs offshore to a depth of 1000 m (NOAA 2012).

There is no Essential Fish Habitat (EFH) and there are no habitats of particular concern (HAPC) in the International Waters where the proposed survey would take place.

Fisheries

ICES Statistical Division Xa (also known as the Azores Grounds) was used in the analysis of the ICES fishery statistics. This Division includes Subdivisions Xa1 and Xa2, the latter corresponding to the Azores EEZ and the former bounded by 43°N and 36°N latitude, and 42°W to the west and the Azores EEZ to the east (FAO 2012). All species caught in this division during 2007–2010 (ICES 2012) were examined and those most likely to occur in the proposed seismic survey area, based on the water depths in the proposed survey area, were included in the following discussion on the fishery. Information on the fishery in all water depths in the Azores Islands EEZ was also used (Sea Around Us Project 2012).

In the deep-water areas southwest of the Azores, commercial fishery catches are likely dominated by large pelagic fish. Tunas, sharks, and swordfish would account for most of the catches. The total aggregated catch for ICES Statistical Division Xa was 21,880 t during 2007–2010. Various tuna species (particularly skipjack, bigeye, albacore, and yellowfin) accounted for 49% of the catch weight, followed by various sharks (especially blue and shortfin mako) (36%) and swordfish (4%). These pelagic fish are harvested using various gear types including pole-and-line, longlines, purse seines, and hooks/gorges.

Portuguese vessels account for most of the harvest (82% overall), although French vessels also recorded harvests (18% overall) during 2007–2010. The total annual commercial catch weights recorded for ICES Statistical Division Xa during 2007–2010 ranged from 1,979 to 10,011 t, an indication of considerable inter-annual variability. Typical vessels fishing for pelagic species in this area are 28–32 m in length, although larger vessels have been introduced during recent years. The Azorean tuna fleet consists of 18 vessels 28 m long (POPA 2012). Most of the fishing effort in ICES Statistical Division Xa is expended in areas where water depths are considerably less than those associated with the proposed seismic survey area.

In the Azores EEZ, the average annual total catch during 2002–2006 was ~15,000 tonnes (Sea Around Us Project 2012). Dominant species caught were "mixed group" (29.4%), blue jack mackerel (19.6%), skipjack tuna (17.1%), and pandoras (family Sparidae; 7.7%). Most of the catch by country was Portugal (72.2%), Spain (20.6%), and France (4.2%). Dominant gear types were bottom trawls (24.5%), pole & line tuna (17.1%), hooks or gorges (16.2%), mid-water trawls (9.0%), and purse seines (6.3%).

IV. Environmental Consequences

Proposed Action

(1) Direct Effects on Marine Mammals and Sea Turtles and Their Significance

The material in this section includes a brief summary of the anticipated potential effects (or lack thereof) on marine mammals and sea turtles of the airgun system to be used by NSF. A more comprehensive review of the relevant background information appears in § 3.4.1, § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS. This section also includes estimates of the numbers of marine mammals that could be affected by the proposed seismic survey scheduled to occur during April–May 2013. A description of the rationale for NSF's estimates of the numbers of individuals exposed to received sound levels ≥160 dB re 1 μPa_{rms} is also provided.

Summary of Potential Effects of Airgun Sounds

The effects of sounds from airguns could include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). Permanent hearing impairment (PTS), in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not an injury (Southall et al. 2007). Although the possibility cannot be entirely excluded, it is unlikely that the project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. If marine mammals encounter the survey while it is underway, some behavioral disturbance could result, but this would be localized and short-term. As a result of the monitoring and mitigation measures, no marine mammals are expected to be exposed to sounds from the survey at levels causing behavioral disturbance.

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

***Masking*.—**Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the seismic pulses. The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking. In general, masking effects of seismic pulses are expected to be minor, given the normally intermittent nature of seismic pulses. We are not aware of any information concerning masking of hearing in sea turtles.

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

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson et al. 1995; Wartzok et al. 2004; Southall et al. 2007; Weilgart 2007). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (e.g., Lusseau and Bejder 2007; Weilgart 2007). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many marine mammals would be present within a particular distance of industrial activities and/or exposed to a particular level of industrial sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important degree by a seismic program are based primarily on behavioral observations of a few species. Detailed studies have been done on humpback, gray, bowhead, and sperm whales. Less detailed data are available for some other species of baleen whales and small toothed whales, but for many species, there are no data on responses to marine seismic surveys.

Baleen Whales

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

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

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

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

Reactions of migrating and feeding (but not wintering) *gray whales* to seismic surveys have been studied. Off St. Lawrence Island in the northern Bering Sea, it was estimated, based on small sample sizes, that 50% of feeding gray whales stopped feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB re 1 μPa_{rms}. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast, and western Pacific gray whales feeding off Sakhalin Island, Russia.

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses; sightings by observers on seismic vessels off the United Kingdom from 1997 to 2000 suggest that, during times of good sightability, sighting rates for mysticetes (mainly fin and sei whales) were similar when large arrays of airguns were shooting vs. silent, although there was localized avoidance. Singing fin whales in the Mediterranean moved away from an operating airgun array.

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades. The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year, and bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years.

Toothed Whales

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

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

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive of the mysticetes and some other odontocetes. A ≥170 dB disturbance criterion (rather than ≥160 dB) is considered appropriate for delphinids, which tend to be less responsive than the more responsive cetaceans.

Sea Turtles

The limited available data indicate that sea turtles would hear airgun sounds and sometimes exhibit localized avoidance (see PEIS). Based on available data, it is likely that sea turtles would exhibit behavioral changes and/or avoidance within an area of unknown size near a seismic vessel. To the extent that there are any impacts on sea turtles, seismic operations in or near areas where turtles concentrate are likely to have the greatest impact. There are no specific data that demonstrate the consequences to sea turtles if seismic operations with large or small arrays of airguns occur in important areas at biologically important times of year.

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

Recommendations for science-based noise exposure criteria for marine mammals, frequency-weighting procedures, and related matters were published by Southall et al. (2007). Those recommendations have not, as of late 2012, been formally adopted by NMFS for use in regulatory processes and during mitigation programs associated with seismic surveys. However, some aspects of the recommendations have been taken into account in certain environmental impact statements and small-take authorizations. NMFS has indicated that it may issue new noise exposure criteria for marine mammals that account for the now-available scientific data on TTS, the expected offset between the TTS and PTS thresholds, differences in the acoustic frequencies to which different marine mammal groups are sensitive (e.g., M-weighting or generalized frequency weightings for various groups of marine mammals, allowing for their functional bandwidths), and other relevant factors.

Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment (see § II and § IV[2], below). Also, many marine mammals and (to a limited degree) sea turtles show some avoidance of the area where received levels of airgun sound are high enough such that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves would reduce or (most likely) avoid any possibility of hearing impairment.

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

Sea Turtles

There is substantial overlap in the frequencies that sea turtles detect vs. the frequencies in airgun pulses. We are not aware of measurements of the absolute hearing thresholds of any sea turtle to water-borne sounds similar to airgun pulses. In the absence of relevant absolute threshold data, we cannot estimate how far away an airgun array might be audible. Moein et al. (1994) and Lenhardt (2002) reported TTS for loggerhead turtles exposed to many airgun pulses (see PEIS). This suggests that sounds from an airgun array might cause temporary hearing impairment in sea turtles if they do not avoid the (unknown) radius where TTS occurs. However, exposure duration during the proposed survey would be much less than during the aforementioned studies. Also, recent monitoring studies show that some sea turtles do show localized movement away from approaching airguns. At short distances from the source, received sound level diminishes rapidly with increasing distance. In that situation, even a small-scale avoidance response could result in a significant reduction in sound exposure.

The PSOs stationed on the *Langseth* would also watch for sea turtles, and airgun operations would be shut down if a turtle enters the designated exclusion zone.

(2) Mitigation Measures

Several mitigation measures are built into the proposed seismic survey as an integral part of the planned activities. These measures include the following: ramp ups; typically two, however a minimum of one dedicated observer maintaining a visual watch during all daytime airgun operations; two observers for 30 min before and during ramp ups during the day and at night; PAM during the day and night to complement visual monitoring (unless the system and back-up systems are damaged during operations); and power downs (or if necessary shut downs) when mammals or turtles are detected in or about to enter designated exclusion zones. These mitigation measures are described in § 2.4.4.1 of the PEIS and summarized earlier in this document, in § II(3). The fact that the 36-airgun array, as a result of its design, directs the majority of the energy downward, and less energy laterally, is also an inherent mitigation measure, as is the long interval between pulses (3.25 min) during the OBS survey.

Previous and subsequent analysis of the potential impacts takes account of these planned mitigation measures. It would not be meaningful to analyze the effects of the planned activities without mitigation, as the mitigation (and associated monitoring) measures are a basic part of the activities, and would be implemented under the Proposed Action or Alternative Actions.

(3) Potential Numbers of Cetaceans Exposed to Received Sound Levels ≥160 dB

All anticipated takes would be “takes by harassment” as described in § I, involving temporary changes in behavior. The mitigation measures to be applied would minimize the possibility of injurious takes. (However, as noted earlier and in the PEIS, there is no specific information demonstrating that injurious “takes” would occur even in the absence of the planned mitigation measures.) In the sections below, we describe methods to estimate the number of potential exposures to sound levels >160 dB re 1 μPa_{rms}, and present estimates of the numbers of marine mammals that could be affected during the proposed seismic program. The estimates are based on consideration of the number of marine mammals that could be disturbed appreciably by ~2600 km of seismic survey on the MAR. The main sources of distributional and numerical data used in deriving the estimates are described in the next subsection.

(a) Basis for Estimating Exposure

The estimates are based on a consideration of the number of marine mammals that could be within the area around the operating airgun array where the received levels (RLs) of sound >160 dB re 1 μPa_{rms} are predicted to occur (see Table 1). The estimated numbers are based on the densities (numbers per unit area) of marine mammals expected to occur in the area in the absence of a seismic survey. To the extent that marine mammals tend to move away from seismic sources before the sound level reaches the criterion level and tend not to approach an operating airgun array, these estimates are likely to overestimate the numbers actually exposed to the specified level of sounds. The overestimation is expected to be particularly large when dealing with the higher sound-level criteria, e.g., 180 dB re 1 μPa_{rms}, as animals are more likely to move away before RL reaches 180 dB than they are to move away before it reaches (for example) 160 dB re 1 μPa_{rms}. Likewise, they are less likely to approach within the ≥180 dB re 1 μPa_{rms} radius than they are to approach within the considerably larger ≥160 dB radius.

We used densities calculated from sightings, effort, mean group sizes, and values for *f*(0) for the southern part of the survey area in Waring et al. (2008), which extends from the Azores at ~38ºN to ~53ºN. The density calculated for undifferentiated "common/striped dolphins" was allocated to common and striped dolphins in proportion to the calculated densities of the two species. The density calculated for "unidentified dolphin" was allocated to bottlenose, Atlantic spotted, and Risso's dolphins, species that could occur in the proposed survey area based on their presence in the Azores, in proportion to the number of sightings in the OBIS database for those species around the Azores. The density calculated for "unidentified small whale" was allocated to the false killer whale, the one small whale species that could occur in the proposed survey area based on its presence in the Azores. The four "long-finned/short-finned pilot whales" sighted in the southern part of the survey area by Waring et al. (2008) were assumed to be short-finned pilot whales based on OBIS sightings around the Azores. The density calculated for the one "sei/Bryde's whale" sighting in the southern part of the survey area was allocated to sei and Bryde's whales in equal proportions. The authors' calculated value of *f*(0) for the sei whale was used for calculating densities of Bryde's, fin, and blue whales, and that for "small Delphinidae" was used for calculating densities of *Mesoplodon* spp., dolphins, the false killer whale, and the short-finned pilot whale.

Because the survey effort in the southern stratum of Waring et al. (2008) is limited (1047 km), the survey area is north of the proposed seismic area (~38–52°N vs. ~36–36.5°N), and the survey was conducted during a somewhat different season (June vs. April–May), there is some uncertainty about the representativeness of the data and the assumptions used in the calculations below. However, the approach used here is believed to be the best available approach.

The estimated numbers of individuals potentially exposed presented below are based on the 160-dB re 1 μPa_{rms} criterion for all cetaceans. It is assumed that marine mammals exposed to airgun sounds that strong could change their behavior sufficiently to be considered "taken by harassment". Table 4 shows the density estimates calculated as described above and the estimates of the number of different individual marine mammals that potentially could be exposed to ≥160 dB re 1 μPa_{rms} during the seismic survey if no animals moved away from the survey vessel. The *Requested Take Authorization* is given in the far right column of Table 4. For species for which densities were not calculated as described above but for which there were OBIS sightings around the Azores, we have included a *Requested Take Authorization* for the mean group size for the species.

It should be noted that the following estimates of exposures to various sound levels assume that the proposed survey would be completed; in fact, the ensonified areas calculated using the planned number of line-kilometers ***have been increased by 25%*** to accommodate turns, lines that may need to be repeated, equipment testing, etc. As is typical during offshore ship surveys, inclement weather and equipment malfunctions are likely to cause delays and may limit the number of useful line-kilometers of seismic operations that can be undertaken. Also, any marine mammal sightings within or near the designated exclusion zones would result in the shut down of seismic operations as a mitigation measure. Thus, the following estimates of the numbers of marine mammals potentially exposed to 160-dB re 1 μPa_{rms} sounds

TABLE 4. Densities and estimates of the possible numbers of individuals that could be exposed to ≥160 dB re 1 µPa_{rms} during L-DEO's proposed seismic survey on the Mid-Atlantic Ridge in April–May 2013. The proposed sound source consists of a 36-airgun array with a total discharge volume of 6600 in^3. Species in italics are listed under the ESA as endangered. The column of numbers in boldface shows the numbers of Level B "takes" for which authorization is requested.

Species	Reported Density (#/1000 km^2) Waring et al 2008[1]	Correction Factor[2]	Estimated Density (#/1000 km^2)	Ensonified Area (km^2)	Calculated Take[3]	% of Regional Pop'n[4]	Requested Level B Take Authorization[5]
Mysticetes							
North Atlantic right whale	*0*		*0*	*5571.7*	*0*	*0*	***0***
Humpback whale	*0*		*0*	*5571.7*	*0*	*0*	***2[5]***
Minke whale	0		0	5571.7	0	0	**3[5]**
Bryde's whale	0.19		0.19	5571.7	1	N/A	**1**
Sei whale	*0.19*		*0.19*	*5571.7*	*1*	*0.01*	***1***
Fin whale	*4.46*		*4.46*	*5571.7*	*25*	*0.10*	***25***
Blue whale	*1.49*		*1.49*	*5571.7*	*8*	*0.89*	***8***
Odontocetes							
Sperm whale	*3.71*		*3.71*	*5571.7*	*21*	*0.16*	***21***
Pygmy/dwarf sperm whale	0		0	5571.7	0	0	**0**
Northern bottlenose whale	0		0	5571.7	0	0	**4[5]**
Cuvier's beaked whale	0		0	5571.7	0	0	**7[5]**
Mesoplodon spp.	7.04		7.04	5571.7	39	1.12	**39**
Rough-toothed dolphin	0		0	5571.7	0	0	**0**
Bottlenose dolphin	8.35		8.35	5571.7	47	0.06	**47**
Pantropical spotted dolphin	0		0	5571.7	0	0	**0**
Atlantic spotted dolphin	20.03		20.03	5571.7	112	0.22	**112**
Striped dolphin	185.50		185.50	5571.7	1034	1.09	**1034**
Short-beaked common dolphin	379.52		379.52	5571.7	2115	1.75	**2115**
Risso's dolphin	3.83		3.83	5571.7	21	0.10	**21**
Pygmy killer whale	0		0	5571.7	0	0	**0**
False killer whale	1.17		1.17	5571.7	7	N/A	**7**
Killer whale	0		0	5571.7	0	0	**5[5]**
Long-finned pilot whale	0		0	5571.7	0	0	**0**
Short-finned pilot whale	120.96		120.96	5571.7	674	0.09	**674**

[1] Reported densities were calculated from sightings, effort, mean group sizes, and values for *f*(0) for the southern part of the survey area in Waring et al. (2008); there is only one density estimate, so no minimum, mean, or maximum density is given

[2] No correction factors were applied for these calculations.

[3] Calculated take is estimated density (reported density x correction factor) multiplied by the 160-dB ensonified area (including the 25% contingency)

[4] Regional populations are from the North Atlantic (Table 3); N/A means not available

[5] Requested take authorization increased to group size for species for which densities were not calculated but for which there were OBIS sightings around the Azores

are precautionary and probably overestimate the actual numbers of marine mammals that could be involved. These estimates assume that there would be no weather, equipment, or mitigation delays, which is highly unlikely.

Furthermore, as summarized in "Summary of Potential Airgun Effects", above, and the PEIS, delphinids seem to be less responsive to airgun sounds than are some mysticetes. The 160-dB (rms) criterion currently applied by NMFS, on which the following estimates are based, was developed based primarily on data from gray and bowhead whales. A ≥170 dB re 1 µPa disturbance criterion (rather than ≥160 dB) is considered appropriate for delphinids (and pinnipeds), which tend to be less responsive than the more responsive cetaceans. The estimates of "takes by harassment" of delphinids given below are thus considered precautionary.

(b) Potential Number of Marine Mammals Exposed

The number of different individuals that could be exposed to airgun sounds with received levels ≥160 dB re 1 μPa_{rms} on one or more occasions can be estimated by considering the total marine area that would be within the 160-dB radius around the operating seismic source on at least one occasion, along with the expected density of animals in the area. The number of possible exposures (including repeated exposures of the same individuals) can be estimated by considering the total marine area that would be within the 160-dB radius around the operating airguns, including areas of overlap. During the proposed survey, the transect lines are closely spaced (1–2 m apart) relative to the 160-dB distance (~7 km), and the OBS and MCS lines are overlapping. Thus, the area including overlap is 9.9 x the area excluding overlap, so a marine mammal that stayed in the survey area during the entire survey could be exposed ~10 times, on average. However, it is unlikely that a particular animal would stay in the area during the entire survey. The numbers of different individuals potentially exposed to ≥160 dB re 1 μPa_{rms} were calculated by multiplying the expected species density times the anticipated area to be ensonified to that level during airgun operations excluding overlap. The area expected to be ensonified was determined by entering the planned survey lines into a MapInfo GIS, using the GIS to identify the relevant areas by "drawing" the applicable 160-dB buffer (see Table 1) around each seismic line, and then calculating the total area within the buffers.

Applying the approach described above, ~4457 km^2 (~5572 km^2 including the 25% contingency) would be within the 160-dB isopleth on one or more occasions during the proposed survey. Because this approach does not allow for turnover in the mammal populations in the area during the course of the survey, the actual number of individuals exposed may be underestimated, although the conservative (i.e., probably overestimated) line-kilometer distances used to calculate the area may offset this. Also, the approach assumes that no cetaceans would move away or toward the trackline as the R/V *Langseth* approaches in response to increasing sound levels before the levels reach 160 dB. Another way of interpreting the estimates that follow is that they represent the number of individuals that are expected (in the absence of a seismic program) to occur in the waters that would be exposed to ≥160 dB re 1 μPa_{rms}.

The estimate of the number of individual cetaceans that could be exposed to seismic sounds with received levels ≥160 dB re 1 μPa_{rms} during the proposed survey is 4105 (Table 4). That total includes 55 cetaceans listed as ***Endangered*** under the ESA, including 1 sei whale (0.01% of the regional population), 25 fin whales (0.10%), 8 blue whales (0.89%), and 21 sperm whales (0.16%).

In addition, 39 beaked whales (*Mesoplodon* spp., which could include Gervais', Sowerby's, and Blainville's beaked whales) could be exposed during the survey (Table 4). Most (97.7%) of the cetaceans potentially exposed are delphinids; the short-beaked common dolphin, striped dolphin, and short-finned pilot whale are estimated to be the most common species in the area, with estimates of 2115 (1.75% of the regional population), 1034 (1.09%), and 674 (0.09%) exposed to ≥160 dB re 1 μPa_{rms}, respectively. It should be noted that the "regional" population sizes for most species are only for the U.S. waters of the North Atlantic, so percentages of actual population sizes (including non-U.S. waters of the North Atlantic) exposed are over-estimated.

(4) Conclusions for Marine Mammals and Sea Turtles

The proposed seismic project would involve towing a 36-airgun array with a total discharge volume of 6600 in^3 that introduces pulsed sounds into the ocean. Routine vessel operations, other than the proposed seismic operations, are conventionally assumed not to affect marine mammals sufficiently to constitute "taking".

(a) Cetaceans

In § 3.6.7 and 3.7.7, the PEIS concluded that airgun operations with implementation of the proposed monitoring and mitigation measures may result in a small number of Level B behavioral effects in some mysticete and odontocete species in the MAR QAA; that Level A effects were highly unlikely; and that operations were unlikely to adversely affect ESA-listed species.

In this Draft EA, estimates of the numbers of marine mammals that could be exposed to strong airgun sounds during the proposed program have been presented, together with the requested "take authorization". The estimated numbers of animals potentially exposed to sound levels sufficient to cause appreciable disturbance are very low percentages of the regional population sizes (Table 4). The estimates are likely overestimates the actual number of animals that would be exposed to and would react to the seismic sounds. The reasons for that conclusion are outlined above. The relatively short-term exposures are unlikely to result in any long-term negative consequences for the individuals or their populations.

(b) Sea Turtles

In § 3.4.7, the PEIS concluded that with implementation of the proposed monitoring and mitigation measures, no significant impacts of airgun operations are likely to sea turtle populations in any of the analysis areas, and that any effects are likely to be limited to short-term behavioral disturbance and short-term localized avoidance of an area of unknown size near the active airguns. Five species of sea turtle—the leatherback, loggerhead, green, hawksbill, and Kemp's ridley—could be encountered in the proposed survey area. Only foraging or migrating individuals would occur.

(5) Direct Effects on Invertebrates, Fish, Fisheries, and EFH and Their Significance

Effects of seismic sound on marine invertebrates (crustaceans and cephalopods), marine fish, and their fisheries are discussed in § 3.2.4 and § 3.3.4 and Appendix D of the PEIS. The PEIS concluded that there could be changes in behavior and other non-lethal, short-term, temporary impacts, and injurious or mortal impacts on a small number of individuals within a few meters of a high-energy acoustic source, but that there would be no significant impacts of NSF-funded marine seismic research on populations, fisheries, and associated EFH. Furthermore, there are no ESA-listed fish species or EFH in the deep, offshore waters of the survey areas.

A total of 50 OBSs would be deployed before and recovered after the proposed survey. The OBSs have a height of ~1 m and a maximum diameter of 50 cm. The anchor is an iron plate weighing ~40 kg with dimensions ~30×30×8 cm. OBS anchors would be left behind upon equipment recovery. Although OBS placement would disrupt a very small area of seafloor habitat and could disturb benthic invertebrates, the impacts are expected to be localized and transitory. There are no HAPCs in the deep, offshore waters of the survey areas.

(6) Direct Effects on Seabirds and Their Significance

Effects of seismic sound and other aspects of seismic operations (collisions, entanglement, and ingestion) on seabirds are discussed in § 3.5.4 of the PEIS. The PEIS concluded that there could be transitory disturbance, but that there would be no significant impacts of NSF-funded marine seismic research on seabirds or their populations.

(7) Indirect Effects on Marine Mammals, Sea Turtles, and Their Significance

The proposed seismic operations would not result in any permanent impact on habitats used by marine mammals or sea turtles, or to the food sources they use. The main impact issue associated with the proposed activities would be temporarily elevated noise levels and the associated direct effects on marine mammals and sea turtles, as discussed above.

During the proposed seismic survey, only a small fraction of the available habitat would be ensonified at any given time. Disturbance to fish species and invertebrates would be short-term, and fish would return to their pre-disturbance behavior once the seismic activity ceased. Thus, the proposed survey would have little impact on the abilities of marine mammals or sea turtles to feed in the area where seismic work is planned.

(8) Cumulative Effects

Under CEQ regulations (40 CFR §§1500–1508) implementing the provisions of NEPA, as amended (42 USC §§4321 *et seq*.), cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." (40 CFR §1508.7). Causal agents of cumulative effects can include multiple causes, multiple effects, effects of activities in more than one locale, and recurring events.

The results of the cumulative impacts analysis in the PEIS indicated that there would not be any significant cumulative effects to marine resources from the proposed NSF-funded marine seismic research. However, the PEIS also stated that, "A more detailed, cruise-specific cumulative effects analysis would be conducted at the time of the preparation of the cruise-specific EAs, allowing for the identification of other potential activities in the area of the proposed seismic survey that may result in cumulative impacts to environmental resources." Here we focus on activities that could impact animals specifically in the proposed survey area (research activities, vessel traffic, and commercial fisheries).

(a) Past and future research activities in the area

L-DEO conducted a marine seismic survey between 31 October and 5 November 2003 on the MAR at ~26ºN, 45ºW. As part of the Integrated Ocean Drilling Program (IODP), the riserless drilling vessel *JOIDES Resolution* has conducted scientific research at several drill sites on the MAR at ~30°N on three expeditions, during 17 November 2004–8 January 2005, 8 January–2 March 2005, and 15 February–2 March 2012. Other scientific research activities have been and may be conducted in this region in the future, however no other marine geophysical surveys are proposed using the *Langseth* in the foreseeable future. At the present time, the action proponents are not aware of other research activities planned to occur in the proposed survey area during the April–May 2013 timeframe, but research activities planned by other entities are possible, although unlikely.

(b) Vessel noise and collisions

No major ports are located near the proposed survey area except for those in the Azores >400 km to the northeast. Some trans-Atlantic shipping lanes do pass near the survey area. Vessel traffic would consist mainly of commercial vessels and possibly commercial fishing vessels. Based on the data available through the Automated Mutual-Assistance Vessel Rescue (AMVER) system managed by the U.S. Coast Guard, 5–14 commercial vessels per month travelled through the majority of proposed survey area during the month of June from 2007 to 2012, and for each month in 2011 and 2012 (USCG 2012).

The total transit distance by L-DEO's vessel *Langseth* (a maximum of ~8000 km) would be minimal relative to total transit length for vessels operating in the proposed survey area during April and May. Thus, the combination of L-DEO's operations with the existing shipping operations is expected to produce only a negligible increase in overall ship disturbance effects on marine mammals.

(c) Fisheries

The commercial fisheries in the general area of the proposed survey are described in § III. The primary contributions of fishing to potential cumulative impacts on marine mammals and sea turtles involve direct removal of prey items, noise, potential entanglement (Reeves et al. 2003), and the direct and indirect removal of prey items. There may be some localized avoidance by marine mammals of fishing vessels near the proposed seismic survey area. Fishing operations in the proposed survey area likely would be limited because of the deep water and distance from land, therefore proposed activities would not have a significant impact on them. L-DEO's operations in the proposed survey area are also limited (duration of ~1 month), and the combination of L-DEO's operations with the existing commercial fishing operations is expected to produce only a negligible increase in overall disturbance effects on marine mammals and sea turtles.

(9) Unavoidable Impacts

Unavoidable impacts to the species of marine mammals and turtles occurring in the proposed survey area would be limited to short-term, localized changes in behavior of individuals. For cetaceans, some of the changes in behavior may be sufficient to fall within the MMPA definition of "Level B Harassment" (behavioral disturbance; no serious injury or mortality). TTS, if it occurs, would be limited to a few individuals, is a temporary phenomenon that does not involve injury, and is unlikely to have long term consequences for the few individuals involved. No long-term or significant impacts are expected on any of these individual marine mammals or turtles, or on the populations to which they belong. Effects on recruitment or survival are expected to be (at most) negligible.

(10) Coordination with Other Agencies and Processes

This Draft EA has been prepared by LGL on behalf of L-DEO and NSF pursuant to Executive Order 12114. 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. This document will also be used as supporting documentation for an IHA application submitted by L-DEO to NMFS, under the U.S. MMPA, for "taking by harassment" (disturbance) of small numbers of marine mammals, for this proposed seismic project.

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

Alternative Action: Another Time

An alternative to issuing the IHA for the period requested, and to conducting the project then, is to issue the IHA for another time, and to conduct the project at that alternative time. The proposed dates for the cruise (35 days in April–May 2013) are the dates when the personnel and equipment essential to meet the overall project objectives are available.

Marine mammals and sea turtles are expected to be found throughout the proposed survey area and throughout the time period during which the project may occur. Most marine mammal species are probably year-round residents in the North Atlantic, based on the number of OBIS sightings around the Azores, so altering the timing of the proposed project likely would result in no net benefits for those species (see § III, above). The baleen whale species have been sighted around the Azores from May to August (most OBIS sightings are made by POPA observers on the tuna fleet, which fishes during May–November), and some species are reported to be most abundant in April–May (see § III).

No Action Alternative

An alternative to conducting the proposed activities is the "No Action" alternative, i.e. do not issue an IHA and do not conduct the operations. If the research were not conducted, the "No Action" alternative would result in no disturbance to marine mammals or sea turtles attributable to the proposed activities, however valuable data about the marine environment would not be collected. Research that would contribute to the understanding of the tectono/magmatic setting of the Rainbow field would also be lost and greater understanding of Earth processes would not be gained. The no Action Alternative would not meet the purpose and need for the proposed activities.

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