Request by Lamont-Doherty Earth Observatory for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Marine Geophysical Survey by the R/V *Marcus G. Langseth* on the mid-Atlantic Ridge, April–May 2013

submitted by

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to

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SUMMARY

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. L-DEO requests that it be issued an Incidental Harassment Authorization (IHA) allowing non-lethal takes of marine mammals incidental to the planned seismic survey. This request is submitted pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371(a)(5).

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. ESA-listed sea turtle species that could occur in the survey area include the ***endangered*** leatherback, hawksbill, green, and Kemp's ridley turtles, and the ***threatened*** loggerhead turtle. Listed seabirds that could be encountered in the area include the ***endangered*** Bermuda petrel and the ***threatened*** roseate tern.

The items required to be addressed pursuant to 50 C.F.R. § 216.104, "Submission of Requests", are set forth below. They include descriptions of the specific operations to be conducted, the marine mammals occurring in the study area, proposed measures to mitigate against any potential injurious effects on marine mammals, and a plan to monitor any behavioral effects of the operations on those marine mammals.

I. OPERATIONS TO BE CONDUCTED

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

Overview of the Activity

L-DEO plans to conduct a seismic survey on the Mid-Atlantic Ridge (MAR) at ~36°N, ~34°W (Fig. 1). Water depths in the survey area range from ~900 m to ~3000 m. The seismic survey would be conducted 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.

L-DEO plans to use conventional seismic methodology at the Rainbow massif and associated hydrothermal field, located within a non-transform discontinuity on the MAR, 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

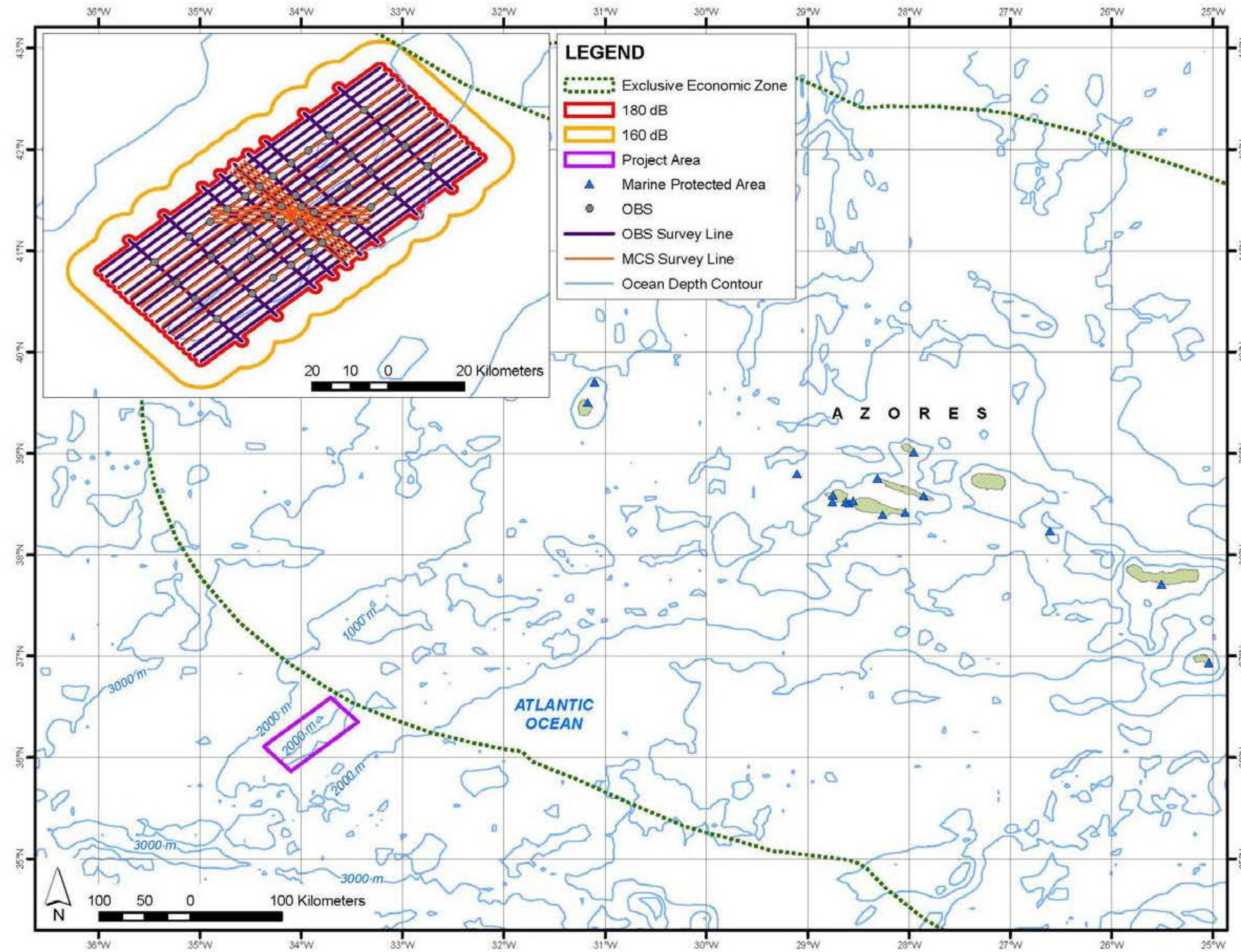

FIGURE 1. Location of the proposed seismic survey, ensonified areas, and OBSs at the proposed study site on the Mid-Atlantic Ridge during April–May 2013, and marine protected areas in the Azores.

faults in the vicinity of the Rainbow massif, and investigate their role in controlling hydrothermal fluid discharge.

The survey will involve one source vessel, the R/V *Marcus G. Langseth*. The *Langseth* will deploy a 36-airgun array as an energy source. The receiving system will consist of an 8-km streamer and/or 46 ocean bottom seismometers (OBSs). As the airgun array is towed along the survey lines, the hydrophone streamer will 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, a total of ~1680 km of survey lines would be shot in a grid pattern using OBSs as receivers, 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). The seismic lines are over water depths of ~900–3000 m. The total survey effort will consist of ~2565 km of transect lines in depths >1000 m and 17 km in depths 100–1000 m. The survey area is in International Waters.

In addition to the operations of the airgun array, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) will also be operated from the *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.

Source Vessel Specifications

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

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.

Predicted Sound Levels

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

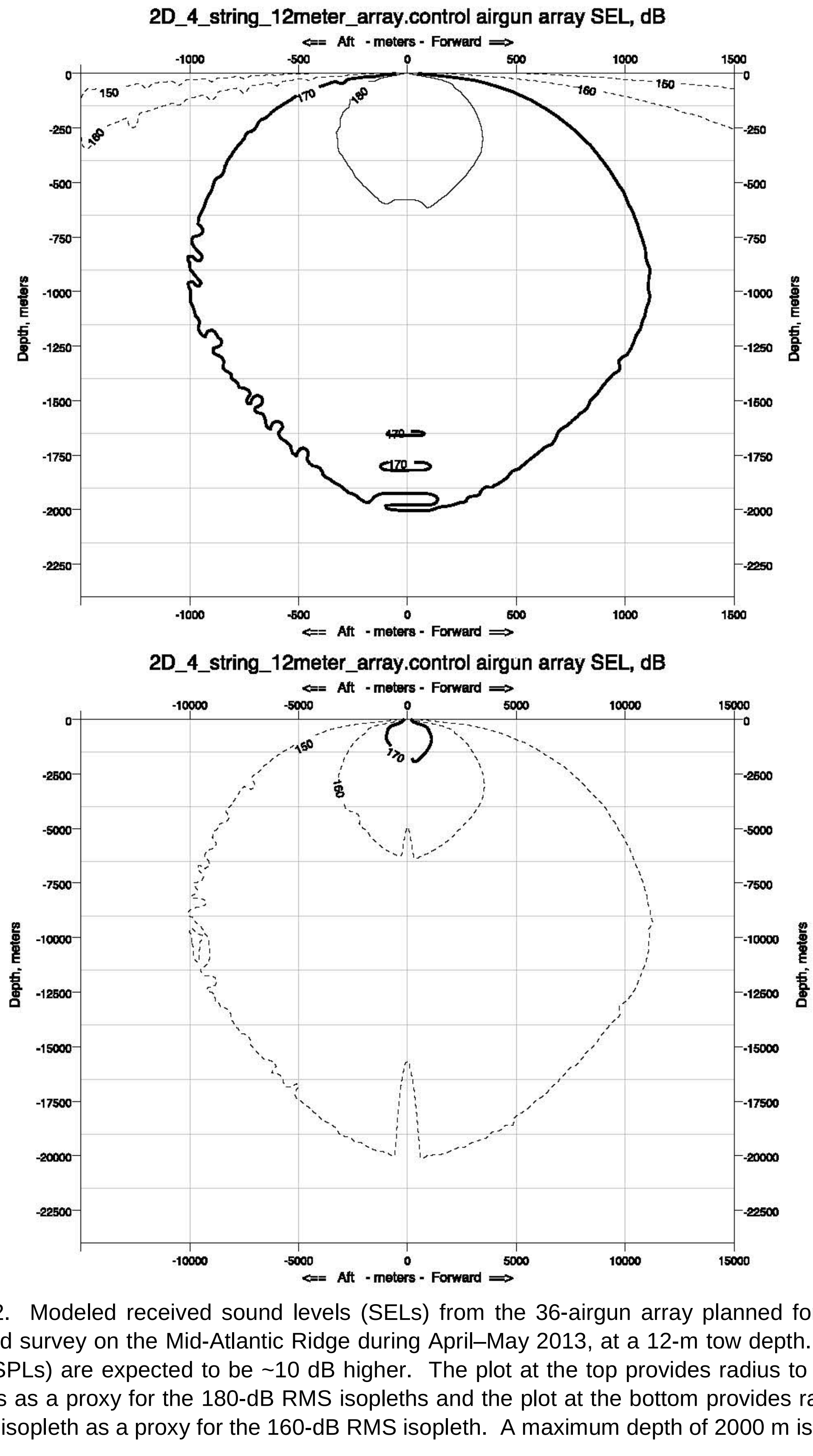

Figure 2. Modeled received sound levels (SELs) from the 36-airgun array planned for use during the proposed survey on the Mid-Atlantic Ridge during April–May 2013, at a 12-m tow depth. Received RMS levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides radius to the 170-dB SEL isopleths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

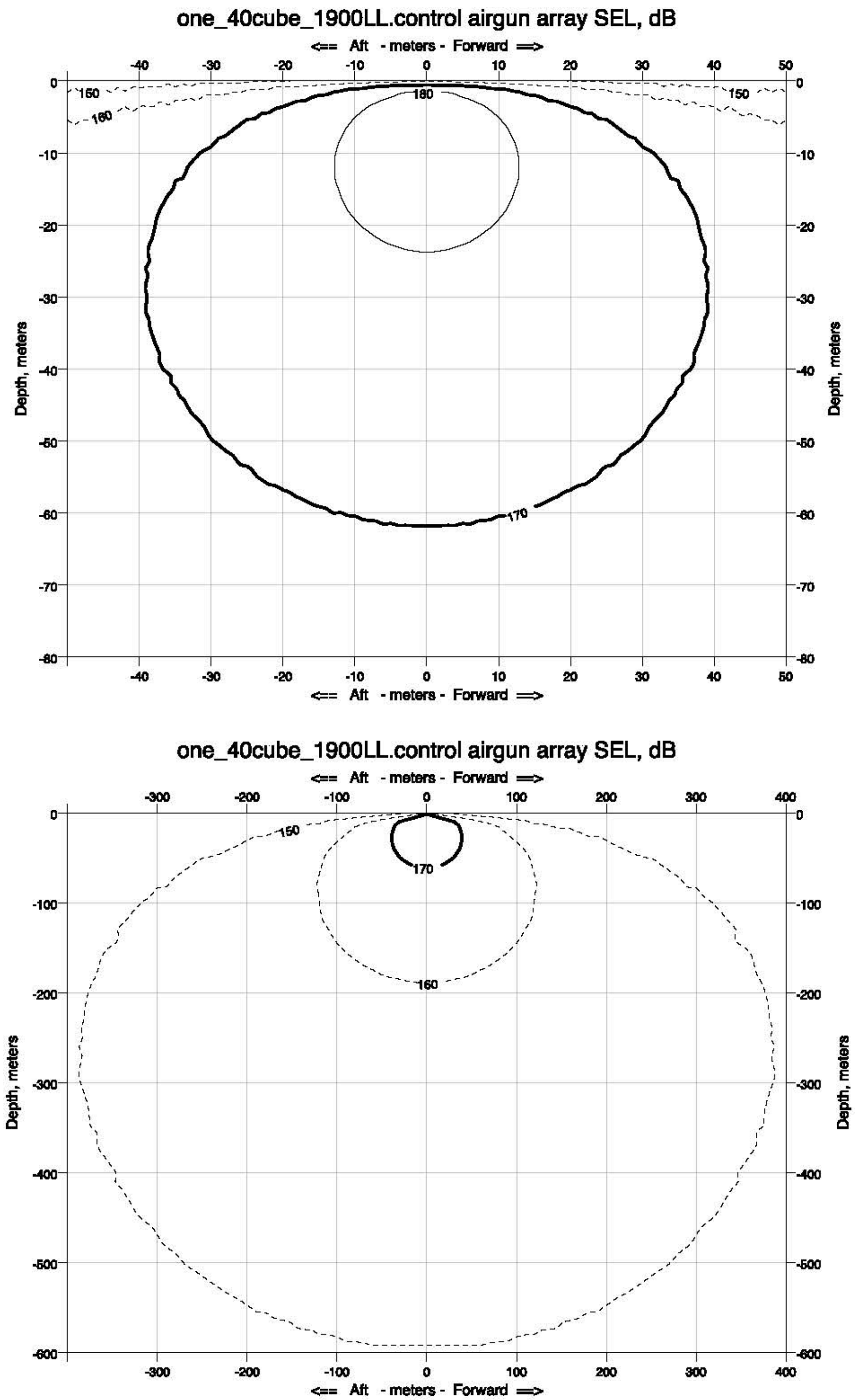

Figure 3. Modeled received sound levels (SELs) from a single 40-in^3 airgun operating in deep water, which is planned for use as a mitigation gun during the proposed survey on the Mid-Atlantic Ridge during April–May 2013. Received RMS levels (SPLs) are expected to be ~10 dB higher. The plot at the top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

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 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 air-gun 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).

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

Description of Operations

The source vessel, the R/V *Marcus G. Langseth*, will deploy an array of 36 airguns as an energy source at a tow depth of 12 m. The receiving system will consist of one 8-km long hydrophone streamer and/or 46 OBSs. As the airgun array is towed along the survey lines, the hydrophone streamer will 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 § VI), 25% has been added for those additional operations. In addition to the operations of the airgun array, a Kongsberg EM 122 multibeam echosounder (MBES) and a Knudsen Chirp 3260 sub-bottom profiler (SBP) will also be operated from the *Langseth* continuously throughout the survey.

Multibeam Echosounder and Sub-bottom Profiler

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.

II. DATES, DURATION, AND REGION OF ACTIVITY

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

The survey activities would encompass the area ~35.5–36.5°N, ~33.5–34.5°W on the MAR in International Waters (Fig. 1). Water depths in the survey area are ~900–3000 m. The exact dates of the activities depend on logistics and weather conditions. The *Langseth* will depart St. George's, Bermuda, on 8 April 2013 and transit to the proposed survey area and then to Ponta Delgada, Azores, to arrive on 13 May. Seismic operations will be carried out for ~16–20 days.

III. SPECIES AND NUMBERS OF MARINE MAMMALS IN AREA

The species and numbers of marine mammals likely to be found within the activity area

Twenty-eight marine mammal species could occur near the proposed survey site. To avoid redundancy, we have included the required information about the species and (insofar as it is known) numbers of these species in § IV, below.

IV. STATUS, DISTRIBUTION AND SEASONAL DISTRIBUTION OF AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities

Sections III and IV are integrated here to minimize repetition.

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 2). 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. One of the qualitative analysis areas (QAAs) assessed in the PEIS is on the MAR, at 26ºN, 40ºW, ~1100 km from the proposed survey area. 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 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).

Table 2. 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)

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).

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).

Dwarf and Pygmy 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). Sowerby'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).

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).

V. TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED

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

L-DEO requests an IHA pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA) for incidental take by harassment during its planned seismic survey on the MAR during April–May 2013.

The operations outlined in § I have the potential to take marine mammals by harassment. Sounds will be generated by the airguns used during the survey, by echosounders, and by general vessel operations. "Takes" by harassment will potentially result when marine mammals near the activities are exposed to the pulsed sounds generated by the airguns or echosounders. The effects will depend on the species of marine mammal, the behavior of the animal at the time of reception of the stimulus, as well as the distance and received level of the sound (see § VII). Disturbance reactions are likely amongst some of the marine mammals near the tracklines of the source vessel. No take by serious injury is anticipated, given the nature of the planned operations and the mitigation measures that are planned (see § XI, MITIGATION MEASURES). No lethal takes are expected.

VI. NUMBERS OF MARINE MAMMALS THAT COULD BE TAKEN

> By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in [section V], and the number of times such takings by each type of taking are likely to occur.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

VII. Anticipated Impact on Species or Stocks

The anticipated impact of the activity upon the species or stock of marine mammal.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

- First we summarize the potential impacts on marine mammals of airgun operations, as called for in § VII. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.
- Then we summarize the potential impacts of operations by the echosounders. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.
- Finally, we estimate the numbers of marine mammals that could be affected by the proposed survey on the MAR during April–May 2013. This section includes a description of the rationale for the estimates of the potential numbers of harassment "takes" during the planned survey, as called for in § VI.

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.

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.

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 § XI and § XIII). 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.

Possible Effects of Multibeam Echosounder and Sub-bottom Profiler Signals

The PEIS concluded in § 3.6.4.3, § 3.7.4.3 that operation of multibeam echosounders (MBES) and sub-bottom profilers (SBP) is not likely to impact mysticetes or odontocetes because the intermittent and narrow, downward-directed nature of the MBES and SBP acoustic sources would result in no more than one or two brief ping exposures of any individual animal, given the movement and speed of the vessel.

Numbers of Marine Mammals that could be "Taken by Harassment"

All anticipated takes would be "takes by harassment", involving temporary changes in behavior. The mitigation measures to be applied will minimize the possibility of injurious takes. (However, as noted earlier, 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 various received sound levels and present estimates of the numbers of marine mammals that could be affected during the proposed seismic program. The estimates are based on a consideration of the number of marine mammals that could be disturbed appreciably by operations with the 36-airgun array to be used during ~2600 km of seismic survey on the MAR. The sources of distributional and numerical data used in deriving the estimates are described in the next subsection.

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

Basis for Estimating "Take by Harassment"

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 3 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 3. 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 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.

TABLE 3. 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 in 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 2); 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

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.

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 (>4 km), and the OBS and MCS lines are overlapping. Thus, the area including overlap is 7.34 x the area excluding overlap, so a marine mammal that stayed in the survey area during the entire survey could be exposed ~7 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 3). 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 3). 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.

Conclusions

The proposed seismic survey will involve towing an airgun array that introduces pulsed sounds into the ocean, along with simultaneous operation of an MBES and SBP. The survey will employ a 36-airgun array similar to the airgun arrays used for typical high-energy seismic surveys. The total airgun discharge volume is ~6600 in^3. Routine vessel operations, other than the proposed airgun operations, are conventionally assumed not to affect marine mammals sufficiently to constitute "taking". No "taking" of marine mammals is expected in association with echosounder operations given the considerations discussed in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.

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 IHA Application, 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 3). 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.

VIII. Anticipated Impact on Subsistence

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

There is no subsistence hunting near the proposed survey area, so the proposed activities will not have any impact on the availability of the species or stocks for subsistence users.

IX. Anticipated Impact on Habitat

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

The proposed seismic survey will not result in any permanent impact on habitats used by marine mammals or to the food sources they use. The main impact issue associated with the proposed activity will be temporarily elevated noise levels and the associated direct effects on marine mammals, as discussed in § VII, above. This section briefly reviews the conclusions of the PEIS about effects of airguns on fish and invertebrates.

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.

X. Anticipated Impact of Loss or Modification of Habitat on Marine Mammals

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, because operations will be limited in duration. However, a small minority of the marine mammals that are present near the proposed activity may be temporarily displaced as much as a few kilometers by the planned activity.

XI. MITIGATION MEASURES

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

Marine mammals and sea turtles are known to occur in the proposed study area. To minimize the likelihood that impacts will occur to the species and stocks, airgun operations will be conducted in accordance with the MMPA and the ESA, including obtaining permission for incidental harassment or incidental 'take' of marine mammals and other endangered species. The proposed activities will take place in International Waters.

The following subsections provide more detailed information about the mitigation measures that are an integral part of the planned activities. The procedures described here are based on protocols used during previous L-DEO seismic research cruises as approved by NMFS, and on best practices recommended in Richardson et al (1995), Pierson et al. (1998), and Weir and Dolman (2007).

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 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 will 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. 2005b; 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 are detected within or about to enter the appropriate exclusion zone, the airguns will be powered down (or shut down if necessary) immediately (see below).

Detailed recommendations for new science-based noise exposure criteria were published in early 2008 (Southall et al. 2007). NSF and L-DEO will be prepared to revise its procedures for estimating numbers of mammals "taken", EZs, etc., as may be required by any new guidelines that result. As yet, NMFS has not specified a new procedure for determining EZs.

Mitigation During Operations

Mitigation measures that will be adopted during the proposed survey include (1) power-down procedures, (2) shut-down procedures, (3) ramp-up procedures, and (4) special procedures for situations or species of particular concern.

Power-down Procedures

A power down involves decreasing the number of airguns in use such that the radius of the 180-dB (or 190-dB) zone is decreased to the extent that marine mammals or turtles are no longer in or about to enter the EZ. A power down of the airgun array will also occur when the vessel is turning from one seismic line to another. During a power down, one airgun will be operated. The continued operation of one airgun is intended to alert marine mammals and turtles to the presence of the seismic vessel in the area. In contrast, a shut down occurs when all airgun activity is suspended.

If a marine mammal or turtle is detected outside the EZ but is likely to enter the EZ, the airguns will be powered down before the animal is within the EZ. Likewise, if a mammal or turtle is already within the EZ when first detected, the airguns will be powered down immediately. During a power down of the airgun array, the 40-in^3 airgun will be operated. If a marine mammal or turtle is detected within or near the smaller EZ around that single airgun (Table 1), it will be shut down (see next subsection).

Following a power down, airgun activity will not resume until the marine mammal or turtle has cleared the safety zone. The animal will be considered to have cleared the safety zone if

- it is visually observed to have left the EZ, or
- it has not been seen within the zone for 15 min in the case of small odontocetes, or
- it has not been seen within the zone for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales, or
- the vessel has moved outside the EZ for turtles, e.g., if a turtle is sighted close to the vessel and the ship speed is 8.3 km/h, it would take the vessel ~8 min to leave the turtle behind.

During airgun operations following a shut down whose duration has exceeded the time limits specified above, the airgun array will be ramped up gradually. Ramp-up procedures are described below. During past R/V *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return to the full seismic source level. Under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity. Furthermore, under these circumstances, ramp-up procedures may unnecessarily extend the length of the survey time needed to collect seismic data. LDEO and NSF have concluded in consultation with NMFS that ramp up is not necessary after an extended power down. Thus, this application does not include this practice as part of the monitoring and mitigation plan.

Shut-down Procedures

The operating airgun(s) will be shut down if a marine mammal or turtle is seen within or approaching the EZ for the single airgun. Shut downs will be implemented (1) if an animal enters the EZ of the single airgun after a power down has been initiated, or (2) if an animal is initially seen within the EZ of the single airgun when more than one airgun (typically the full array) is operating. Airgun activity will not resume until the marine mammal or turtle has cleared the safety zone, or until the PSO is confident that the animal has left the vicinity of the vessel. Criteria for judging that the animal has cleared the safety zone will be as described in the preceding subsection.

Ramp-up Procedures

A ramp-up procedure will be followed when the airgun array begins operating after a specified period without airgun operations. It is proposed that, for the present survey, this period would be ~8 min. Similar periods (~8–10 min) were used during previous L-DEO surveys. Ramp up will not occur if a marine mammal or sea turtle has not cleared the safety zone as described earlier.

Ramp up will begin with the smallest airgun in the array (40 in^3). Airguns will be added in a sequence such that the source level of the array will increase in steps not exceeding 6 dB per 5-min period over a total duration of ~35 min. During ramp up, the PSOs will monitor the EZ, and if marine mammals or turtles are sighted, a power down or shut down will be implemented as though the full array were operational.

If the complete EZ has not been visible for at least 30 min prior to the start of operations in either daylight or nighttime, ramp up will not commence unless at least one airgun (40 in^3 or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the airgun array will not be ramped up from a complete shut down at night or in thick fog, because the outer part of the safety zone for that array will not be visible during those conditions. If one airgun has operated during a power-down period, ramp up to full power will be permissible at night or in poor visibility, on the assumption that marine mammals and turtles will be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. Ramp up of the airguns will not be initiated if a sea turtle or marine mammal is sighted within or near the applicable EZs during the day or night.

As noted above under "Power-down Procedures", during past R/V *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return to the full seismic source level. Under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity.

Special Procedures for Situations or Species of Concern

It is unlikely that a North Atlantic right whale would be encountered, but if so, the airguns will be shut down immediately if one is sighted at any distance from the vessel because of its rarity and conservation status. Also, it is unlikely that concentrations of humpback, fin, sperm, blue, or sei whales would be encountered, but if so, they will be avoided.

XII. PLAN OF COOPERATION

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

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

Not applicable. The proposed activity will take place on the MAR in the mid North Atlantic Ocean, and no activities will take place in or near a traditional Arctic subsistence hunting area.

XIII. Monitoring and Reporting Plan

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding...

L-DEO proposes to sponsor marine mammal monitoring during the present project, in order to implement the proposed mitigation measures that require real-time monitoring, and to satisfy the anticipated monitoring requirements of the IHA.

L-DEO's proposed Monitoring Plan is described below. L-DEO understands that this Monitoring Plan will be subject to review by NMFS, and that refinements may be required.

The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same regions. L-DEO is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

Vessel-based Visual Monitoring

PSO observations will take place during daytime airgun operations and nighttime start ups of the airguns. Airgun operations will be suspended when marine mammals or turtles are observed within, or about to enter, designated exclusion zones [see § XI above] where there is concern about potential effects on hearing or other physical effects. PSOs will also watch for marine mammals and turtles near the seismic vessel for at least 30 min prior to the planned start of airgun operations. Observations will also be made during daytime periods when the *Langseth* is underway without seismic operations, such as during transits.

During seismic operations, at least four visual PSOs will be based aboard the *Langseth*. PSOs will be appointed by L-DEO with NMFS concurrence. During the majority of seismic operations, two PSOs will monitor for marine mammals and sea turtles around the seismic vessel. Use of two simultaneous observers will increase the effectiveness of detecting animals around the source vessel. However, during meal times, only one PSO may be on duty. PSO(s) will be on duty in shifts of duration no longer than 4 h. Other crew will also be instructed to assist in detecting marine mammals and turtles and implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew will be given additional instruction regarding how to do so.

The *Langseth* is a suitable platform for marine mammal and turtle observations. When stationed on the observation platform, the eye level will be ~21.5 m above sea level, and the observer will have a good view around the entire vessel. During daytime, the PSO(s) will scan the area around the vessel systematically with reticle binoculars (e.g., 7×50 Fujinon), Big-eye binoculars (25×150), and with the naked eye. During darkness, night vision devices (NVDs) will be available (ITT F500 Series Generation 3 binocular-image intensifier or equivalent), when required. Laser rangefinding binoculars (Leica LRF 1200 laser rangefinder or equivalent) will be available to assist with distance estimation. Those are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly; that is done primarily with the reticles in the binoculars.

Passive Acoustic Monitoring

Passive acoustic monitoring (PAM) will take place to complement the visual monitoring program. Visual monitoring typically is not effective during periods of poor visibility or at night, and even with good visibility, is unable to detect marine mammals when they are below the surface or beyond visual range. Acoustical monitoring can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. The acoustic monitoring will serve to alert visual observers (if on duty) when vocalizing cetaceans are detected. It is only useful when marine mammals call, but it can be effective either by day or by night, and does not depend on good visibility. It will be monitored in real time so that the visual observers can be advised when cetaceans are detected.

The PAM system consists of hardware (i.e., hydrophones) and software. The "wet end" of the system consists of a towed hydrophone array that is connected to the vessel by a tow cable. The tow cable is 250 m long, and the hydrophones are fitted in the last 10 m of cable. A depth gauge is attached to the free end of the cable, and the cable is typically towed at depths <20 m. The array will be deployed from a winch located on the back deck. A deck cable will connect the tow cable to the electronics unit in the main computer lab where the acoustic station, signal conditioning, and processing system will be located. The acoustic signals received by the hydrophones are amplified, digitized, and then processed by the Pamguard software. The system can detect marine mammal vocalizations at frequencies up to 250 kHz.

One acoustic PSO or PSAO (in addition to the 4 visual PSOs) will be on board. The towed hydrophones will ideally be monitored 24 h per day while at the seismic survey area during airgun operations, and during most periods when the *Langseth* is underway while the airguns are not operating. However, PAM may not be possible if damage occurs to the array or back-up systems during operations. One PSO will monitor the acoustic detection system at any one time, by listening to the signals from two channels via headphones and/or speakers and watching the real-time spectrographic display for frequency ranges produced by cetaceans. The PSAO monitoring the acoustical data will be on shift for 1–6 h at a time. All observers are expected to rotate through the PAM position, although the most experienced with acoustics will be on PAM duty more frequently.

When a vocalization is detected while visual observations are in progress, the PSAO will contact the visual PSO immediately, to alert him/her to the presence of cetaceans (if they have not already been seen), and to allow a power down or shut down to be initiated, if required. The information regarding the call will be entered into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position and water depth when first detected, bearing if determinable, species or species group (e.g., unidentified dolphin, sperm whale), types and nature of sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information. The acoustic detection can also be recorded for further analysis.

PSO Data and Documentation

PSOs will record data to estimate the numbers of marine mammals and turtles exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data will be used to estimate numbers of animals potentially 'taken' by harassment (as defined in the MMPA). They will also provide information needed to order a power down or shut down of the airguns when a marine mammal or sea turtle is within or near the EZ.

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

1. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting

cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace.

2. Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare.

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

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

Results from the vessel-based observations will provide

1. The basis for real-time mitigation (airgun power down or shut down).
2. Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS.
3. Data on the occurrence, distribution, and activities of marine mammals and turtles in the area where the seismic study is conducted.
4. Information to compare the distance and distribution of marine mammals and turtles relative to the source vessel at times with and without seismic activity.
5. Data on the behavior and movement patterns of marine mammals and turtles seen at times with and without seismic activity.

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

XIV. Coordinating Research to Reduce and Evaluate Incidental Take

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

L-DEO and NSF will coordinate the planned marine mammal monitoring program associated with the seismic survey with other parties that may have interest in this area. L-DEO and NSF will coordinate with applicable U.S. agencies (e.g., NMFS), and will comply with their requirements.

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