exposure of a small group of individuals does not present the deleterious effect on the regional stock that is suggested by the figure of 18.5 percent. This activity is expected to result in a negligible impact on the affected species or stocks. None of the species for which take authorization is requested are either ESA-listed or considered depleted under the MMPA.

For reasons stated previously in this document, the negligible impact determination is also supported by the likelihood that, given sufficient "notice" through mitigation measures including soft start, marine mammals are expected to move away from a noise source that is annoying prior to its becoming potentially injurious, and the likelihood that marine mammal detection ability by trained observers is high under the environmental conditions described for Hood Canal, enabling the implementation of shut-downs to avoid injury, serious injury, or mortality. As a result, no take by injury or death is anticipated, and the potential for temporary or permanent hearing impairment is very low and will be avoided through the incorporation of the proposed mitigation measures.

While the number of marine mammals potentially incidentally harassed will depend on the distribution and abundance of marine mammals in the vicinity of the survey activity, the number of potential harassment takings is estimated to be small relative to regional stock or population number, and has been mitigated to the lowest level practicable through incorporation of the proposed mitigation and monitoring measures mentioned previously in this document.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the mitigation and monitoring measures, NMFS preliminarily finds that the proposed pile replacement project will result in the incidental take of small numbers of marine mammal, by Level B harassment only, and that the total taking from the activity will have a negligible impact on the affected species or stocks.

Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses

No Tribal subsistence hunts are held in the vicinity of the project area; thus, temporary behavioral impacts to individual animals would not affect any subsistence activity. Further, no population or stock level impacts to marine mammals are anticipated or authorized. As a result, no impacts to the availability of the species or stock to the Pacific Northwest treaty Tribes are expected as a result of the proposed activities. Therefore, no relevant subsistence uses of marine mammals are implicated by this action.

Endangered Species Act (ESA)

There is one marine mammal species that is listed as endangered under the ESA with confirmed or possible occurrence in the study area: the Eastern DPS of the Steller sea lion. However, as described previously, the pile driving and removal activities associated with the project will occur from July 16–October 31 only, a time at which Steller sea lions are not present in the project area. The Navy conducted an informal consultation with the NWRO under Section 7 of the ESA; the NWRO concurred that there would be no presence of ESA-listed marine mammals during the project and that formal consultation was not required.

National Environmental Policy Act (NEPA)

In December 2010, the Navy prepared a draft EA, which has been posted on the NMFS Web site (*see* **ADDRESSES**) concurrently with the publication of this proposed IHA and public comments have been solicited. NMFS will review the draft EA and the public comments received and subsequently either adopt it or prepare its own NEPA document before making a determination on the issuance of an IHA.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to authorize the take of marine mammals incidental to the Navy's pile replacement project, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

Dated: January 31, 2011.

James H. Lecky,

Director, Office of Protected Resources, National Marine Fisheries Service.

[FR Doc. 2011–2530 Filed 2–3–11; 8:45 am]

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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XA124

Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey in the Pacific Ocean off Costa Rica, April Through May, 2011

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; proposed incidental harassment authorization; request for comments.

SUMMARY: NMFS has received an application from Lamont-Doherty Earth Observatory (L–DEO), a part of Columbia University, for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment, incidental to conducting a marine geophysical survey in the eastern tropical Pacific (ETP) Ocean off Costa Rica, April through May, 2011. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to L–DEO to incidentally harass, by Level B harassment only, 19 species of marine mammals during the specified activity.

DATES: Comments and information must be received no later than March 7, 2011.

ADDRESSES: Comments on the application should be addressed to P. Michael Payne, Chief, Permits, Conservation and Education Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. The mailbox address for providing e-mail comments is *ITP.Cody@noaa.gov.* NMFS is not responsible for e-mail comments sent to addresses other than the one provided here. Comments sent via e-mail, including all attachments, must not exceed a 10-megabyte file size.

All comments received are a part of the public record and will generally be posted to *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications* without change. All Personal Identifying Information (for example, name, address, etc.) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

A copy of the application containing a list of the references used in this document may be obtained by writing to the above address, telephoning the contact listed here (*see* **FOR FURTHER INFORMATION CONTACT**) or visiting the Internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.*

The National Science Foundation (NSF), which is providing funding for the proposed action, has prepared a draft Environmental Analysis which incorporates an "Environmental Assessment of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Pacific Ocean off Costa Rica, April–May, 2011", prepared by LGL Limited, on behalf of NSF is also available at the same internet address. Documents cited in this notice may be viewed, by appointment, during regular business hours, at the aforementioned address.

FOR FURTHER INFORMATION CONTACT: Jeannine Cody, Office of Protected Resources, NMFS, (301) 713–2289, ext. 113.

SUPPLEMENTARY INFORMATION:

Background

Section 101(a)(5)(D) of the MMPA (16 U.S.C. 1371(a)(5)(D)) directs the Secretary of Commerce to authorize, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock, by United States citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review.

Authorization for the incidental taking of small numbers of marine mammals shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant). The authorization must set forth the permissible methods of taking, other means of effecting the least practicable adverse impact on the species or stock and its habitat, and requirements pertaining to the mitigation, monitoring and reporting of such takings. NMFS has defined "negligible impact" in 50 CFR 216.103 as "* * * an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

Section 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. Section 101(a)(5)(D) of the MMPA establishes a 45-day time limit for NMFS' review of an application followed by a 30-day public notice and comment period on any proposed authorizations for the incidental harassment of small numbers of marine mammals. Within 45 days of the close of the public comment period, NMFS must either issue or deny the authorization.

Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as:

any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

Summary of Request

NMFS received an application on November 12, 2010, from L–DEO for the taking by harassment, of marine mammals, incidental to conducting a marine geophysical survey in the eastern tropical Pacific Ocean within the Exclusive Economic Zone (EEZ) of Costa Rica. L–DEO, with research funding from the U.S. National Science Foundation (NSF), plans to conduct the proposed survey from April 7, 2011, through May 9, 2011. Upon receipt of additional information, NMFS determined the application complete and adequate on January 4, 2011.

L–DEO plans to use one source vessel, the R/V *Marcus G. Langseth* (*Langseth*) and a seismic airgun array to image the structures along a major plate-boundary fault off in the ETP off Costa Rica using three-dimensional (3–D) seismic reflection techniques. L–DEO will use the 3–D seismic reflection data to determine the fault structure and the properties of the rocks that lie along the fault zone. In addition to the proposed operations of the seismic airgun array, L–DEO intends to operate a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) continuously throughout the survey.

Acoustic stimuli (*i.e.,* increased underwater sound) generated during the operation of the seismic airgun array, may have the potential to cause a short-term behavioral disturbance for marine mammals in the survey area. This is the principal means of marine mammal taking associated with these activities and L–DEO has requested an authorization to take 19 species marine mammals by Level B harassment. Take is not expected to result from the use of the MBES or SBP, for reasons discussed in this notice; nor is take expected to result from collision with the vessel because it is a single vessel moving at a relatively slow speed during seismic acquisition within the survey, for a relatively short period of time (approximately 32 days). It is likely that any marine mammal would be able to avoid the vessel.

Description of the Specified Activity

L–DEO's proposed seismic survey in the ETP off Costa Rica is scheduled to commence on April 7, 2011 and continue for approximately 32 days ending on May 9, 2011. L–DEO will operate the *Langseth* to deploy a seismic airgun array and hydrophone streamers to complete the survey.

The *Langseth* will depart from Caldera, Costa Rica on April 7, 2011 and transit to the survey area offshore from Costa Rica. Some minor deviation from these dates is possible, depending on logistics, weather conditions, and the need to repeat some lines if data quality is substandard. Therefore, NMFS plans to issue an authorization that extends to June 6, 2011.

Geophysical survey activities will involve 3–D seismic methodologies to determine the fault structure and the properties of the rocks that lie along the fault zone and to assess the property changes along the fault and determine where the large stress accumulations that lead to large earthquakes occur along the fault zone.

To obtain 3–D images of the fault zone which lies two to nine kilometers (km) below the seafloor, the *Langseth* will deploy a two-string subarray of nine airguns each as an energy source. The identical subarrays will fire alternately, so that no more than 18 airguns will fire at any time during the proposed survey. The receiving system will consist of four 6-km-long hydrophone streamers. As the airgun subarrays are towed along the survey lines, the hydrophone streamers will receive the returning acoustic signals and transfer the data to the on-board processing system. L–DEO also plans to use two or three small fishing vessels around the *Langseth* to ensure that other vessels do not entangle the streamers.

The proposed study (e.g., equipment testing, startup, line changes, repeat coverage of any areas, and equipment recovery) will take place in the EEZ of Costa Rica in water depths ranging from less than 100 meters (m) (328 feet (ft)) to greater than 2,500 m (1.55 miles (mi)). The survey will require approximately 32 days (d) to complete approximately 19 transects in a racetrack configuration that will cover an area of approximately 57 x 12 km (35.4 x 7.5 mi). In all, the proposed survey will complete approximately 2,145 km (1,333 mi) of survey lines with an additional 365 km (227 mi) of turns. Data acquisition will include approximately 672 hours (hr) of airgun operation (28 d x 24 hr).

The scientific team consists of Drs. Nathan Bangs, Kirk McIntosh (Institute for Geophysics, University of Texas) and Eli Silver (University of California at Santa Cruz).

Vessel Specifications

The *Langseth,* owned by NSF, is a seismic research vessel with a propulsion system designed to be as quiet as possible to avoid interference with the seismic signals emanating from the airgun array. The vessel, which has a length of 71.5 m (235 ft); a beam of 17.0 m (56 ft); a maximum draft of 5.9 m (19 ft); and a gross tonnage of 3,834, is powered by two 3,550 horsepower (hp) Bergen BRG–6 diesel engines which drive two propellers. Each propeller has four blades and the shaft typically rotates at 750 revolutions per minute. The vessel also has an 800-hp bowthruster, which is not used during seismic acquisition. The *Langseth's* operation speed during seismic acquisition will be approximately 8.5 km per hr (km/h) (5.3 mi per hr (mph) or 4.6 knots (kts)) and the cruising speed of the vessel outside of seismic operations is 18.5 km/h (11.5 mph or 10 kts).

The vessel also has an observation tower from which protected species visual observers (PSVO) will watch for marine mammals before and during the proposed airgun operations. When stationed on the observation platform, the PSVO's eye level will be approximately 21.5 m (71 ft) above sea level providing the PSVO an unobstructed view around the entire vessel.

Acoustic Source Specifications

Seismic Airguns

The *Langseth* will deploy a 36-airgun array (two subarrays with 18 airguns each) at a tow depth of 7 meters (m) (23 feet (ft)). However, the *Langseth* will fire one subarray at a time, so that no more than 18 airguns will fire at any time. The maximum discharge volume is 3,300 cubic inches (in^3). The airguns are a mixture of Bolt 1500LL and Bolt 1900LLX airguns ranging in size from 40 to 360 in^3, with a firing pressure of 1,900 pounds per square inch. The dominant frequency components range from zero to 188 Hertz (Hz).

The subarray configuration consists of two identical linear or strings, with 10 airguns on each string; the first and last airguns will be spaced 16 m (52 ft) apart. Of the 10 airguns, nine will fire simultaneously while the tenth airgun will serve as a spare and will be turned on in case of failure of one of the other airguns. Each airgun subarray will emit a pulse at approximately 11-second (s) intervals which corresponds to a shot interval of approximately 25 m (82 ft). During firing, the airguns will emit a brief (approximately 0.1 s) pulse of sound; during the intervening periods of operations, the airguns will be silent.

L–DEO will tow each subarray approximately 140 m (459.3 ft) behind the vessel and will distribute the subarrays across an area of approximately 12 by 16 m (39.4 by 52.5 ft) behind the *Langseth,* offset by 75 m (246 ft).

Metrics Used in This Document

This section includes a brief explanation of the sound measurements frequently used in the discussions of acoustic effects in this document. Sound pressure is the sound force per unit area, and is usually measured in micropascals (μPa), where 1 pascal (Pa) is the pressure resulting from a force of one newton exerted over an area of one square meter. Sound pressure level (SPL) is expressed as the ratio of a measured sound pressure and a reference level. The commonly used reference pressure level in underwater acoustics is 1 μPa, and the units for SPLs are dB re: 1 μPa.

SPL (in decibels (dB)) = 20 log (pressure/reference pressure)

SPL is an instantaneous measurement and can be expressed as the peak, the peak-peak (p-p), or the root mean square (rms). Root mean square, which is the square root of the arithmetic average of the squared instantaneous pressure values, is typically used in discussions of the effects of sounds on vertebrates and all references to SPL in this document refer to the root mean square unless otherwise noted. SPL does not take the duration of a sound into account.

Characteristics of the Airgun Pulses

Airguns function by venting high-pressure air into the water which creates an air bubble. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by the oscillation of the resulting air bubble. The oscillation of the air bubble transmits sounds downward through the seafloor and the amount of sound transmitted in the near horizontal directions is reduced. However, the airgun array also emits sounds that travel horizontally toward non-target areas.

The nominal source levels of the airgun arrays used by L–DEO on the *Langseth* are 236 to 265 dB re: 1 $\mu Pa_{(p-p)}$ and the rms value for a given airgun pulse is typically 16 dB re: 1 μPa lower than the peak-to-peak value. However, the difference between rms and peak or peak-to-peak values for a given pulse depends on the frequency content and duration of the pulse, among other factors.

Accordingly, L–DEO has predicted the received sound levels in relation to distance and direction from the 18-airgun subarray and the single Bolt 1900LL 40-in^3 airgun, which will be used during power downs. A detailed description of L–DEO's modeling for marine seismic source arrays for species mitigation is provided in Appendix A of L–DEO's application. These are the nominal source levels applicable to downward propagation. The effective source levels for horizontal propagation are lower than those for downward propagation when the source consists of numerous airguns spaced apart from one another.

Appendix B of L–DEO's environmental analysis discusses the characteristics of the airgun pulses. NMFS refers the reviewers to the application and environmental analysis documents for additional information.

Predicted Sound Levels for the Airguns

Tolstoy *et al.,* (2009) reported results for propagation measurements of pulses from the *Langseth's* 36-airgun, 6,600 in^3 array in shallow-water (approximately 50 m (164 ft)) and deep-water depths (approximately 1,600 m (5,249 ft)) in the Gulf of Mexico in 2007 and 2008. L–DEO has used these reported empirical values to determine exclusion zones for the 18-airgun subarray and the single airgun; to designate mitigation zones, and to estimate take (described in greater detail in Section VII and Section IV of L–DEO's application and environmental analysis, respectively) for marine mammals.

Results of the Gulf of Mexico calibration study (Tolstoy *et al.,* 2009) showed that radii around the airguns for various received levels varied with water depth. The empirical data for deep water (greater than 1,000 m; 3,280 ft) indicated that the L–DEO model (as applied to the *Langseth's* 36-airgun array) overestimated the received sound levels at a given distance. However, to be conservative, L–DEO has applied the modeled distances for the 36-airgun array in deep water to the 18-airgun subarray when operating in deep-water areas during the proposed study (Table 1). L–DEO set 2,000 m (1.2 mi) as the maximum relevant depth as very few, if any, mammals are expected to occur below this depth.

The empirical data for shallow water (< 100 m; 328 ft) indicated that the L–DEO model (as applied to the Langseth's 36-airgun array) underestimated actual received levels. Accordingly, L–DEO has applied correction factors to the distances reported by Tolstoy *et al.* (2009) for shallow depth water. For the 36-airgun array, the distances measured in shallow-water to the 160- to 190-dB isopleths ranged from 1.7 to 5.2 times higher than the distances in deep water (Tolstoy et al. 2009). During the proposed cruise, the same factors will be applied to derive appropriate shallow-water radii from the modeled deep-water radii for the *Langseth's* 18-airgun subarray (Table 1).

For intermediate-depths (100–1,000 m; 328–3,280 ft), L–DEO has applied a correction factor of 1.5 to the estimates provided by the model for the 18-airgun subarray operating in deep-water situations to predict safety radii for intermediate-depth sites. L–DEO applied the same correction factor to model estimates for an L–DEO cruise in the same area in 2003 and 2004.

Table 1 summarizes the predicted distances at which sound levels (160- and 180-dB) are expected to be received from the 18-airgun subarray and a single airgun operating in shallow, intermediate and deep water depths.

TABLE 1—PREDICTED DISTANCES TO WHICH SOUND LEVELS ≥ 190, 180, AND 160 DB RE: 1 μPA$_{rms}$ COULD BE RECEIVED DURING THE PROPOSED SURVEY USING A 18-AIRGUN SUBARRAY, AS WELL AS A SINGLE AIRGUN TOWED AT A DEPTH OF 7 M IN THE ETP DURING APRIL–MAY, 2011

[Distances are based on model results provided by L–DEO.]

Source and volume	Water depth	*Predicted RMS Distances (m)*	
		180 dB	160 dB
Single Bolt airgun (40 in³)	Shallow < 100 m	296	1,050
	Intermediate 100–1,000 m	60	578
	Deep > 1,000 m	40	385
18-Airgun subarray (3,300 in³)	Shallow < 100 m	1,030	* 19,500
	Intermediate 100–1,000 m	675	5,700
	Deep > 1,000 m	450	3,800

* This is likely an overestimate, as the measured distance for the 36-airgun array operating in shallow waters of the northern Gulf of Mexico was 17,500 m (17.5 km).

L–DEO conducted modeling for a 2008 survey off Costa Rica using site specific data on sound velocity profiles in the water column and bottom composition at a depth of 65 m (213.5 ft) in Drake Bay (at the proposed survey area) and at a depth of 340 m (1,115 ft) in an area approximately 100 km (62 mi) north of the survey area. The modeled exclusion zones were smaller than the shallow- and intermediate-depth ranges listed in Table 1, suggesting that L–DEO's estimates for the proposed survey are overestimates and thus precautionary. Also, the estimated 160-dB distance for the 18-airgun subarray in water depths less than 100 m (328 ft) (Table 1) is higher than the measured distance for the 36-airgun array (17.5 km; Tolstoy *et al.,* 2009), again suggesting that these estimates are precautionary. Refer to Appendix A of L–DEO's environmental analysis for additional information on L–DEO's calculations for the model.

Multibeam Echosounder

The *Langseth* will operate a Kongsberg EM 122 MBES concurrently during airgun operations to map characteristics of the ocean floor. The hull-mounted MBES emits brief pulses of sound (also called a ping) (10.5 to 13 kilohertz (kHz)) in a fan-shaped beam that extends downward and to the sides of the ship. The transmitting beamwidth is one or two degrees (°) fore-aft and 150° athwartship and the maximum source level is 242 dB re: 1 μPa.

For deep-water operations, each ping consists of eight (in water greater than 1,000 m; 3,280 ft) or four (less than 1,000 m; 3,280 ft) successive, fan-shaped transmissions, from two to 15 milliseconds (ms) in duration and each ensonifying a sector that extends 1° fore-aft. The eight successive transmissions span an overall cross-track angular extent of about 150°, with 2-ms gaps between the pulses for successive sectors.

Sub-Bottom Profiler

The *Langseth* will also operate a Knudsen 320B SBP continuously throughout the cruise with the MBES to provide information about the sedimentary features and bottom topography. The dominant frequency component of the SBP is 3.5 kHz which is directed downward in a 30° cone by a hull-mounted transducer on the vessel. The maximum output is 1,000 watts (204 dB re: 1 μPa), but in practice, the output varies with water depth. The pulse interval is one second, but a common mode of operation is to broadcast five pulses at 1-s intervals followed by a 5-s pause.

NMFS expects that acoustic stimuli resulting from the proposed operation of the single airgun or the 18-airgun subarray has the potential to harass marine mammals, incidental to the conduct of the proposed seismic survey. NMFS expects these disturbances to be temporary and result, at worst, in a temporary modification in behavior and/or low-level physiological effects (Level B Harassment) of small numbers of certain species of marine mammals. NMFS does not expect that the movement of the *Langseth,* during the conduct of the seismic survey, has the potential to harass marine mammals because of the relatively slow operation speed of the vessel (4.6 kts; 8.5 km/h; 5.3 mph) during seismic acquisition.

Description of the Specified Geographic Region

The survey will encompass the area bounded by 8.5–9° N, 83.75–84.25° W offshore from Costa Rica in the Pacific Ocean (*see* Figure 1 in L–DEO's application). The closest that the *Langseth* will approach the coastline is approximately 30 km.

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

Twenty-eight marine mammal species may occur in the proposed survey area, including 20 odontocetes (toothed cetaceans), 6 mysticetes (baleen whales) and two pinnipeds. Of these, 19 cetacean species are likely to occur in the proposed survey area in the ETP during April through May. Five of these species are listed as endangered under the U.S. Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq.*), including the humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and sperm (*Physeter macrocephalus*) whale.

The species of marine mammals expected to be most common in the survey area (all delphinids) include the short-beaked common dolphin (*Delphinus delphis*), spinner dolphin (*Stenella longirostris*), pantropical spotted dolphin (*Stenella attenuata*), striped dolphin (*Stenella coeruleoalba*), melon-headed whale (*Peponocephala electra*), and bottlenose dolphin (Tursiops truncatus).

Two pinnipeds, the California sea lion (*Zalophus californianus*) and the Galápagos sea lion (*Zalophus wollebaeki*), have the potential to transit in the vicinity of the proposed seismic survey, although any occurrence would be rare as they are vagrants to the area. Based on available data and monitoring reports from previous seismic surveys in the area, L–DEO does not expect to encounter these species within the proposed survey area and does not present analysis for these species. Accordingly, NMFS will not consider these pinniped species in greater detail and the proposed IHA will only address requested take authorizations for mysticetes and odontocetes.

Table 2 presents information on the abundance, distribution, population status, and conservation status of the marine mammals that may occur in the proposed survey area April through May, 2011.

TABLE 2—HABITAT, REGIONAL ABUNDANCE, AND CONSERVATION STATUS OF MARINE MAMMALS THAT MAY OCCUR IN OR NEAR THE PROPOSED SEISMIC SURVEY AREAS OFF COSTA RICA IN THE EASTERN TROPICAL PACIFIC OCEAN

[See text and Tables 2–4 in L–DEO's application and environmental analysis for further details.]

Species	Occurrence in survey area during April–May	Habitat	Abundance in the ETP [1]	ESA [2]	Density	
					Best [3]	Max [4]
Mysticetes						
Humpback whale	Very rare	Mainly nearshore waters and banks.	NE Pacific 1392 [6] SE Pacific 2900 [7]	EN	0.25	4.40
Bryde's whale	Uncommon	Pelagic and coastal	13,000 [8]	NL	0.96	2.52
Sei whale	Very rare	Mostly pelagic	N.A.	EN	0.01	0.01
Fin whale	Very rare	Slope, mostly pelagic	2636 [6]	EN	0.01	0.01
Blue whale	Rare	Pelagic and coastal	1415 [9]	EN	0.13	1.86
Common minke whale	Very rare	Coastal	N.A.	NL	< 0.01	< 0.01
Odontocetes						
Sperm whale	Uncommon	Usually deep pelagic, steep topography.	26,053 [10]	EN	4.19	9.80
Pygmy sperm whale	Very rare	Deep waters off shelf	N.A. [11]	NL	0.03	0.05
Dwarf sperm whale	Rare	Deep waters off shelf	11,200 [12]	NL	0.03	0.05
Cuvier's beaked whale	Uncommon	Slope and pelagic	20,000 [9]	NL	2.47	3.70
Mesoplodon spp.	Very rare or rare	Pelagic	25,300 [13]	NL	0.36	1.00
Rough-toothed dolphin	Common	Mainly pelagic	107,633	NL	4.19	11.19
Bottlenose dolphin	Very common	Coastal, shelf, pelagic	335,834	NL	17.06	90.91
Pantropical spotted dolphin	Very common	Coastal and pelagic	1,575,247 [14]	NL	76.96	236.66
Spinner dolphin	Common	Coastal and pelagic	1,797,716 [14]	NL	58.43	364.26
Striped dolphin	Uncommon	Off continental shelf	964,362	NL	67.75	154.21
Fraser's dolphin	Rare	Pelagic	289,300 [9]	NL	< 0.01	< 0.01
Short-beaked common dolphin.	Common	Shelf, pelagic, high relief	3,127,203	NL	110.89	763.50
Risso's dolphin	Common	Shelf, slope, seamounts	110,457	NL	12.76	12.76
Melon-headed whale	Rare	Pelagic	45,400 [9]	NL	11.06	57.70
Pygmy killer whale	Rare	Pelagic	38,900 [9]	NL	1.25	2.30
False killer whale	Uncommon	Pelagic	39,800 [9]	NL	0.01	0.01
Killer whale	Rare	Widely distributed	8500 [15]	NL	0.19	0.40
Short-finned pilot whale	Common	Mostly pelagic, high-relief	589,315 [16]	NL	11.88	28.22

N.A. Not available or not assessed.
[1] Abundance from Gerrodette *et al.* (2008) unless otherwise stated.
[2] U.S. Endangered Species Act: EN = Endangered, T = Threatened, NL = Not listed.
[3] Best density (#/1000km^2) estimate as listed in Table 3 of the application. Cetecean densities are based on NMFS SWFSC ship transect surveys conducted in 1986–2006 from predictive modeling (Barlow *et al.* 2009; Read *et al.* 2009) or in 1986–1996 from Ferguson and Barlow (2003).
[4] Maximum density (#/1000km^2) estimate as listed in Table 3 of the application.
[6] U.S. west coast (Carretta *et al.,* 2010).
[7] Southeast Pacific; Félix *et al.* (2005).
[8] This estimate is mainly for *Balaenoptera edeni* but may include some *B. borealis* (Wade and Gerrodette, 1993).
[9] ETP (Wade and Gerrodette, 1993).
[10] Eastern temperate North Pacific (Whitehead, 2002).
[11] California/Oregon/Washington (Carretta *et al.,* 2010).
[12] This abundance estimate is mostly for *K. sima* but may also include some *K. breviceps* (Wade and Gerrodette, 1993).
[13] This estimate includes all species of the genus *Mesoplodon* in the ETP (Wade and Gerrodette, 1993).
[14] For all stocks in ETP.
[15] ETP (Ford, 2002).

[16] This estimate is for *G. macrorhynchus* and *G. melas* in the ETP (Gerrodette and Forcada, 2002).
[17] U.S. stock (Carretta *et al.,* 2010).
[18] Galapagos Islands (Alava and Salazar, 2006).

Refer to Section III of L–DEO's application for detailed information regarding the abundance and distribution, population status, and life history and behavior of these species and their occurrence in the proposed project area. The application also presents how L–DEO calculated the estimated densities for the marine mammals in the proposed survey area. NMFS has reviewed these data and determined them to be the best available scientific information for the purposes of the proposed IHA.

Potential Effects on Marine Mammals

Acoustic stimuli generated by the operation of the airguns, which introduce sound into the marine environment, may have the potential to cause Level B harassment of marine mammals in the proposed survey area. The effects of sounds from airgun operations might include one of the following: tolerance, masking of natural sounds, behavioral disturbance, temporary or permanent impairment, or non-auditory physical or physiological effects (Richardson *et al.,* 1995; Gordon *et al.,* 2004; Nowacek *et al.,* 2007; Southall *et al.,* 2007).

Permanent hearing impairment, in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not an injury (Southall *et al.,* 2007). Although the possibility cannot be entirely excluded, it is unlikely that the proposed project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. Based on the available data and studies described here, some behavioral disturbance is expected, but NMFS expects the disturbance to be localized and short-term.

Tolerance to Sound

Studies on marine mammals' tolerance to sound in the natural environment are relatively rare. Richardson *et al.* (1995) defines tolerance as the occurrence of marine mammals in areas where they are exposed to human activities or man-made noise. In many cases, tolerance develops by the animal habituating to the stimulus (i.e., the gradual waning of responses to a repeated or ongoing stimulus) (Richardson, *et al.,* 1995; Thorpe, 1963), but because of ecological or physiological requirements, many marine animals may need to remain in areas where they are exposed to chronic stimuli (Richardson, *et al.,* 1995).

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Malme *et al.,* (1985) studied the responses of humpback whales on their summer feeding grounds in southeast Alaska to seismic pulses from a airgun with a total volume of 100-in^3. They noted that the whales did not exhibit persistent avoidance when exposed to the airgun and concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 dB: re 1 μPa.

Weir (2008) observed marine mammal responses to seismic pulses from a 24-airgun array firing a total volume of either 5,085 in^3 or 3,147 in^3 in Angolan waters between August 2004 and May 2005. She recorded a total of 207 sightings of humpback whales (n = 66), sperm whales (n = 124), and Atlantic spotted dolphins (n = 17) and reported that there were no significant differences in encounter rates (sightings/hr) for humpback and sperm whales according to the airgun array's operational status (*i.e.,* active versus silent).

Masking of Natural Sounds

The term masking refers to the inability of a subject to recognize the occurrence of an acoustic stimulus as a result of the interference of another acoustic stimulus (Clark *et al.,* 2009). Introduced underwater sound may, through masking, reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant fraction of the time (Richardson *et al.,* 1995).

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited. Because of the intermittent nature and low duty cycle of seismic airgun pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in some situations, reverberation occurs for much or the entire interval between pulses (*e.g.,* Simard *et al.,* 2005; Clark and Gagnon, 2006) which could mask calls. Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls can usually be heard between the seismic pulses (*e.g.,* Richardson *et al.,* 1986; McDonald *et al.,* 1995; Greene *et al.,* 1999; Nieukirk *et al.,* 2004; Smultea *et al.,* 2004; Holst *et al.,* 2005a,b, 2006; and Dunn and Hernandez, 2009). However, Clark and Gagnon (2006) reported that fin whales in the northeast Pacific Ocean went silent for an extended period starting soon after the onset of a seismic survey in the area. Similarly, there has been one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles *et al.,* 1994). However, more recent studies found that they continued calling in the presence of seismic pulses (Madsen *et al.,* 2002; Tyack *et al.,* 2003; Smultea *et al.,* 2004; Holst *et al.,* 2006; and Jochens *et al.,* 2008). Dolphins and porpoises commonly are heard calling while airguns are operating (e.g., Gordon *et al.,* 2004; Smultea *et al.,* 2004; Holst *et al.,* 2005a, b; and Potter *et al.,* 2007). The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking.

In general, NMFS expects the masking effects of seismic pulses to be minor, given the normally intermittent nature of seismic pulses. Refer to Appendix B (4) of L–DEO's environmental analysis for a more detailed discussion of masking effects on marine mammals.

Behavioral Disturbance

Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson *et al.,* 1995; Wartzok *et al.,* 2004; Southall *et al.,* 2007; Weilgart, 2007). 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 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. Scientists have conducted detailed studies on humpback, gray, bowhead (*Balaena mysticetus*), and sperm whales. Less detailed data are available for some other species of baleen whales, small toothed whales, and sea otters (*Enhydra lutris*), 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 (reviewed in Richardson, *et al.,* 1995). 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, as reviewed in Appendix B (5) of L–DEO's environmental analysis, 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 (Richardson, *et al.,* 1995). They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Studies of gray, bowhead, and humpback whales have shown that seismic pulses with received levels of 160 to 170 dB re: 1 μPa seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed (Malme *et al.,* 1986, 1988; Richardson *et al.,* 1995). In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from four to 15 km from the source. A substantial proportion of the baleen whales within those distances may show avoidance or other strong behavioral reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and studies summarized in Appendix B (5) of L–DEO's environmental analysis have shown that some species of baleen whales, notably bowhead and humpback whales, at times, show strong avoidance at received levels lower than 160–170 dB re: 1 μPa.

McCauley *et al.* (1998, 2000) studied the responses of humpback whales off western Australia to a full-scale seismic survey with a 16-airgun array (2,678-in^3) and to a single airgun (20-in^3) with source level of 227 dB re: 1 $\mu Pa_{(p-p)}$. In the 1998 study, they documented that avoidance reactions began at five to eight km from the array, and that those reactions kept most pods approximately three to four km from the operating seismic boat. In the 2000 study, they noted localized displacement during migration of four to five km by traveling pods and seven to 12 km by more sensitive resting pods of cow-calf pairs. Avoidance distances with respect to the single airgun were smaller but consistent with the results from the full array in terms of the received sound levels. The mean received level for initial avoidance of an approaching airgun was 140 dB re: 1 μPa for humpback pods containing females, and at the mean closest point of approach distance the received level was 143 dB re: 1 μPa. The initial avoidance response generally occurred at distances of five to eight km from the airgun array and two km from the single airgun. However, some individual humpback whales, especially males, approached within distances of 100 to 400 m (328 to 1,312 ft), where the maximum received level was 179 dB re: 1 μPa.

Humpback whales on their summer feeding grounds in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64–L (100-in^3) airgun (Malme *et al.,* 1985). Some humpbacks *see*med "startled" at received levels of 150 to 169 dB re: 1 μPa. Malme *et al.* (1985) concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 dB re: 1 μPa.

Studies have suggested that south Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel *et al.,* 2004). The evidence for this was circumstantial and subject to alternative explanations (IAGC, 2004). Also, the evidence was not consistent with subsequent results from the same area of Brazil (Parente *et al.,* 2006), or with direct studies of humpbacks exposed to seismic surveys in other areas and seasons. After allowance for data from subsequent years, there was no observable direct correlation between strandings and seismic surveys (IWC, 2007:236).

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 versus 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 to 30 km from a medium-sized airgun source at received sound levels of around 120 to 130 dB re: 1 μPa (Miller *et al.,* 1999; Richardson *et al.,* 1999; *see* Appendix B (5) of L–DEO's environmental analysis). However, more recent research on bowhead whales (Miller *et al.,* 2005; Harris *et al.,* 2007) corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. Nonetheless, subtle but statistically significant changes in surfacing–respiration–dive cycles were evident upon statistical analysis (Richardson *et al.,* 1986). In the summer, bowheads typically begin to show avoidance reactions at received levels of about 152 to 178 dB re: 1 μPa (Richardson *et al.,* 1986, 1995; Ljungblad *et al.,* 1988; Miller *et al.,* 2005).

Reactions of migrating and feeding (but not wintering) gray whales to seismic surveys have been studied. Malme *et al.* (1986, 1988) studied the responses of feeding eastern Pacific gray whales to pulses from a single 100-in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50 percent of feeding gray whales stopped feeding at an average received pressure level of 173 dB re: 1 μPa on an (approximate) rms basis, and that 10 percent of feeding whales interrupted feeding at received levels of 163 dB re: 1 μPa. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast (Malme *et al.,* 1984; Malme and Miles, 1985), and western Pacific gray whales feeding off Sakhalin Island, Russia (Wursig *et al.,* 1999; Gailey *et al.,* 2007; Johnson *et al.,* 2007; Yazvenko *et al.,* 2007a, b), along with data on gray whales off British Columbia (Bain and Williams, 2006).

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses (Stone, 2003; MacLean and Haley, 2004; Stone and Tasker, 2006), and calls from blue and fin whales have been localized in areas with airgun operations (e.g., McDonald *et al.,* 1995; Dunn and

Hernandez, 2009). 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 (Stone, 2003; Stone and Tasker, 2006). However, these whales tended to exhibit localized avoidance, remaining significantly further (on average) from the airgun array during seismic operations compared with non-seismic periods (Stone and Tasker, 2006). In a study off of Nova Scotia, Moulton and Miller (2005) found little difference in sighting rates (after accounting for water depth) and initial sighting distances of balaenopterid whales when airguns were operating vs. silent. However, there were indications that these whales were more likely to be moving away when *see*n during airgun operations. Similarly, ship-based monitoring studies of blue, fin, sei and minke whales offshore of Newfoundland (Orphan Basin and Laurentian Sub-basin) found no more than small differences in sighting rates and swim directions during seismic versus non-seismic periods (Moulton *et al.,* 2005, 2006a,b).

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades (Appendix A *in* Malme *et al.,* 1984; Richardson *et al.,* 1995; Allen and Angliss, 2010). The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year (Johnson *et al.,* 2007). Similarly, bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years (Richardson *et al.,* 1987; Angliss and Allen, 2009).

Toothed Whales—Little systematic information is available about reactions of toothed whales to noise pulses. Few studies similar to the more extensive baleen whale/seismic pulse work summarized above and (in more detail) in Appendix B of L–DEO's environmental analysis have been reported for toothed whales. However, there are recent systematic studies on sperm whales (*e.g.,* Gordon *et al.,* 2006; Madsen *et al.,* 2006; Winsor and Mate, 2006; Jochens *et al.,* 2008; Miller *et al.,* 2009). There is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (e.g., Stone, 2003; Smultea *et al.,* 2004; Moulton and Miller, 2005; Bain and Williams, 2006; Holst *et al.,* 2006; Stone and Tasker, 2006; Potter *et al.,* 2007; Hauser *et al.,* 2008; Holst and Smultea, 2008; Weir, 2008; Barkaszi *et al.,* 2009; Richardson *et al.,* 2009).

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 (e.g., Goold, 1996a,b,c; Calambokidis and Osmek, 1998; Stone, 2003; Moulton and Miller, 2005; Holst *et al.,* 2006; Stone and Tasker, 2006; Weir, 2008; Richardson *et al.,* 2009; *see* also Barkaszi *et al.,* 2009). Some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when large arrays of airguns are firing (*e.g.,* Moulton and Miller, 2005). Nonetheless, small toothed whales more often tend to head away, or to maintain a somewhat greater distance from the vessel, when a large array of airguns is operating than when it is silent (*e.g.,* Stone and Tasker, 2006; Weir, 2008). In most cases, the avoidance radii for delphinids appear to be small, on the order of one km less, and some individuals show no apparent avoidance. The beluga whale (*Delphinapterus leucas*) is a species that (at least at times) shows long-distance avoidance of seismic vessels. Aerial surveys conducted in the southeastern Beaufort Sea during summer found that sighting rates of beluga whales were significantly lower at distances 10 to 20 km compared with 20 to 30 km from an operating airgun array, and observers on seismic boats in that area rarely *see* belugas (Miller *et al.,* 2005; Harris *et al.,* 2007).

Captive bottlenose dolphins (*Tursiops truncatus*) and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran *et al.,* 2000, 2002, 2005). However, the animals tolerated high received levels of sound before exhibiting aversive behaviors.

Results for porpoises depend on species. The limited available data suggest that harbor porpoises (*Phocoena phocoena*) show stronger avoidance of seismic operations than do Dall's porpoises (*Phocoenoides dalli*) (Stone, 2003; MacLean and Koski, 2005; Bain and Williams, 2006; Stone and Tasker, 2006). Dall's porpoises seem relatively tolerant of airgun operations (MacLean and Koski, 2005; Bain and Williams, 2006), although they too have been observed to avoid large arrays of operating airguns (Calambokidis and Osmek, 1998; Bain and Williams, 2006). This apparent difference in responsiveness of these two porpoise species is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson *et al.,* 1995; Southall *et al.,* 2007).

Most studies of sperm whales exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses (*e.g.,* Stone, 2003; Moulton *et al.,* 2005, 2006a; Stone and Tasker, 2006; Weir, 2008). In most cases the whales do not show strong avoidance, and they continue to call (*see* Appendix B of L–DEO's environmental analysis for review). However, controlled exposure experiments in the Gulf of Mexico indicate that foraging behavior was altered upon exposure to airgun sound (Jochens *et al.,* 2008; Miller *et al.,* 2009; Tyack, 2009).

There are almost no specific data on the behavioral reactions of beaked whales to seismic surveys. However, some northern bottlenose whales (*Hyperoodon ampullatus*) remained in the general area and continued to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys (Gosselin and Lawson, 2004; Laurinolli and Cochrane, 2005; Simard *et al.,* 2005). Most beaked whales tend to avoid approaching vessels of other types (e.g., Wursig *et al.,* 1998). They may also dive for an extended period when approached by a vessel (e.g., Kasuya, 1986), although it is uncertain how much longer such dives may be as compared to dives by undisturbed beaked whales, which also are often quite long (Baird *et al.,* 2006; Tyack *et al.,* 2006). Based on a single observation, Aguilar-Soto *et al.* (2006) suggested that foraging efficiency of Cuvier's beaked whales may be reduced by close approach of vessels. In any event, it is likely that most beaked whales would also show strong avoidance of an approaching seismic vessel, although this has not been documented explicitly.

There are increasing indications that some beaked whales tend to strand when naval exercises involving mid-frequency sonar operation are ongoing nearby (*e.g.,* Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; NOAA and

USN, 2001; Jepson *et al.,* 2003; Hildebrand, 2005; Barlow and Gisiner, 2006; *see* also the Stranding and Mortality section in this notice). These strandings are apparently a disturbance response, although auditory or other injuries or other physiological effects may also be involved. Whether beaked whales would ever react similarly to seismic surveys is unknown. Seismic survey sounds are quite different from those of the sonar in operation during the above-cited incidents.

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids and Dall's porpoises, *see*m to be confined to a smaller radius than has been observed for the more responsive of the mysticetes, belugas, and harbor porpoises (Appendix B of L–DEO's environmental analysis).

Hearing Impairment and Other Physical Effects

Exposure to high intensity sound for a sufficient duration may result in auditory effects such as a noise-induced threshold shift—an increase in the auditory threshold after exposure to noise (Finneran, Carder, Schlundt, and Ridgway, 2005). Factors that influence the amount of threshold shift include the amplitude, duration, frequency content, temporal pattern, and energy distribution of noise exposure. The magnitude of hearing threshold shift normally decreases over time following cessation of the noise exposure. The amount of threshold shift just after exposure is called the initial threshold shift. If the threshold shift eventually returns to zero (i.e., the threshold returns to the pre-exposure value), it is called temporary threshold shift (TTS) (Southall *et al.,* 2007).

Researchers have studied TTS in certain captive odontocetes and pinnipeds exposed to strong sounds (reviewed in Southall *et al.,* 2007). However, there has been no specific documentation of TTS let alone permanent hearing damage, *i.e.,* permanent threshold shift (PTS), in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions.

Temporary Threshold Shift—TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. At least in terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the noise ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound. Available data on TTS in marine mammals are summarized in Southall *et al.* (2007). Table 1 presents the distances from the *Langseth's* airguns at which the received energy level (per pulse, flat-weighted) that would be expected to be greater than or equal to 180 dB re: 1 μPa.

To avoid the potential for injury, NMFS (1995, 2000) concluded that cetaceans should not be exposed to pulsed underwater noise at received levels exceeding 180 dB re: 1 μPa. NMFS believes that to avoid the potential for permanent physiological damage (Level A harassment), cetaceans should not be exposed to pulsed underwater noise at received levels exceeding 180 dB re: 1 μPa. The 180-dB level is a shutdown criterion applicable to cetaceans, as specified by NMFS (2000); these levels were used to establish the EZs. NMFS also assumes that cetaceans exposed to levels exceeding 160 dB re: 1 μPa (rms) may experience Level B harassment.

Researchers have derived TTS information for odontocetes from studies on the bottlenose dolphin and beluga. For the one harbor porpoise tested, the received level of airgun sound that elicited onset of TTS was lower (Lucke *et al.,* 2009). If these results from a single animal are representative, it is inappropriate to assume that onset of TTS occurs at similar received levels in all odontocetes (*cf.* Southall *et al.,* 2007). Some cetaceans apparently can incur TTS at considerably lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin.

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. The frequencies to which baleen whales are most sensitive are assumed to be lower than those to which odontocetes are most sensitive, and natural background noise levels at those low frequencies tend to be higher. As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison, 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales (Southall *et al.,* 2007). For this proposed study, L—DEO expects no cases of TTS given: (1) The low abundance of baleen whales in the planned study area at the time of the survey; and (2) the strong likelihood that baleen whales would avoid the approaching airguns (or vessel) before being exposed to levels high enough for TTS to occur. *Permanent Threshold Shift*—When PTS occurs, there is physical damage to the sound receptors in the ear. In severe cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985). There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the possibility that mammals close to an airgun array might incur at least mild TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson *et al.,* 1995, p. 372*ff;* Gedamke *et al.,* 2008). Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are assumed to be similar to those in humans and other terrestrial mammals. PTS might occur at a received sound level at least several decibels above that inducing mild TTS if the animal were exposed to strong sound pulses with rapid rise time–*see* Appendix B (6) of L–DEO's environmental analysis. Based on data from terrestrial mammals, a precautionary assumption is that the PTS threshold for impulse sounds (such as airgun pulses as received close to the source) is at least 6 dB higher than the TTS threshold on a peak-pressure basis, and probably greater than six dB (Southall *et al.,* 2007).

Given the higher level of sound necessary to cause PTS as compared with TTS, it is considerably less likely that PTS would occur. Baleen whales generally avoid the immediate area around operating seismic vessels, as do some other marine mammals.

Stranding and Mortality—Marine mammals close to underwater detonations of high explosives can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten *et al.,* 1993; Ketten, 1995). However, explosives are no longer used for marine waters for commercial seismic surveys or (with rare exceptions) for seismic research; they have been replaced entirely by airguns or related non-explosive pulse generators. Airgun pulses are less energetic and have slower rise times, and there is no specific evidence that they can cause serious injury, death, or stranding even in the case of large airgun arrays. However, the association of strandings of beaked whales with naval exercises involving mid-frequency active sonar and, in one case, an L–DEO seismic survey (Malakoff, 2002; Cox *et al.,* 2006), has raised the possibility that beaked whales exposed to strong "pulsed" sounds may be especially susceptible to injury and/or behavioral reactions that can lead to stranding (e.g., Hildebrand, 2005; Southall *et al.,* 2007). Appendix B (6) of L–DEO's environmental analysis provides additional details.

Specific sound-related processes that lead to strandings and mortality are not well documented, but may include:

(1) Swimming in avoidance of a sound into shallow water;

(2) a change in behavior (such as a change in diving behavior) that might contribute to tissue damage, gas bubble formation, hypoxia, cardiac arrhythmia, hypertensive hemorrhage or other forms of trauma;

(3) a physiological change such as a vestibular response leading to a behavioral change or stress-induced hemorrhagic diathesis, leading in turn to tissue damage; and

(4) tissue damage directly from sound exposure, such as through acoustically-mediated bubble formation and growth or acoustic resonance of tissues. Some of these mechanisms are unlikely to apply in the case of impulse sounds. However, there are increasing indications that gas-bubble disease (analogous to the bends), induced in supersaturated tissue by a behavioral response to acoustic exposure, could be a pathologic mechanism for the strandings and mortality of some deep-diving cetaceans exposed to sonar. However, the evidence for this remains circumstantial and associated with exposure to naval mid-frequency sonar, not seismic surveys (Cox *et al.,* 2006; Southall *et al.,* 2007).

Seismic pulses and mid-frequency sonar signals are quite different, and some mechanisms by which sonar sounds have been hypothesized to affect beaked whales are unlikely to apply to airgun pulses. Sounds produced by airgun arrays are broadband impulses with most of the energy below one kHz. Typical military mid-frequency sonar emits non-impulse sounds at frequencies of two to 10 kHz, generally with a relatively narrow bandwidth at any one time. A further difference between seismic surveys and naval exercises is that naval exercises can involve sound sources on more than one vessel. Thus, it is not appropriate to assume that there is a direct connection between the effects of military sonar and seismic surveys on marine mammals. However, evidence that sonar signals can, in special circumstances, lead (at least indirectly) to physical damage and mortality (*e.g.,* Balcomb and Claridge, 2001; NOAA and USN, 2001; Jepson *et al.,* 2003; Fernández *et al.,* 2004, 2005; Hildebrand 2005; Cox *et al.,* 2006) suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity "pulsed" sound.

There is no conclusive evidence of cetacean strandings or deaths at sea as a result of exposure to seismic surveys, but a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings. Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel *et al.,* 2004) were not well founded (IAGC, 2004; IWC, 2007). In September 2002, there was a stranding of two Cuvier's beaked whales (*Ziphius cavirostris*) in the Gulf of California, Mexico, when the L DEO vessel R/V *Maurice Ewing* was operating a 20-airgun (8,490 in^3) in the general area. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence (Hogarth, 2002; Yoder, 2002). Nonetheless, the Gulf of California incident plus the beaked whale strandings near naval exercises involving use of mid-frequency sonar suggests a need for caution in conducting seismic surveys in areas occupied by beaked whales until more is known about effects of seismic surveys on those species (Hildebrand, 2005). No injuries of beaked whales are anticipated during the proposed study because of:

(1) The high likelihood that any beaked whales nearby would avoid the approaching vessel before being exposed to high sound levels,

(2) differences between the sound sources operated by L–DEO and those involved in the naval exercises associated with strandings.

Non-auditory Physiological Effects—Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007). Studies examining such effects are limited. However, resonance effects (Gentry, 2002) and direct noise-induced bubble formations (Crum *et al.,* 2005) are implausible in the case of exposure to an impulsive broadband source like an airgun array. If seismic surveys disrupt diving patterns of deep-diving species, this might perhaps result in bubble formation and a form of the bends, as speculated to occur in beaked whales exposed to sonar. However, there is no specific evidence of this upon exposure to airgun pulses.

In general, very little is known about the potential for seismic survey sounds (or other types of strong underwater sounds) to cause non-auditory physical effects in marine mammals. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall *et al.,* 2007), or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales and some odontocetes, are especially unlikely to incur non-auditory physical effects.

Potential Effects of Other Acoustic Devices

MBES

L–DEO will operate the Kongsberg EM 122 MBES from the source vessel during the planned study. Sounds from the MBES are very short pulses, occurring for two to 15 ms once every five to 20 s, depending on water depth. Most of the energy in the sound pulses emitted by this MBES is at frequencies near 12 kHz, and the maximum source level is 242 dB re: 1 μPa. The beam is narrow (1 to 2°) in fore-aft extent and wide (150°) in the cross-track extent. Each ping consists of eight (in water greater than 1,000 m deep) or four (less than 1,000 m deep) successive fan-shaped transmissions (segments) at different cross-track angles. Any given mammal at depth near the trackline would be in the main beam for only one or two of the nine segments. Also, marine mammals that encounter the Kongsberg EM 122 are unlikely to be subjected to repeated pulses because of the narrow fore-aft width of the beam and will receive only limited amounts of pulse energy because of the short pulses. Animals close to the ship (where the beam is narrowest) are especially unlikely to be ensonified for more than one 2-to-15 ms pulse (or two pulses if in the overlap area). Similarly, Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when an MBES emits a pulse is small. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to receive the multiple pulses that might result in sufficient exposure to cause TTS.

Navy sonars that have been linked to avoidance reactions and stranding of cetaceans: (1) Generally have longer pulse duration than the Kongsberg EM 122; and (2) are often directed close to horizontally versus more downward for the MBES. The area of possible influence of the MBES is much smaller—a narrow band below the source vessel. Also, the duration of exposure for a given marine mammal can be much longer for naval sonar. During L–DEO's operations, the individual pulses will be very short, and a given mammal would not receive many of the downward-directed pulses as the vessel passes by. Possible effects of an MBES on marine mammals are outlined below.

Masking—Marine mammal communications will not be masked appreciably by the MBES signals given the low duty cycle of the echosounder and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of baleen whales, the MBES signals (12 kHz) do not overlap with the predominant frequencies in the calls, which would avoid any significant masking.

Behavioral Responses—Behavioral reactions of free-ranging marine mammals to sonars, echosounders, and other sound sources appear to vary by species and circumstance. Observed reactions have included silencing and dispersal by sperm whales (Watkins *et al.,* 1985), increased vocalizations and no dispersal by pilot whales (*Globicephala melas*) (Rendell and Gordon, 1999), and the previously-mentioned beachings by beaked whales. During exposure to a 21 to 25 kHz "whale-finding" sonar with a source level of 215 dB re: 1 μPa, gray whales reacted by orienting slightly away from the source and being deflected from their course by approximately 200 m (Frankel, 2005). When a 38-kHz echosounder and a 150-kHz acoustic Doppler current profiler were transmitting during studies in the Eastern Tropical Pacific, baleen whales showed no significant responses, while spotted and spinner dolphins were detected slightly more often and beaked whales less often during visual surveys (Gerrodette and Pettis, 2005).

Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1-s tonal signals at frequencies similar to those that will be emitted by the MBES used by L DEO, and to shorter broadband pulsed signals. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure (Schlundt *et al.,* 2000; Finneran *et al.,* 2002; Finneran and Schlundt, 2004). The relevance of those data to free-ranging odontocetes is uncertain, and in any case, the test sounds were quite different in duration as compared with those from an MBES.

Hearing Impairment and Other Physical Effects—Given recent stranding events that have been associated with the operation of naval sonar, there is concern that mid-frequency sonar sounds can cause serious impacts to marine mammals (*see* above). However, the MBES proposed for use by L DEO is quite different than sonar used for navy operations. Pulse duration of the MBES is very short relative to the naval sonar. Also, at any given location, an individual marine mammal would be in the beam of the MBES for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; navy sonar often uses near-horizontally-directed sound. Those factors would all reduce the sound energy received from the MBES rather drastically relative to that from naval sonar.

NMFS believes that the brief exposure of marine mammals to one pulse, or small numbers of signals, from the MBES is not likely to result in the harassment of marine mammals.

SBP

L–DEO will also operate a SBP from the source vessel during the proposed survey. Sounds from the SBP are very short pulses, occurring for one to four ms once every second. Most of the energy in the sound pulses emitted by the SBP is at 3.5 kHz, and the beam is directed downward. The sub-bottom profiler on the Langseth has a maximum source level of 204 dB re: 1 μPa.

Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when a bottom profiler emits a pulse is small—even for an SBP more powerful than that on the *Langseth*—if the animal was in the area, it would have to pass the transducer at close range and in order to be subjected to sound levels that could cause TTS.

Masking—Marine mammal communications will not be masked appreciably by the SBP signals given the directionality of the signal and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of most baleen whales, the SBP signals do not overlap with the predominant frequencies in the calls, which would avoid significant masking.

Behavioral Responses—Marine mammal behavioral reactions to other pulsed sound sources are discussed above, and responses to the SBP are likely to be similar to those for other pulsed sources if received at the same levels. However, the pulsed signals from the SBP are considerably weaker than those from the MBES. Therefore, behavioral responses are not expected unless marine mammals are very close to the source.

Hearing Impairment and Other Physical Effects—It is unlikely that the SBP produces pulse levels strong enough to cause hearing impairment or other physical injuries even in an animal that is (briefly) in a position near the source. The SBP is usually operated simultaneously with other higher-power acoustic sources. Many marine mammals will move away in response to the approaching higher-power sources or the vessel itself before the mammals would be close enough for there to be any possibility of effects from the less intense sounds from the SBP.

The potential effects to marine mammals described in this section of the document do not take into consideration the proposed monitoring and mitigation measures described later in this document (*see* the "Proposed Mitigation" and "Proposed Monitoring and Reporting" sections) which, as noted are designed to effect the least practicable adverse impact on affected marine mammal species and stocks.

Anticipated Effects on Marine Mammal Habitat

The proposed seismic survey will not result in any permanent impact on habitats used by the marine mammals in the proposed survey area, including the food sources they use (i.e. fish and invertebrates), and there will be no physical damage to any habitat. While it is anticipated that the specified activity may result in marine mammals avoiding certain areas due to temporary ensonification, this impact to habitat is temporary and reversible and was considered in further detail earlier in this document, as behavioral modification. The main impact associated with the proposed activity will be temporarily elevated noise levels and the associated direct effects on marine mammals, previously discussed in this notice.

Anticipated Effects on Fish

One reason for the adoption of airguns as the standard energy source for marine seismic surveys is that, unlike explosives, they have not been associated with large-scale fish kills. However, existing information on the impacts of seismic surveys on marine fish populations is limited (*see* Appendix D of L–DEO's environmental analysis). There are three types of potential effects of exposure to seismic surveys: (1) Pathological, (2) physiological, and (3) behavioral. Pathological effects involve lethal and temporary or permanent sub-lethal injury. Physiological effects involve temporary and permanent primary and secondary stress responses, such as changes in levels of enzymes and proteins. Behavioral effects refer to temporary and (if they occur) permanent changes in exhibited behavior (*e.g.,* startle and avoidance behavior). The three categories are interrelated in complex ways. For example, it is possible that certain physiological and behavioral changes could potentially lead to an ultimate pathological effect on individuals (*i.e.,* mortality).

The specific received sound levels at which permanent adverse effects to fish potentially could occur are little studied and largely unknown. Furthermore, the available information on the impacts of seismic surveys on marine fish is from studies of individuals or portions of a population; there have been no studies at the population scale. The studies of individual fish have often been on caged fish that were exposed to airgun pulses in situations not representative of an actual seismic survey. Thus, available information provides limited insight on possible real-world effects at the ocean or population scale.

Hastings and Popper (2005), Popper (2009), and Popper and Hastings (2009a,b) provided recent critical reviews of the known effects of sound on fish. The following sections provide a general synopsis of the available information on the effects of exposure to seismic and other anthropogenic sound as relevant to fish. The information comprises results from scientific studies of varying degrees of rigor plus some anecdotal information. Some of the data sources may have serious shortcomings in methods, analysis, interpretation, and reproducibility that must be considered when interpreting their results (*see* Hastings and Popper, 2005). Potential adverse effects of the program's sound sources on marine fish are then noted.

Pathological Effects—The potential for pathological damage to hearing structures in fish depends on the energy level of the received sound and the physiology and hearing capability of the species in question (*see* Appendix D L–DEO's environmental analysis). For a given sound to result in hearing loss, the sound must exceed, by some substantial amount, the hearing threshold of the fish for that sound (Popper, 2005). The consequences of temporary or permanent hearing loss in individual fish on a fish population are unknown; however, they likely depend on the number of individuals affected and whether critical behaviors involving sound (e.g., predator avoidance, prey capture, orientation and navigation, reproduction, etc.) are adversely affected.

Little is known about the mechanisms and characteristics of damage to fish that may be inflicted by exposure to seismic survey sounds. Few data have been presented in the peer-reviewed scientific literature. As far as we know, there are only two papers with proper experimental methods, controls, and careful pathological investigation implicating sounds produced by actual seismic survey airguns in causing adverse anatomical effects. One such study indicated anatomical damage, and the second indicated TTS in fish hearing. The anatomical case is McCauley *et al.* (2003), who found that exposure to airgun sound caused observable anatomical damage to the auditory maculae of pink snapper (*Pagrus auratus*). This damage in the ears had not been repaired in fish sacrificed and examined almost two months after exposure. On the other hand, Popper *et al.* (2005) documented only TTS (as determined by auditory brainstem response) in two of three fish species from the Mackenzie River Delta. This study found that broad whitefish (*Coregonus nasus*) that exposed to five airgun shots were not significantly different from those of controls. During both studies, the repetitive exposure to sound was greater than would have occurred during a typical seismic survey. However, the substantial low-frequency energy produced by the airguns [less than 400 Hz in the study by McCauley *et al.* (2003) and less than approximately 200 Hz in Popper *et al.* (2005)] likely did not propagate to the fish because the water in the study areas was very shallow (approximately 9 m in the former case and less than two m in the latter). Water depth sets a lower limit on the lowest sound frequency that will propagate (the "cutoff frequency") at about one-quarter wavelength (Urick, 1983; Rogers and Cox, 1988).

Wardle *et al.* (2001) suggested that in water, acute injury and death of organisms exposed to seismic energy depends primarily on two features of the sound source: (1) The received peak pressure and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. According to Buchanan *et al.* (2004), for the types of seismic airguns and arrays involved with the proposed program, the pathological (mortality) zone for fish would be expected to be within a few meters of the seismic source. Numerous other studies provide examples of no fish mortality upon exposure to seismic sources (Falk and Lawrence, 1973; Holliday *et al.,* 1987; La Bella *et al.,* 1996; Santulli *et al.,* 1999; McCauley *et al.,* 2000a,b, 2003; Bjarti, 2002; Thomsen, 2002; Hassel *et al.,* 2003; Popper *et al.,* 2005; Boeger *et al.,* 2006).

Some studies have reported, some equivocally, that mortality of fish, fish eggs, or larvae can occur close to seismic sources (Kostyuchenko, 1973; Dalen and Knutsen, 1986; Booman *et al.,* 1996; Dalen *et al.,* 1996). Some of the reports claimed seismic effects from treatments quite different from actual seismic survey sounds or even reasonable surrogates. However, Payne *et al.* (2009) reported no statistical differences in mortality/morbidity between control and exposed groups of capelin eggs or monkfish larvae. Saetre and Ona (1996) applied a 'worst-case scenario' mathematical model to investigate the effects of seismic energy on fish eggs and larvae. They concluded that mortality rates caused by exposure to seismic surveys are so low, as compared to natural mortality rates, that the impact of seismic surveying on recruitment to a fish stock must be regarded as insignificant.

Physiological Effects—Physiological effects refer to cellular and/or biochemical responses of fish to acoustic stress. Such stress potentially could affect fish populations by increasing mortality or reducing reproductive success. Primary and secondary stress responses of fish after exposure to seismic survey sound appear to be temporary in all studies done to date (Sverdrup *et al.,* 1994; Santulli *et al.,* 1999; McCauley *et al.,* 2000a,b). The periods necessary for the biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus (*see* Appendix D of L–DEO's environmental analysis).

Behavioral Effects—Behavioral effects include changes in the distribution, migration, mating, and catchability of fish populations. Studies investigating the possible effects of sound (including seismic survey sound) on fish behavior have been conducted on both uncaged and caged individuals (*e.g.,* Chapman and Hawkins, 1969; Pearson *et al.,* 1992;

Santulli *et al.,* 1999; Wardle *et al.,* 2001; Hassel *et al.,* 2003). Typically, in these studies fish exhibited a sharp startle response at the onset of a sound followed by habituation and a return to normal behavior after the sound ceased.

There is general concern about potential adverse effects of seismic operations on fisheries, namely a potential reduction in the "catchability" of fish involved in fisheries. Although reduced catch rates have been observed in some marine fisheries during seismic testing, in a number of cases the findings are confounded by other sources of disturbance (Dalen and Raknes, 1985; Dalen and Knutsen, 1986; Lokkeborg, 1991; Skalski *et al.,* 1992; Engas *et al.,* 1996). In other airgun experiments, there was no change in catch per unit effort (CPUE) of fish when airgun pulses were emitted, particularly in the immediate vicinity of the seismic survey (Pickett *et al.,* 1994; La Bella *et al.,* 1996). For some species, reductions in catch may have resulted from a change in behavior of the fish, *e.g.,* a change in vertical or horizontal distribution, as reported in Slotte *et al.* (2004).

In general, any adverse effects on fish behavior or fisheries attributable to seismic testing may depend on the species in question and the nature of the fishery (season, duration, fishing method). They may also depend on the age of the fish, its motivational state, its size, and numerous other factors that are difficult, if not impossible, to quantify at this point, given such limited data on effects of airguns on fish, particularly under realistic at-sea conditions.

Anticipated Effects on Invertebrates

The existing body of information on the impacts of seismic survey sound on marine invertebrates is very limited. However, there is some unpublished and very limited evidence of the potential for adverse effects on invertebrates, thereby justifying further discussion and analysis of this issue. The three types of potential effects of exposure to seismic surveys on marine invertebrates are pathological, physiological, and behavioral. Based on the physical structure of their sensory organs, marine invertebrates appear to be specialized to respond to particle displacement components of an impinging sound field and not to the pressure component (Popper *et al.,* 2001; *see* also Appendix E of L–DEO's environmental analysis).

The only information available on the impacts of seismic surveys on marine invertebrates involves studies of individuals; there have been no studies at the population scale. Thus, available information provides limited insight on possible real-world effects at the regional or ocean scale. The most important aspect of potential impacts concerns how exposure to seismic survey sound ultimately affects invertebrate populations and their viability, including availability to fisheries.

Literature reviews of the effects of seismic and other underwater sound on invertebrates were provided by Moriyasu *et al.* (2004) and Payne *et al.* (2008). The following sections provide a synopsis of available information on the effects of exposure to seismic survey sound on species of decapod crustaceans and cephalopods, the two taxonomic groups of invertebrates on which most such studies have been conducted. The available information is from studies with variable degrees of scientific soundness and from anecdotal information. A more detailed review of the literature on the effects of seismic survey sound on invertebrates is provided in Appendix E of L–DEO's environmental analysis.

Pathological Effects—In water, lethal and sub-lethal injury to organisms exposed to seismic survey sound appears to depend on at least two features of the sound source: (1) The received peak pressure; and (2) the time required for the pressure to rise and decay. Generally, as received pressure increases, the period for the pressure to rise and decay decreases, and the chance of acute pathological effects increases. For the type of airgun array planned for the proposed program, the pathological (mortality) zone for crustaceans and cephalopods is expected to be within a few meters of the seismic source, at most; however, very few specific data are available on levels of seismic signals that might damage these animals. This premise is based on the peak pressure and rise/decay time characteristics of seismic airgun arrays currently in use around the world.

Some studies have suggested that seismic survey sound has a limited pathological impact on early developmental stages of crustaceans (Pearson *et al.,* 1994; Christian *et al.,* 2003; DFO, 2004). However, the impacts appear to be either temporary or insignificant compared to what occurs under natural conditions. Controlled field experiments on adult crustaceans (Christian *et al.,* 2003, 2004; DFO, 2004) and adult cephalopods (McCauley *et al.,* 2000a,b) exposed to seismic survey sound have not resulted in any significant pathological impacts on the animals. It has been suggested that exposure to commercial seismic survey activities has injured giant squid (Guerra *et al.,* 2004), but the article provides little evidence to support this claim.

Physiological Effects—Physiological effects refer mainly to biochemical responses by marine invertebrates to acoustic stress. Such stress potentially could affect invertebrate populations by increasing mortality or reducing reproductive success. Primary and secondary stress responses (i.e., changes in haemolymph levels of enzymes, proteins, etc.) of crustaceans have been noted several days or months after exposure to seismic survey sounds (Payne *et al.,* 2007). The periods necessary for these biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus.

Behavioral Effects—There is increasing interest in assessing the possible direct and indirect effects of seismic and other sounds on invertebrate behavior, particularly in relation to the consequences for fisheries. Changes in behavior could potentially affect such aspects as reproductive success, distribution, susceptibility to predation, and catchability by fisheries. Studies investigating the possible behavioral effects of exposure to seismic survey sound on crustaceans and cephalopods have been conducted on both uncaged and caged animals. In some cases, invertebrates exhibited startle responses (*e.g.,* squid in McCauley *et al.,* 2000a,b). In other cases, no behavioral impacts were noted (*e.g.,* crustaceans in Christian *et al.,* 2003, 2004; DFO 2004). There have been anecdotal reports of reduced catch rates of shrimp shortly after exposure to seismic surveys; however, other studies have not observed any significant changes in shrimp catch rate (Andriguetto-Filho *et al.,* 2005). Similarly, Parry and Gason (2006) did not find any evidence that lobster catch rates were affected by seismic surveys. Any adverse effects on crustacean and cephalopod behavior or fisheries attributable to seismic survey sound depend on the species in question and the nature of the fishery (season, duration, fishing method).

Proposed Mitigation

In order to issue an incidental take authorization (ITA) under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable adverse impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and the availability of such species or stock for taking for certain subsistence uses.

L–DEO has based the mitigation measures described herein, to be implemented for the proposed seismic survey, on the following:

(1) Protocols used during previous L–DEO seismic research cruises as approved by NMFS;

(2) previous IHA applications and IHAs approved and authorized by NMFS; and

(3) recommended best practices in Richardson *et al.* (1995), Pierson *et al.* (1998), and Weir and Dolman (2007).

To reduce the potential for disturbance from acoustic stimuli associated with the activities, L–DEO and/or its designees has proposed to implement the following mitigation measures for marine mammals:

(1) Proposed exclusion zones;

(2) power-down procedures;

(3) shutdown procedures; and

(4) ramp-up procedures.

Proposed Exclusion Zones–L–DEO uses safety radii to designate exclusion zones and to estimate take (described in greater detail in Section IV and Appendix A of L–DEO's environmental analysis) for marine mammals. Table 1 shows the distances at which two sound levels (160– and 180–dB) are expected to be received from the 18-airgun subarray and a single airgun. The 180–dB level shut-down criterion is applicable to cetaceans, as specified by NMFS (2000); and L–DEO used these levels to establish the EZs. If the protected species visual observer (PSVO) detects marine mammal(s) within or about to enter the appropriate EZ, the *Langseth* crew will immediately power down the airgun subarrays, or perform a shut down if necessary (*see* Shut-down Procedures).

Power-down Procedures–A power-down involves decreasing the number of airguns in use such that the radius of the 180–dB zone is decreased to the extent that marine mammals are no longer in or about to enter the EZ. A power down of the airgun subarray can also occur when the vessel is moving from one seismic line to another. During a power-down for mitigation, L–DEO will operate one airgun. The continued operation of one airgun is intended to alert marine mammals to the presence of the seismic vessel in the area. In contrast, a shut down occurs when the *Langseth* suspends all airgun activity.

If the PSVO detects a marine mammal outside the EZ, but it is likely to enter the EZ, L–DEO will power down the airguns before the animal is within the EZ. Likewise, if a mammal is already within the EZ, when first detected L–DEO will power down the airguns immediately. During a power down of the airgun array, L–DEO will also operate the 40-in^3 airgun. If a marine mammal is detected within or near the smaller EZ around that single airgun (Table 1), L–DEO will shut down the airgun (*see* next section).

Following a power-down, L–DEO will not resume airgun activity until the marine mammal has cleared the safety zone. L–DEO will consider the animal to have cleared the EZ if

- a PSVO has visually observed the animal leave the EZ, or
- a PSVO has not sighted the animal within the EZ for 15 min for small odontocetes, or 30 min for mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales.

During airgun operations following a power-down (or shut-down) whose duration has exceeded the time limits specified previously, L–DEO will ramp-up the airgun array gradually (*see* Shut-down Procedures).

Shut-down Procedures—L–DEO will shut down the operating airgun(s) if a marine mammal is seen within or approaching the EZ for the single airgun. L–DEO will implement a shut-down:

(1) if an animal enters the EZ of the single airgun after L–DEO has initiated a power down, or

(2) if an animal is initially seen within the EZ of the single airgun when more than one airgun (typically the full airgun array) is operating.

L–DEO will not resume airgun activity until the marine mammal has cleared the EZ, or until the PSVO is confident that the animal has left the vicinity of the vessel. Criteria for judging that the animal has cleared the EZ will be as described in the preceding section.

Ramp-up Procedures—L–DEO will follow a ramp-up procedure when the airgun subarrays begin operating after a specified period without airgun operations or when a power down has exceeded that period. L–DEO proposes that, for the present cruise, this period would be approximately eight min. This period is based on the 180–dB radius for the 18-airgun subarray towed at a depth of seven m (23 ft) in relation to the minimum planned speed of the Langseth while shooting (8.5 km/h; 5.3 mph; 4.6 kts). L–DEO has used similar periods (8–10 min) during previous L–DEO surveys.

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 six dB per five-minute period over a total duration of approximately 30 min. During ramp-up, the PSVOs will monitor the EZ, and if marine mammals are sighted, L–DEO will implement a power down or shut down as though the full airgun 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, L–DEO will not commence the ramp-up 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 will be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. L–DEO will not initiate a ramp-up of the airguns if a marine mammal is sighted within or near the applicable EZs during the day or close to the vessel at night.

NMFS has carefully evaluated the applicant's proposed mitigation measures and has considered a range of other measures in the context of ensuring that NMFS prescribes the means of effecting the least practicable adverse impact on the affected marine mammal species and stocks and their habitat. Our evaluation of potential measures included consideration of the following factors in relation to one another: (1) The manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation.

Based on our evaluation of the applicant's proposed measures, as well as other measures considered by NMFS or recommended by the public, NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable adverse impacts on marine mammals species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to issue an ITA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS must set forth "requirements pertaining to the monitoring and reporting of such taking." The MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for IHAs must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the action area.

Monitoring

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 this section. 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

PSVOs will be based aboard the seismic source vessel and will watch for marine mammals near the vessel during daytime airgun operations and during any start-ups at night. PSVOs will also watch for marine mammals near the seismic vessel for at least 30 min prior to the start of airgun operations after an extended shut down.

PSVOs will conduct observations during daytime periods when the seismic system is not operating for comparison of sighting rates and behavior with and without airgun operations and between acquisition periods. Based on PSVO observations, the airguns will be powered down or shut down when marine mammals are observed within or about to enter a designated EZ. The EZ is a region in which a possibility exists of adverse effects on animal hearing or other physical effects.

During seismic operations off Costa Rica, at least three PSVOs will be based aboard the *Langseth.* L–DEO will appoint the PSVOs with NMFS' concurrence. During all daytime periods, two PSVOs will be on duty from the observation tower to monitor and PSVOs will be on duty in shifts of duration no longer than four hours.

During mealtimes it is sometimes difficult to have two PSVOs on effort, but at least one PSVO will be on watch during bathroom breaks and mealtimes. Use of two simultaneous observers increases the effectiveness of detecting animals near the source vessel. However, during meal times, only one PSVO may be on duty.

Two PSVOs will also be on visual watch during all nighttime start-ups of the seismic airguns. A third PSVO will monitor the PAM equipment 24 hours a day to detect vocalizing marine mammals present in the action area. In summary, a typical daytime cruise would have scheduled two PSVOs on duty from the observation tower, and a third PSVO on PAM.

L–DEO will also instruct other crew to assist in detecting marine mammals and implementing mitigation requirements (if practical). Before the start of the seismic survey, L–DEO will give the crew additional instruction regarding how to accomplish this task.

The *Langseth* is a suitable platform for marine mammal observations. When stationed on the observation platform, the eye level will be approximately 21.5 m (70.5 ft) above sea level, and the observer will have a good view around the entire vessel. During daytime, the PSVOs 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 range-finding 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 complement the visual monitoring program, when practicable. 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.

Besides the three PSVOs, an additional acoustic Protected Species Observer (PSO) with primary responsibility for PAM will also be aboard the vessel. L–DEO can use acoustical monitoring 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. When bearings (primary and mirror-image) to calling cetacean(s) are determined, the bearings will be relayed to the visual observer to help him/her sight the calling animal(s).

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 cable. The lead in from the hydrophone array is approximately 400 m (1,312 ft) long, the active section of the array is approximately 56 m (184 ft) long, and the hydrophone array is typically towed at depths of less than 20 m (66 ft).

The deck cable is connected from the array to a computer in the laboratory where signal conditioning and processing takes place. The digitized signal is then sent to the main laboratory, where the acoustic PSO monitors the system.

Ideally, the acoustic PSO will monitor the towed hydrophones 24 h per day 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 both the primary and back-up hydrophone the arrays during operations. The primary PAM streamer on the Langseth is a digital hydrophone streamer. Should the digital streamer fail, back-up systems should include an analog spare streamer and a hull-mounted hydrophone. Every effort would be made to have a working PAM system during the cruise. In the unlikely event that all three of these systems were to fail, L–DEO would continue science acquisition with the visual-based observer program. The PAM system is a supplementary enhancement to the visual monitoring program. If weather conditions were to prevent the use of PAM then conditions would also likely prevent the use of the airgun array.

One acoustic 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. Acoustic PSOs monitoring the acoustical data will be on shift for one to six hours at a time. Besides the PSVO, an additional acoustic PSO with primary responsibility for PAM will also be aboard the source vessel. All PSVOs 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 acoustic PSO will contact the visual PSVO 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. Data entry will 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.

PSVO Data and Documentation

PSVOs will record data to estimate the numbers of marine mammals exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data 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 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 seen at times with and without seismic activity.

L–DEO will submit a report 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 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.

L–DEO will report all injured or dead marine mammals (regardless of cause) to NMFS as soon as practicable. The report should include the species or description of the animal, the condition of the animal, location, time first found, observed behaviors (if alive) and photo or video, if available.

Estimated Take by Incidental Harassment

Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as:

> any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

Only take by Level B harassment is anticipated and authorized as a result of the proposed marine geophysical survey off Costa Rica. Acoustic stimuli (*i.e.,* increased underwater sound) generated during the operation of the seismic airgun array, may have the potential to cause marine mammals in the survey area to be exposed to sounds at or greater than 160 decibels (dB) or cause temporary, short-term changes in behavior. There is no evidence that the planned activities could result in injury, serious injury or mortality within the specified geographic area for which L–DEO seeks the IHA. The required mitigation and monitoring measures will minimize any potential risk for injury or mortality.

The following sections describe L–DEO's methods to estimate take by incidental harassment and present the applicant's estimates of the numbers of marine mammals that could be affected during the proposed geophysical survey. The estimates are based on a consideration of the number of marine mammals that could be disturbed appreciably by operations with the 18-airgun subarray to be used during approximately 2,145 km (1,333 mi) of survey lines with an additional 365 km (227 mi) of turns.

L–DEO assumes that, during simultaneous operations of the airgun array and the other sources, any marine mammals close enough to be affected by the MBES and SBP would already be affected by the airguns. However, whether or not the airguns are operating simultaneously with the other sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to the MBES and SBP given their characteristics (e.g., narrow downward-directed beam) and other considerations described previously. Such reactions are not considered to constitute "taking" (NMFS, 2001). Therefore, L–DEO provides no additional allowance for animals that could be affected by sound sources other than airguns.

Density data on the marine mammal species in the proposed survey area are available from extensive ship-based surveys for marine mammals in the ETP conducted by NMFS' Southwest Fisheries Science Center (SWFSC). L–DEO used densities from two sources: (1) The SWFSC's habitat models that predict density for 15 cetacean species in the ETP; and (2) densities from the surveys conducted during summer and fall 1986–1996, as summarized by Ferguson and Barlow (2001, 2003) for species sighted in SWFSC surveys whose sample sizes were too small to model density.

For the predictive models, the SWFSC developed habitat modeling as a method to estimate cetacean densities on a finer spatial scale compared to traditional line-transect analyses by using a continuous function of habitat variables, *e.g.,* sea surface temperature, depth, distance from shore, and prey density (Barlow et al. 2009). The SWFSC incorporated the models into a web-based Geographic Information System (GIS) developed by Duke University's Department of Defense Strategic Environmental Research and Development Program (SERDP) team and L–DEO used the GIS to obtain mean and maximum densities for 11 cetacean species in the model in the proposed survey area.

For the second source, L–DEO used the densities calculated from Ferguson and Barlow (2003) for 5° × 5° blocks that include the proposed survey area (Block 138) and blocks adjacent to 138 that include coastal waters: Blocks 119, 137, 138, 139, 158, and 159. Those blocks included 18,385 km (11,423 mi) of survey effort in Beaufort sea states 0–5, and 3,899 square kilometers (km^2) (1,505 square miles (mi^2)) of survey effort in Beaufort sea states 0–2. L–DEO also obtained densities for an additional seven species that were sighted in one or more of those blocks.

For two endangered species for which there are only unconfirmed sightings in the region, the sei and fin whales, L–DEO assigned low density values (equal to the density of the species with the lowest calculated density). The false killer whale has been sighted near the survey area but not in the seven blocks of Ferguson and Barlow (2003), so it was also assigned the same low density value.

Oceanographic conditions, including occasional El Niño and La Niña events, influence the distribution and numbers of marine mammals present in the ETP, resulting in considerable year-to-year variation in the distribution and abundance of many marine mammal species (*e.g.,* Escorza-Treviño, 2009). Thus, for some species the densities derived from recent surveys may not be representative of the densities that will be encountered during the proposed seismic survey. Table 2 includes L–DEO's estimates of the "best" and "maximum" densities of marine mammals in the ETP near the proposed survey area. For the modeled species, best estimates and maximum estimates of density in the survey area are the mean and maximum densities given in Read *et al.* (2009). For the other species, best estimates of density are the effort-weighted mean densities in the seven 5° × 5° blocks from Ferguson and Barlow (2001, 2003), and maximum estimates of density are the highest densities in any of the blocks.

L–DEO's estimates of exposures to various sound levels assume that the proposed surveys will be completed. 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. L–DEO has included an additional 25% of line transects to account for mission uncertainty and follow a precautionary approach. Furthermore, any marine mammal sightings within or near the designated exclusion zones will result in the power down or shut down of seismic operations as a mitigation measure. Thus, the following estimates of the numbers of marine mammals potentially exposed to sound levels of 160 dB re: 1 μPa are precautionary and probably overestimate the actual numbers of marine mammals that might be involved. These estimates also assume that there will be no weather, equipment, or mitigation delays, which is highly unlikely.

L–DEO estimated the number of different individuals that may be exposed to airgun sounds with received levels greater than or equal to 160 dB re: 1 μPa on one or more occasions by considering the total marine area that would be within the 160-dB radius around the operating airgun array on at least one occasion and the expected density of marine mammals. 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. In the proposed survey, the seismic lines are parallel and in close proximity; thus individuals could be exposed on two or more occasions. The area including overlap is 31.9 times the area excluding overlap. Thus a marine mammal that stayed in the survey area during the entire survey could be exposed 32 times (14 times), on average. Given the pattern of the seismic lines, the interval between exposures of a stationary animal would be approximately 18 hr. Moreover, it is unlikely that a particular animal would stay in the area during the entire survey. The number of different individuals potentially exposed to received levels greater than or equal to 160 re: 1 μPa was calculated by multiplying:

(1) The expected species density, either "mean" (*i.e.,* best estimate) or "maximum", times

(2) the anticipated area to be ensonified to that level during airgun operations excluding overlap, which is approximately 3,225 km^2 (2,003 mi^2).

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. Areas of overlap were included only once when estimating the number of individuals exposed. Applying this approach, approximately 3,225 km^2 (1,245 mi^2) would be within the 160-dB isopleth on one or more occasions during the survey. Because this approach does not allow for turnover in the mammal populations in the study area during the course of the survey, the actual number of individuals exposed could be underestimated. However, the approach assumes that no cetaceans will move away from or toward the trackline as the *Langseth* approaches in response to increasing sound levels prior to the time the levels reach 160 dB, which will result in overestimates for those species known to avoid seismic vessels.

Table 3 shows the best and maximum estimates of the number individual cetaceans that potentially could be exposed to greater than or equal to 160 dB re: 1 μPa during the seismic survey if no animals moved away from the survey vessel. The requested take authorization, given in the far right column of Table 3, is based on the maximum estimates rather than the best estimates of the numbers of individuals exposed, because of uncertainties associated with applying density data from one area to another.

The total 'maximum estimate' of the number of individual cetaceans that could be exposed to seismic sounds with received levels greater than or equal to 160 dB re: 1 μPa during the proposed survey is 7,078 (*see* Table 3 below this section). That total includes 38 baleen whales, four of which are endangered: 18 humpback whales or 1.2

percent of the regional population; one sei whale, one fin whale (less than 0.01 percent); and eight blue whales (0.6 percent). In addition, 40 sperm whales (also listed as endangered under the ESA) or 0.15 percent of the regional population could be exposed during the survey, and 19 beaked whales. Most (97 percent) of the cetaceans that could be potentially exposed are delphinids (*e.g.,* short-beaked common, striped, pantropical spotted, striped and spinner dolphins) with maximum estimates ranging from two to 3,077 exposed to levels greater than or equal to 160 dB re: 1 μPa.

TABLE 3—ESTIMATES OF THE POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO DIFFERENT SOUND LEVELS DURING L–DEO'S PROPOSED SEISMIC SURVEY IN THE ETP DURING APRIL–MAY, 2011.

Species	Estimated number of individuals exposed to sound levels ≥ 160 dB re: 1 μPa (Best[1])	Estimated number of individuals exposed to sound levels ≥ 160 dB re: 1 μPa (Maximum[1])	Requested take authorization	Approximate percent of regional population[2] (Max)
Humpback whale	1	18	18	1.29
Bryde's whale	4	10	10	0.08
Sei whale	0	0	[3] 1	NA
Fin whale	0	0	[3] 1	0.04
Blue whale	1	8	8	0.57
Sperm whale	17	40	40	0.15
Pygmy/Dwarf sperm whale	0	0	0	0.00
Cuvier's beaked whale	10	15	15	0.08
Mesoplodon spp.	1	4	4	0.01
Rough-toothed dolphin	17	45	45	0.04
Bottlenose dolphin	69	366	366	0.11
Pantropical spotted dolphin	310	954	954	0.06
Spinner dolphin	236	1,468	1468	0.08
Striped dolphin	273	622	622	0.06
Short-beaked common dolphin	447	3,077	3077	0.10
Risso's dolphin	51	91	91	0.08
Melon-headed whale	45	233	[3] 258	0.57
Pygmy killer whale	5	9	[3] 30	0.08
False killer whale	0	0	0	0.00
Killer whale	1	2	[3] 5	0.06
Short-finned pilot whale	48	114	114	0.02

[1] Best and maximum estimates are based on densities from Table 3 and ensonified areas (including 25% contingency) of 4030.63 for 160 dB and 1605.71 km^2 for 170 dB (identified in parentheses). Takes are not anticipated for the minke whale and Fraser's dolphin.
[2] Regional population size estimates are from Table 2; NA means not available.
[3] Requested Take Authorization increased to mean group size in the ETP for baleen whales (Jackson et al. 2008) and delphinids (Ferguson et al. 2006).

Negligible Impact and Small Numbers Analysis and Determination

NMFS has defined "negligible impact" in 50 CFR 216.103 as "* * * an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

In making a negligible impact determination, NMFS considers:

(1) The number of anticipated mortalities;

(2) the number and nature of anticipated injuries;

(3) the number, nature, and intensity, and duration of Level B harassment; and

(4) the context in which the takes occur.

As mentioned previously, NMFS estimates that 19 species of marine mammals could be potentially affected by Level B harassment over the course of the IHA. For each species, these numbers are small (each, less than two percent) relative to the population size.

No injuries, serious injuries or mortalities are anticipated to occur as a result of the L–DEO's planned marine geophysical survey, and none are authorized. Only short-term behavioral disturbance is anticipated to occur due to the brief and sporadic duration of the survey activities. No mortality or injury is expected to occur, and due to the nature, degree, and context of behavioral harassment anticipated, the activity is not expected to impact rates of recruitment or survival.

NMFS has preliminarily determined, provided that the aforementioned mitigation and monitoring measures are implemented, that the impact of conducting a marine geophysical survey in the ETP off Costa Rica, April through May, 2011, may result, at worst, in a temporary modification in behavior and/or low-level physiological effects (Level B harassment) of small numbers of certain species of marine mammals.

While behavioral modifications, including temporarily vacating the area during the operation of the airgun(s), may be made by these species to avoid the resultant acoustic disturbance, the availability of alternate areas within these areas and the short and sporadic duration of the research activities, have led NMFS to preliminary determine that this action will have a negligible impact on the species in the specified geographic region.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the mitigation and monitoring measures, NMFS preliminarily finds that L–DEO's planned research activities, will result in the incidental take of small numbers of marine mammals, by Level B harassment only, and that the total taking from the marine geophysical survey will have a negligible impact on the affected species or stocks.

Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses

There are no relevant subsistence uses of marine mammals implicated by this action.

Endangered Species Act

Of the species of marine mammals that may occur in the proposed survey area, five are listed as endangered under the ESA, including the humpback, sei, fin, blue, and sperm whales. Under Section 7 of the ESA, NSF has initiated formal consultation with the NMFS, Office of Protected Resources, Endangered Species Division, on this proposed seismic survey. NMFS' Office of Protected Resources, Permits, Conservation and Education Division, has initiated formal consultation under section 7 of the ESA with NMFS' Office of Protected Resources, Endangered Species Division, to obtain a Biological Opinion evaluating the effects of issuing the IHA on threatened and endangered marine mammals and, if appropriate, authorizing incidental take. NMFS will conclude formal section 7 consultation prior to making a determination on whether or not to issue the IHA. If the IHA is issued, L–DEO, in addition to the mitigation and monitoring requirements included in the IHA, will be required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS' Biological Opinion issued to both NSF and NMFS' Office of Protected Resources.

National Environmental Policy Act (NEPA)

To meet NMFS' National Environmental Policy Act (NEPA; 42 U.S.C. 4321 *et seq.*) requirements for the issuance of an IHA to L–DEO, NMFS will prepare an Environmental Assessment (EA) titled "Issuance of an Incidental Harassment Authorization to the Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Pacific Ocean off Costa Rica, April–May, 2011." This EA will incorporate the NSF's Environmental Analysis Pursuant To Executive Order 12114 (NSF, 2010) and an associated report (Report) prepared by LGL Limited Environmental Research Associates (LGL) for NSF, titled, "Environmental Assessment of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Pacific Ocean off Costa Rica (LGL, 2010) (draft)," by reference pursuant to 40 CFR 1502.21 and NOAA Administrative Order (NAO) 216–6 § 5.09(d). Prior to making a final decision on the IHA application, NMFS will make a decision of whether or not to issue a Finding of No Significant Impact (FONSI).

Preliminary Determinations

NMFS has preliminarily determined that the impact of conducting the specific seismic survey activities described in this notice and the IHA request in the specific geographic region within the ETP off Costa Rica may result, at worst, in a temporary modification in behavior (Level B harassment) of small numbers of marine mammals. Further, NMFS has preliminarily determined that this activity is expected to result in a negligible impact on the affected species or stocks of marine mammals. The provision requiring that the activity not have an unmitigable impact on the availability of the affected species or stock of marine mammals for subsistence uses is not implicated for this proposed action.

For reasons stated previously in this document, the specified activities associated with the proposed survey are not likely to cause TTS, PTS or other non-auditory injury, serious injury, or death to affected marine mammals because:

(1) The likelihood that, given sufficient notice through relatively slow ship speed, marine mammals are expected to move away from a noise source that is annoying prior to its becoming potentially injurious;

(2) The fact that cetaceans would have to be closer than 450 m (1,476 ft) in deep water when the 18-airgun subarray is in use at a 7 m (23 ft) tow depth from the vessel to be exposed to levels of sound believed to have even a minimal chance of causing PTS;

(3) The fact that marine mammals would have to be closer than 3,800 m (2.4 mi) in deep water when the full array is in use at a 7 m (23 ft) tow depth from the vessel to be exposed to levels of sound (160 dB) believed to have even a minimal chance at causing TTS; and

(4) The likelihood that marine mammal detection ability by trained observers is high at that short distance from the vessel.

As a result, no take by injury, serious injury, or death is presently anticipated nor would it be authorized were NMFS to issue a final IHA, and the potential for temporary or permanent hearing impairment is very low and would likely be avoided through the incorporation of the proposed monitoring and mitigation measures.

While the number of marine mammals potentially incidentally harassed would depend on the distribution and abundance of marine mammals in the vicinity of the survey activity, the number of potential Level B incidental harassment takings (*see* Table 3 above this section) should a final IHA be issued is estimated to be small, less than two percent of any of the estimated population sizes based on the data disclosed in Table 2 of this notice. NMFS has preliminarily determined that impacts to affected species or stocks of marine mammals have been mitigated to the lowest level practicable through incorporation of the monitoring and mitigation measures mentioned previously in this document.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to L–DEO for conducting a marine geophysical survey in the ETP off Costa Rica, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. The duration of the IHA would not exceed one year from the date of its issuance.

Information Solicited

NMFS requests interested persons to submit comments and information concerning this proposed project and NMFS' preliminary determination of issuing an IHA (*see* **ADDRESSES**). Concurrent with the publication of this notice in the **Federal Register,** NMFS is forwarding copies of this application to the Marine Mammal Commission and its Committee of Scientific Advisors.

Dated: January 31, 2011.

James H. Lecky,

Director, Office of Protected Resources, National Marine Fisheries Service.

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BILLING CODE 3510–22–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XA178

Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Space Vehicle and Test Flight Activities From Vandenberg Air Force Base, CA

AGENCY: National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Commerce.

ACTION: Notice of issuance of a letter of authorization.

SUMMARY: In accordance with the Marine Mammal Protection Act (MMPA), as amended, and