

**DEPARTMENT OF COMMERCE****National Oceanic and Atmospheric Administration**

RIN 0648-XC072

**Takes of Marine Mammals Incidental to Specified Activities; Marine Geophysical Survey off the Central Coast of California, November to December, 2012**

**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 the Lamont-Doherty Earth Observatory of Columbia University (L-DEO), in cooperation with the Pacific Gas and Electric Company (PG&E), for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment, incidental to conducting a marine geophysical (seismic) survey off the central coast of California, November to December, 2012. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to L-DEO and PG&E to incidentally harass, by Level B harassment only, 25 species of marine mammals during the specified activity.

**DATES:** Comments and information must be received no later than October 15, 2012.

**ADDRESSES:** Comments on the application should be addressed to P. Michael Payne, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. The mailbox address for providing email comments is [ITP.Goldstein@noaa.gov](mailto:ITP.Goldstein@noaa.gov). NMFS is not responsible for email comments sent to addresses other than the one provided here. Comments sent via email, 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 owns the R/V *Marcus G. Langseth*, has prepared a draft "Environmental Assessment Pursuant to the National Environmental Policy Act, 42 U.S.C. 4321 *et seq.* Marine Seismic Survey in the Pacific Ocean off Central California, 2012" (EA). NSF's EA incorporates a draft "Environmental Assessment of Marine Geophysical Surveys by the R/V *Marcus G. Langseth* for the Central California Seismic Imaging Project," prepared by Padre Associates, Inc., on behalf of NSF, PG&E, and L-DEO, which 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:** Howard Goldstein or Jolie Harrison, Office of Protected Resources, NMFS, 301-427-8401.

**SUPPLEMENTARY INFORMATION:****Background**

Section 101(a)(5)(D) of the MMPA, as amended (16 U.S.C. 1371(a)(5)(D)), directs the Secretary of Commerce (Secretary) 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's 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**

On May 17, 2012, NMFS received an application from the L-DEO and PG&E requesting that NMFS issue an IHA for the take, by Level B harassment only, of small numbers of marine mammals incidental to conducting a marine seismic survey within the U.S. Exclusive Economic Zone off the central coast of California during November to December, 2012. NMFS received a revised application on August 31, 2012. The updated IHA application reflects revisions to the proposed project that have resulted from discussions between NMFS and the applicant during the MMPA consultation process, as well as other Federal and State regulatory requirements and include the elimination of portions of the originally planned survey area (specifically Survey Box 3) and the splitting of the proposed project into two years, and the shortening of the 2012 work window to November and December. Additionally, PG&E has agreed to operationally and financially support the design and implementation of a comprehensive monitoring, stranding response, and adaptive management plan that will support real-time decision making to reduce impacts to the Morro Bay stock of harbor porpoises (*Phocoena phocoena*). L-DEO and PG&E plan to

use one source vessel, the R/V *Marcus G. Langseth* (*Langseth*) and a seismic airgun array to collect seismic data as part of the "Offshore Central Coastal California Seismic Imaging Project" located in the central area of San Luis Obispo County, California.

PG&E proposes to conduct a high energy seismic survey in the vicinity of the Diablo Canyon Power Plant and known offshore fault zones near the power plant. The observations will be interpreted in the context of global synthesis of observations bearing on earthquake rupture geometries, earthquake displacements, fault interactions, and fault evolution. Estimating the limits of future earthquake ruptures is becoming increasingly important as seismic hazard maps are based on geologists' maps of active faults and, locally, the Hosgri Fault strikes adjacent to one of California's major nuclear power plants. In addition to the proposed operations of the seismic airgun array and hydrophone streamer, L-DEO and PG&E intend to operate a multibeam echosounder and a sub-bottom profiler 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 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 and PG&E have requested an authorization to take 25 species of marine mammals by Level B harassment. Take is not expected to result from the use of the multibeam echosounder or sub-bottom profiler, for reasons discussed in this notice; nor is take expected to result from collision with the source vessel because it is a single vessel moving at a relatively slow speed (4.6 knots [kts]; 8.5 kilometers per hour [km/hr]; 5.3 miles per hour [mph]) during seismic acquisition within the survey, for a relatively short period of time (approximately 50 days). It is likely that any marine mammal would be able to avoid the vessel.

### Description of the Proposed Specified Activity

#### Project Purpose

PG&E proposes to conduct a high energy seismic survey in the vicinity of the Diablo Canyon Power Plant and known offshore fault zones near the power plant (see Figure 1 of the IHA application). The project, as proposed by L-DEO and PG&E, consists of deploying seismic or sound sources and receivers at onshore and offshore

locations to generate data that can be used to improve imaging of major geologic structures and fault zones in the vicinity of the Diablo Canyon Power Plant. The details of the proposed seismic studies are outlined in a Science Plan submitted to the National Science Foundation (NSF) by L-DEO, University of Nevada, and Scripps Institution of Oceanography. NSF, as owner of the *Langseth* will serve as the lead Federal agency and will ensure the approval of the proposed Science Plan is in compliance with the National Environmental Policy Act (NEPA) of 1969.

These seismic studies would provide additional insights of any relationships or connection between the known faults as well as enhance knowledge of offshore faults in proximity to the central coast of California and the Diablo Canyon Power Plant. The proposed deep penetrating (10 to 15 kilometers [km] or 6 to 9 miles [mi]), high energy seismic survey (energy greater than 2 kilo Joule) would complement a previously completed shallow (less than 1 km [0.6 mi]), low energy (less than 2 kilo Joule) three-dimensional (3D) seismic reflection survey.

The objectives of the proposed high energy 3D seismic survey are to:

- Record high resolution two-dimensional (2D) and 3D seismic reflection profiles of major geologic structures and fault zones in the vicinity of the central coast of California and Diablo Canyon Power Plant.
- Obtain high-resolution deep-imaging (greater than 1 km [0.6 mi]) of the Hosgri and Shoreline fault zones in the vicinity of the Diablo Canyon Power Plant to constrain fault geometry and slip rate (scheduled for the seismic survey activities in 2013).
- Obtain high-resolution, deep-imaging of the intersection of the Hosgri and Shoreline fault zones near Point Buchon.
- Obtain high-resolution, deep-imaging of the geometry and slip rate of the Los Osos fault, as well as the intersection of the Hosgri and Los Osos fault zones in Estero Bay.
- Augment the current regional seismic database for subsequent use and analysis through the provision of all data to the broader scientific and safety community.

The studies require the collection of data over a long period of time. However, the project timeframe is limited to fall and winter months to minimize environmental impacts to the greatest extent feasible. L-DEO and PG&E are proposing to conduct the studies 24 hours a day for 7 days a

week. This schedule is designed to reduce overall air emissions, length of time for operation in the water thereby reducing impacts to marine wildlife, commercial fishing, and other area users. PG&E will work with environmental agencies to appropriately address the balancing of public health and safety and environmental concerns during the conduct of these studies.

#### Survey Details

The proposed survey involves both marine (offshore) and land (onshore) activities. The offshore components consist of operating a seismic survey vessel and support/monitoring vessels within the areas shown in Figure 1 of the IHA application and transiting between the four different survey box areas extending between the mouth of the Santa Maria River and Estero Bay. The seismic survey vessel would tow a series of sound-generating airguns and sound-recording hydrophones along pre-determined shore parallel and shore-perpendicular transects to conduct deep (10 to 15 km [6 to 9 mi]) seismic reflection profiling of major geologic structures and fault zones in the vicinity of the Diablo Canyon Power Plant.

The offshore part of the survey activities include the placement of a limited number of seafloor geophones (e.g., Fairfield Z700 nodal units) into nearshore waters.

The planned seismic survey (e.g., equipment testing, startup, line changes, repeat coverage of any areas, and equipment recovery) will consist of approximately 3,565.8 km (1,925.4 nmi) (1,417.6 km [765.4 nmi] for Survey Box 4 and 2,148.2 km [1,159.9 nmi] for Survey Box 2) of transect lines (including turns) in the survey area off the central coast of California (see Figure 2 of the IHA application). In addition to the operations of the airgun array, a Kongsberg EM 122 multibeam echosounder and Knudsen Chirp 3260 sub-bottom profiler will also be operated from the *Langseth* continuously throughout the cruise. There will be additional seismic operations associated with equipment testing, ramp-up, and possible line changes or repeat coverage of any areas where initial data quality is sub-standard. In L-DEO and PG&E's estimated take calculations, 25% has been added for those additional operations. Detailed descriptions of the proposed actions for each component are provided below in this document.

#### Vessel Movements

The tracklines for the 3D seismic survey will encompass an area of

approximately 740.52 km<sup>2</sup> (215.9 square nautical miles [nmi<sup>2</sup>]). The 2012 project area is divided into two “primary target areas” (Survey Boxes 2 and 4) are described below and shown in Figure 2 of the IHA application. The offshore (vessel) survey would be conducted in both Federal and State waters and water depths within the proposed survey areas ranging from 0 to over 400 m (1,300 ft). The State Three-Mile Limit is identified in Figure 1 of the IHA application. The Point Buchon Marine Protected Area lies within portions of the survey area. In addition, the Monterey Bay National Marine Sanctuary, a Federally-protected marine sanctuary that extends northward from Cambria to Marine County, is located to the north and outside of the proposed project area.

Survey Box 2 (Survey area from Estero Bay to offshore Santa Maria River Mouth):

- Area: 406.04 km<sup>2</sup> (118.4 nmi<sup>2</sup>);
- Total survey line length is 2,148.2 km (1,159.9 nmi); and
- Strike line surveys along the Hosgri fault zone and Shoreline, Hosgri, and Los Osos fault intersections.

Survey Box 4 (Estero Bay):

- Area: 334.48 km<sup>2</sup> (97.5 nmi<sup>2</sup>);
- Total survey line length is 1,417.6 km (765.4 nmi);
- Dip line survey across the Hosgri and Los Osos fault zones in Estero Bay.

Figure 2 of the IHA application depicts the proposed survey transit lines. These lines depict the survey lines as well as the turning legs. The full seismic array is firing during the straight portions of the track lines as well as the initial portions of the run-out (offshore) sections and later portions of the run-in (inshore) sections. During turns and most of the initial portion of the run-ins, there will only be one airgun firing (i.e., mitigation airgun). Assuming a daily survey rate of approximately 8.3 km/hour (km/hr) (4.5 knots [kts] for 24/7 operations), the Survey Box 2 is expected to take approximately 14 days and approximately 9.25 days for Survey Box 4. When considering mobilization, demobilization, refueling, equipment maintenance, weather, marine mammal activity, and other contingencies, the proposed survey is expected to be completed in 49.25 days.

#### Mobilization and Demobilization

The offshore equipment and vessels for the proposed 3D marine seismic survey are highly specialized and typically no seismic vessels are located in California. The proposed seismic survey vessel (R/V *Marcus G. Langseth*) is currently operating on the U.S. west coast and is available to conduct the proposed seismic survey work.

The *Langseth* would transit south prior to the start of survey operations (approximately October 15 through December 31, 2012, with active airgun survey operations starting approximately November 1, 2012). Once the vessel has arrived in the project area, the survey crew, any required equipment, and support provisions would be transferred to the vessel. Larger equipment, if required, would need to be loaded onboard the vessel at either Port of San Francisco/Oakland or Port Hueneme. The proposed survey vessel is supported by two chase/scout boats, each with three Protected Species Observers (PSOs) and a third support boat that will provide logistical support to the *Langseth* or chase boats. This support vessel will also serve as a relief vessel for either of the two chase boats as required or equivalent. Any additional scout/monitoring vessels required for the proposed project will be drawn from local vessel operators. Upon completion of the offshore survey operations, the survey crew would be transferred to shore and the survey vessel would transit out to the proposed project area.

Nearshore operations would be conducted using locally available vessels such as the M/V *Michael Uhl* (*Michael Uhl*) or equivalent vessel. Equipment, including the geophones and cables, would be loaded aboard the *Michael Uhl* in Morro Bay Harbor and transferred to the offshore deployment locations. Following deployment and recovery of the geophones and cables, they would be transferred back to Morro Bay Harbor for transport offsite.

During onshore operations, receiver line equipment would be deployed by foot-based crews supported by four-wheel drive vehicles or small vessel. Once the proposed project has been completed, the equipment would demobilize from the area by truck.

#### Offshore Survey Operations

The proposed offshore seismic survey would be conducted with vessels specifically designed and built to conduct such surveys. PG&E has selected the *Langseth*, which is operated by L-DEO. The following outlines the general specifications for the *Langseth* and the support vessels needed to complete the proposed offshore seismic survey.

In water depths from 30 to 305 m (100 to greater than 1,000 ft), the *Langseth* will tow four hydrophone streamers with a length of approximately 6 km (3.2 nmi). The intended tow depth of the streamers is approximately 9 m (29.5 ft). Flotation is provided on each streamer as well as streamer recovery

devices. The streamer recovery devices are activated when the streamer sinks to a pre-determined depth (e.g., 50 m [164 ft]) to aid in recovery.

- Primary vessel—the *Langseth* is 71.5 m (235 ft) in length, and is outfitted to deploy/retrieve hydrophone streamers and airgun array, air compressors for the airgun array, and survey recording facilities.

- Two Chase/Scout boats—22.9 to 41.2 m (75 to 135 ft) in length and will be around the *Langseth* to observe potential obstructions, conduct additional marine mammal monitoring and support deployment of seismic equipment.

- Third support vessel—will be approximately 18.3 to 25.9 m (60 to 85 ft) in length and would act as a support boat for the *Langseth* and the two other chase/scout and would provide relief to either chase/scout boat as required.

- A nearshore work vessel (e.g., *Michael Uhl*) approximately 50 m (150 ft) in length would be used to deploy and retrieve seafloor geophones in the shallow water (0 to 20 m) zone.

- Monitoring aircraft—Partenavia P68—OBS “Observer,” a high-wing, twin-engine plane or equivalent aircraft is 9.5 m (31 ft) in length and has a wingspan of 12 m (39 ft) with a carrying capacity of six persons. The aircraft has two “bubble” observation windows, a glass nose for clear observation, and will be equipped with communication and safety equipment sufficient to support the proposed operations. The aircraft would be used to perform aerial surveys of marine mammals.

#### Vessel Specifications

The *Langseth*, a seismic research vessel owned by the NSF, will tow the 36 airgun array, as well as the hydrophone streamer, along predetermined lines (see Figure 2 of the IHA application). When the *Langseth* is towing the airgun array and the hydrophone streamer, the turning rate of the vessel is limited to three degrees per minute (2.5 km [1.5 mi]). Thus, the maneuverability of the vessel is limited during operations with the streamer. The vessel would “fly” the appropriate U.S. Coast Guard-approved day shapes (mast head signals used to communicate with other vessels) and display the appropriate lighting to designate the vessel has limited maneuverability.

The vessel 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. The *Langseth* was designed as 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 ship is powered by two 3,550 horsepower (hp) Bergen BRG-6 diesel engines which drive two propellers directly. Each propeller has four blades and the shaft typically rotates at 750 revolutions per minute. The vessel also has an 800 hp bowthruuster, which is not used during seismic acquisition. The *Langseth's* operation speed during seismic acquisition is typically 7.4 to 9.3 km per hour (hr) (km/hr) (4 to 5 knots [kts]). When not towing seismic survey gear, the *Langseth* typically cruises at 18.5 km/hr (10 kts). The *Langseth* has a range of 25,000 km (13,499 nmi) (the distance the vessel can travel without refueling).

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. More details of the *Langseth* can be found in the IHA application.

#### *Acoustic Source Specifications*

##### Seismic Airguns

The *Langseth* will deploy a 36-airgun array, consisting of two 18 airgun sub-arrays. Each sub-array will have a volume of approximately 3,300 cubic inches (in<sup>3</sup>). The airgun array will consist of a mixture of Bolt 1500LL and Bolt 1900LLX airguns ranging in size from 40 to 360 in<sup>3</sup>, with a firing pressure of 1,900 pounds per square inch (psi). The 18 airgun sub-arrays will be configured as two identical linear arrays or "strings" (see Figure 3 and 4 of the IHA application). Each string will have 10 airguns, the first and last airguns in the strings are spaced 16 m (52.5 ft) apart. Of the 10 airguns, nine airguns in each string will be fired simultaneously (1,650 in<sup>3</sup>), whereas the tenth is kept in reserve as a spare, to be turned on in case of failure of another airgun. The sub-arrays would be fired alternately during the survey. The two airgun sub-arrays will be distributed across an area of approximately 12 x 16 m (40 x 52.5 ft) behind the *Langseth* and will be towed approximately 140 m (459.3 ft) behind the vessel. Discharge intervals depend on both the ship's speed and Two Way Travel Time recording intervals. The shot interval will be 37.5 m (123) during the study. The shot interval will be relatively short, approximately 15 to 20 seconds (s) based on an assumed boat speed of 4.5 knots. During firing, a brief (approximately 0.1 s) pulse sound is

emitted; the airguns will be silent during the intervening periods. The dominant frequency components range from two to 188 Hertz (Hz).

The tow depth of the airgun array will be 9 m (29.5 ft) during the surveys. Because the actual source is a distributed sound source (18 airguns) rather than a single point source, the highest sound measurable at any location in the water will be less than the nominal source level. In addition, the effective source level for sound propagating in near-horizontal directions will be substantially lower than the nominal omni-directional source level applicable to downward propagation because of the directional nature of the sound from the airgun array (i.e., sound is directed downward). Figure 3 of the IHA application shows one linear airgun array or "string" with ten airguns. Figure 4 of the IHA application diagrams the airgun array and streamer deployment from the *Langseth*.

##### Hydrophone Streamer

Acoustic signals will be recorded using a system array of four hydrophone streamers, which would be towed behind the *Langseth*. Each streamer would consist of Sentry Solid Streamer Sercel cable approximately 6 km (3.2 nmi) long. The streamers are attached by floats to a diverter cable, which keeps the streamer spacing at approximately 100 to 150 m (328 to 492 ft) apart.

Seven hydrophones will be present along each streamer for acoustic measurement. The hydrophones will consist of a mixture of Sonardyne Transceivers. Each streamer will contain three groups of paired hydrophones, with each group approximately 2,375 m (7,800 ft) apart. The hydrophones within each group will be approximately 300 m (984 ft) apart. One additional hydrophone will be located on the tail buoy attached to the end of the streamer cable. In addition, one Sonardyne Transducer will be attached to the airgun array. Compass birds will be used to keep the streamer cables and hydrophones at a depth of approximately 10 m (32.8 ft). One compass bird will be placed at the front end of each streamer as well as periodically along the streamer. Figure 4 of the IHA application depicts the configuration of both the streamer and airgun array used by the *Langseth*. Details regarding the hydrophone streamer and acoustic recording equipment specifications are included in Table 1 of the IHA application.

#### *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 ( $\mu\text{Pa}$ ), 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  $\mu\text{Pa}$ , and the units for SPLs are dB re: 1  $\mu\text{Pa}$ . 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 and PG&E on the *Langseth* are 236 to 265 dB re 1  $\mu\text{Pa}$  (p-p) and the rms value for a given airgun pulse is typically 16 dB re 1  $\mu\text{Pa}$  lower than the peak-to-peak value (Greene, 1997; McCauley *et al.*, 1998, 2000a). The specific source output for the 18 airgun array is 252 dB (peak) and 259 dB (p-p). 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 and PG&E have predicted the received sound levels in relation to distance and direction from the 18 airgun array and the single Bolt

1900LL 40 in<sup>3</sup> airgun, which will be used during power-downs. A detailed description of L-DEO and PG&E's modeling for this survey's marine seismic source arrays for protected species mitigation is provided in Appendix A of the IHA application and NSF's EA. Appendix A (GSI Technical Memorandum 470-3 and GSI Technical Memorandum 470-2RevB) of the IHA application and NSF's EA discusses the characteristics of the airgun pulses. NMFS refers the reviewers to the IHA application and EA documents for additional information.

*Predicted Sound Levels for the Airguns*

To determine exclusion zones for the airgun array to be used off the central coast of California, the noise modeling for the proposed 3D seismic survey is based on the results of mathematical modeling conducted by Greeneridge Sciences, Inc. (2011). The model results are based upon the airgun specifications provided for the *Langseth* and seafloor characteristics available for the project area. Specifically, L-DEO's predicted sound contours were used to estimate pulse sound level extrapolated to an effective distance of one meter, effectively reducing the multi-element array to a point source. Such a description is valid for descriptions of the far field sounds, i.e., at distances that are long compared to the dimensions of the array and the sound wavelength. Greeneridge Sciences, Inc. did not account for near-field effects. However, since the vast majority of acoustic energy radiated by an airgun array is below 500 Hz and the near field is small for the given airgun array at these frequencies (the radius of the near field around the array is 21 m [68.9 ft] or less for frequencies below 500 Hz), near-field effects are considered minimal.

The sound propagation from the airgun array was modeled in accordance

with physical description of sound propagation and depends on waveguide characteristics, including water depth, water column sound velocity profile, and geoacoustic parameters of the ocean bottom. For the sound propagation model, Greeneridge Sciences, Inc. relied on variants of the U.S. Navy's range-dependent Acoustic Model. Greeneridge Sciences, Inc. modeled three 2D (range versus depth) propagation paths, each with range-dependent (i.e., range-varying) bathymetry and range-independent geoacoustic profiles. The resulting received sound levels at a receiver depth of 6 m (19.7 ft) and across range were then "smoothed" via least-squares regression. The monotonically-decreasing regression equations yielded the estimated safety radii.

The accuracy of the sound field predicted by the acoustic propagation model is limited by the quality and resolution of the available environmental data. Greeneridge Sciences, Inc. used environmental information provided by the client for the proposed survey area, specifically, bathymetry data, a series of measured water column sound speed profiles, and descriptive sediment and basement properties. Greeneridge Sciences, Inc. used two geoacoustic profiles for its three propagation paths: One for the upslope propagation path (sand overlaying sandstone) and one for the downslope and alongshore propagation paths (silt overlaying sandstone)

L-DEO and PG&E have used these calculated values to determine exclusion zones for the 18 airgun array and previously modeled measurements by L-DEO for the single airgun, to designate exclusion zones for purposes of mitigation, and to estimate take for marine mammals off the central coast of California. A detailed description of the modeling effort is provided in Appendix A of NSF's EA.

Using the model (airgun array and single airgun), Table 1 (below) shows the distances at which three rms sound levels are expected to be received from the 18 airgun array and a single airgun. To avoid the potential for injury or permanent physiological damage (Level A harassment), NMFS (1995, 2000) has concluded that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding 180 dB re: 1 μPa and 190 dB re: 1 μPa, respectively. L-DEO and PG&E used these levels to establish the exclusion zones. If marine mammals are detected within or about to enter the appropriate exclusion zone, the airguns will be powered-down (or shut-down, if necessary) immediately. NMFS also assumes that marine mammals exposed to levels exceeding 160 dB re: 1 μPa may experience Level B harassment.

Table 1 summarizes the predicted distances at which sound levels (160, 180, and 190 dB [rms]) are expected to be received from the 18 airgun array and a single airgun operating in upslope (inshore), downslope (offshore), and alongshore depths. For the proposed project, L-DEO and PG&E plan to use the upslope distance (inshore) for the 160 dB (6,210 m [20,374 ft]) and 180 dB (1,010 m [3,313.7 ft]), and alongshore distance for the 190 dB (320 m [1,049.9 ft]), for the determination of the buffer and exclusion zones since this represents the largest and therefore most conservative distances determined by the Greeneridge Sciences, Inc. modeling.

Table 1. Modeled (array) or predicted (single airgun) distances to which sound levels ≥ 190, 180, and 160 dB re: 1 μPa (rms) could be received in upslope, downslope, and alongshore propagation paths during the proposed survey off the central coast of California, November to December, 2012.

Sound pressure level (SPL) (dB re 1 μPa)	Predicted RMS radii distances for 18 airgun array		
	Upslope distance (inshore)	Downslope distance (offshore)	Alongshore distance
190 dB .....	250 m (0.13 nmi) .....	280 m (0.15 nmi) .....	320 m (0.17 nmi)
180 dB .....	1,010 m (0.55 nmi) .....	700 m (0.38 nmi) .....	750 m (0.40 nmi)
160 dB .....	6,210 m (3.35 nmi) .....	4,450 m (2.40 nmi) .....	4,100 m (2.21 nmi)

  

Sound pressure level (SPL) (dB re 1 μPa)	Predicted RMS radii distances for single airgun		
	Shallow water (< 100 m)	Intermediate water (100 to 1,000 m)	Deep Water (> 1,000 m)
190 dB .....	150 m (0.08 nmi) .....	18 m (< 0.01 nmi) .....	12 m (< 0.01 nmi)
180 dB .....	296 m (0.16 nmi) .....	60 m (0.03 nmi) .....	40 m (0.02 nmi)
160 dB .....	1,050 m (0.57 nmi) .....	578 m (0.31 nmi) .....	385 m (0.21 nmi)

Along with the airgun operations, two additional acoustical data acquisition systems will be operated from the *Langseth* continuously during the survey. The ocean floor will be mapped with the Kongsberg EM 122 multibeam echosounder and a Knudsen 320B sub-bottom profiler. These sound sources will be operated continuously from the *Langseth* throughout the cruise.

#### *Multibeam Echosounder*

The *Langseth* will operate a Kongsberg EM 122 multibeam echosounder concurrently during airgun operations to map characteristics of the ocean floor. The hull-mounted multibeam echosounder emits brief pulses of sound (also called a ping) (10.5 to 13, usually 12 kHz) in a fan-shaped beam that extends downward and to the sides of the ship. The transmitting beamwidth is 1° or 2° fore-aft and 150° athwartship and the maximum source level is 242 dB re: 1  $\mu$ Pa.

Each ping consists of eight (in water greater than 1,000 m) or four (less than 1,000 m) successive, fan-shaped transmissions, each encompassing a sector that extends 1° fore-aft. Continuous-wave pulses increase from 2 to 15 milliseconds (ms) long in water depths up to 2,600 m (8,350.2 ft), and frequency modulated (FM) chirp pulses up to 100 ms long are used in water greater than 2,600 m. The successive transmissions span an overall cross-track angular extent of about 150°, with 2 ms gaps between the pulses for successive sectors (see Table 2 of the IHA application).

#### *Sub-Bottom Profiler*

The *Langseth* will also operate a Knudsen Chirp 320B sub-bottom profiler continuously throughout the cruise simultaneously with the multibeam echosounder to map and provide information about the sedimentary features and bottom topography. The beam is transmitted as a 27° cone, which is directed downward by a 3.5 kHz transducer in the hull of the *Langseth*. The maximum output is 1 kilowatt (kW), 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 one second intervals followed by a 5-second pause.

Both the multibeam echosounder and sub-bottom profiler are operated continuously during survey operations. Given the relatively shallow water depths of the survey area (20 to 300 m [66 to 984 ft]), the number of pings or transmissions would be reduced from 8 to 4, and the pulse durations would be

reduced from 100 ms to 2 to 15 ms for the multibeam echosounder. Power levels of both instruments would be reduced from maximum levels to account for water depth. Actual operating parameters will be established at the time of the survey.

NMFS expects that acoustic stimuli resulting from the proposed operation of the single airgun or the 18 airgun array has the potential to harass 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 (approximately 4.6 knots [kts]; 8.5 km/hr; 5.3 mph) during seismic acquisition.

#### *Gravimeter*

The *Langseth* will employ a Bell Aerospace BGM-3 gravimeter system (see Figure 5 of the IHA application) to measure very tiny fractional changes within the Earth's gravity caused by nearby geologic structures, the shape of the Earth, and by temporal tidal variations. The gravimeter has been specifically designed to make precision measurements in a high motion environment. Precision gravity measurements are attained by the use of the highly accurate Bell Aerospace Model XI inertial grade accelerometer.

#### *Magnetometer*

The *Langseth* will employ a Bell Aerospace BGM-3 geometer, which contains a model G-882 cesium-vapor marine magnetometer (see Figure 6 of the IHA application). Magnetometers measure the strength and/or direction of a magnetic field, generally in units of nanotesla in order to detect and map geologic formations. These data would enhance earlier marine magnetic mapping conducted by the U.S. Geologic Survey (Sliter *et al.*, 2009).

The G-882 is designed for operation from small vessels for shallow water surveys as well as for the large survey vessels for deep tow applications. Power may be supplied from a 24 to 30 VDC battery power or a 110/220 VAC power supply. The standard G-882 tow cable includes a Vectran strength member and can be built to up to 700 m (2,297 ft) (no telemetry required). The shipboard end of the tow cable is attached to a junction box or onboard cable. Output data are recorded on a computer with an RS-232 serial port.

Both the gravimeter and magnetometers are "passive" instruments and do not emit sounds, impulses, or signals, and are not expected to affect marine mammals.

#### *Nearshore and Onshore Survey Operations*

To collect deep seismic data in water depths that are not accessible by the *Langseth* (less than 25 m [82 ft]), seafloor geophones and both offshore and onshore seismic sources will be used. The currently proposed locations for the seafloor geophone lines between Point Buchon and Point San Luis are shown in Figure 7 of the IHA application.

Twelve Fairfield Z700 marine nodes would be placed on the seafloor along two nearshore survey routes as a pilot test prior to the full deployment of 600 nodes scheduled for 2013. The northern route (Crowbar Beach) traverses the Point Buchon MPA north of Diablo Canyon Power Plant. The southern route (either Green Peak or Deer Canyon) is located south of the Diablo Canyon Power Plant. The approximate locations of the proposed nodal routes are depicted in Figure 7 of the IHA application. Six nodes would be placed at 500 m (1,640.4 ft) intervals along each route for a total length of 3 km (1.9 mi). Maximum water depth ranges from 70 m (229.7 ft) (Crowbar) to 30 m (98.4 ft) (Deer Canyon). Marine nodes would be deployed using a vessel and (in some locations) divers and will be equipped with ultra-short baseline acoustic tracking system to position and facilitate recovery of each node. The tracking equipment will be used to provide underwater positioning of a remotely operated vehicle during deployment and recovery of the nodes.

The seafloor equipment will be in place for the duration of the data collection for the offshore 3D high energy seismic surveys plus deployment and recovery time. Node deployment will be closely coordinated with both offshore and onshore survey operations to ensure survey activities are completed before the projected batter life of 45 days is exceeded. PG&E anticipates using a locally-available vessel to deploy and retrieve the geophones. The vessel would be a maximum of 50 m in length. The *Michael Uhl*, which is locally available, its sister vessel, or a vessel of similar size and engine specification, is proposed for this purpose.

Onshore, a linear array of ZL and nodals will be deployed along a single route on the Morro Strand to record onshore sound transmitted from the offshore airgun surveys. Route location is shown in Figure 9 of the IHA application. Ninety nodes would be placed at 100 m (328 ft) intervals along the strand for a total route length of approximately 9 km (5.6 mi). The

autonomous, nodal, cable-less recording devices (see Figure 9 of the IHA application) would be deployed by foot into the soil adjacent to existing roads, trails, and beaches. The nodal systems are carried in backpacks and pressed into the ground at each receiver point. Each nodal would be removed following completion of the data collection. PG&E estimates that the onshore receiver activities would be conducted over a 2 to 3 day period, concurrent with the offshore surveys. The onshore receivers would record the offshore sound sources during the seismic operations. Figure 10 of the IHA application depicts the area where the onshore receivers are proposed to be placed along the Morro Strand. PG&E and NMFS have determined that onshore activities are unlikely to impact marine mammals, including pinnipeds at haul-outs and rookeries, in the proposed action area.

More information on the vessels, equipment, and personnel requirements proposed for use in the offshore survey can be found in sections 1.4 and 1.5 of the IHA application.

*Dates, Duration, and Specified Geographic Region*

The proposed project located offshore of central California would have a total duration of approximately 49.25 operational days occurring during the November through December, 2012 timeframe, which will include approximately 24 days of active seismic airgun operations. Mobilization will initiate on October 15, 2012, with active airgun surveys taking place from November 1 through December 31, 2012. Below is an estimated schedule for the proposed project based on the use of the *Langseth* as the primary survey vessel (the total number of days is based on adding the non-concurrent tasks):

- Mobilization to project site—6 days;
- Initial equipment deployment—3 days (includes offshore geophone deployment);
- Pre-activity marine mammal surveys—5 days (concurrent with offshore deployment activities);

- Onshore geophone deployment—2 to 3 days (concurrent with offshore deployment activities);
- Equipment calibration and sound check (i.e., sound source verification)—5 days;
- Seismic survey—23.25 days (Survey Box 4 will be surveyed first followed by Survey Box 2, 24/7 operations in all areas);
- Survey Box 4 (survey area within Estero Bay)—9.25 days;
- Survey Box 2 (survey area from Estero Bay to offshore to the mouth of the Santa Maria River)—14 days;
- Streamer and airgun preventative maintenance—2 days;
- Additional shut-downs (marine mammal presence, crew changes, and unanticipated weather delays)—4 days;
- Demobilization—6 days.

Placement of the onshore receiver lines would be completed prior to the start of offshore survey activities and would remain in place until the offshore survey can be completed. Some minor deviation from this schedule is possible, depending on logistics and weather (i.e., the cruise may depart earlier or be extended due to poor weather; there could be additional days of seismic operations if collected data are deemed to be of substandard quality).

The latitude and longitude for the bounds of the two survey boxes are:

- Survey Box 4:  
 35° 25' 21.7128" North, 120° 57' 44.7001" West  
 35° 20' 16.0648" North, 121° 9' 24.1914" West  
 35° 18' 38.3096" North, 120° 53' 29.9525" West  
 35° 14' 42.003" North, 121° 3' 36.9513" West
- Survey Box 2:  
 34° 57' 43.3388" North, 120° 45' 12.8318" West  
 34° 55' 40.383" North, 120° 48' 59.3101" West  
 35° 25' 40.62" North, 121° 00' 27.12" West  
 35° 23' 57.26" North, 121° 04' 37.28" West

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

Thirty-six marine mammal species (29 cetaceans [whales, dolphins, and porpoises], 6 pinnipeds [seals and sea lions], and 1 fissiped) are known to or could occur off the central coast of California study area. Several 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 North Pacific right (*Eubalaena japonica*), humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and sperm (*Physeter macrocephalus*) whales. The Guadalupe fur seal (*Arctocephalus townsendi*) and Eastern stock of Steller sea lion (*Eumetopias jubatus*), and southern sea otter (*Enhydra lutris nereis*) are listed as threatened under the ESA. The southern sea otter is the one marine mammal species mentioned in this document that is managed by the U.S. Fish and Wildlife Service (USFWS) and is not considered further in this analysis; all others are managed by NMFS. While in their range, North Pacific right, sei, and sperm whale sightings are uncommon in the proposed project area, and have a low likelihood of occurrence during the proposed seismic survey. Similarly, the proposed project area is generally north of the range of the Guadalupe fur seal. Table 2 (below) presents information on the abundance, distribution, population status, conservation status, and population trend of the species of marine mammals that may occur in the proposed study area during November to December, 2012.

Table 2. The habitat, regional abundance, and conservation status of marine mammals that may occur in or near the proposed seismic survey area off the central coast of California. (See text and Table 4 in L-DEO and PG&E's application for further details.)

Species	Habitat	Population estimate <sup>3</sup> (minimum)	ESA <sup>1</sup>	MMPA <sup>2</sup>	Population trend <sup>3</sup>
Mysticetes:					
North Pacific right whale ( <i>Eubalaena japonica</i> ).	Pelagic and coastal .....	NA (18 to 21)—Eastern North Pacific stock.	EN .....	D .....	No information available
Gray whale ( <i>Eschrichtius robustus</i> ).	Coastal, shallow shelf ..	19,126 (18,017)—Eastern North Pacific stock.	DL—Eastern North Pacific stock EN—Western North Pacific stock.	NC—Eastern North Pacific stock D—Western North Pacific stock.	Increasing over past several decades
Humpback whale ( <i>Megaptera novaeangliae</i> ).	Mainly nearshore, banks.	2,043 (1,878)—California/Oregon/Washington stock.	EN .....	D .....	Increasing
Minke whale ( <i>Balaenoptera acutorostrata</i> ).	Pelagic and coastal .....	478 (202)—California/Oregon/Washington stock.	NL .....	NC .....	No information available

Species	Habitat	Population estimate <sup>3</sup> (minimum)	ESA <sup>1</sup>	MMPA <sup>2</sup>	Population trend <sup>3</sup>
Sei whale ( <i>Balaenoptera borealis</i> ).	Primarily offshore, pelagic.	126 (83)—Eastern North Pacific stock.	EN .....	D .....	No information available
Fin whale ( <i>Balaenoptera physalus</i> ).	Continental slope, pelagic.	3,044 (2,624)—California/Oregon/Washington stock.	EN .....	D .....	Unable to determine
Blue whale ( <i>Balaenoptera musculus</i> ).	Pelagic, shelf, coastal ..	2,497 (2,046)—Eastern North Pacific stock.	EN .....	D .....	Unable to determine
Odontocetes:					
Sperm whale ( <i>Physeter macrocephalus</i> ).	Pelagic, deep sea .....	971 (751)—California/Oregon/Washington stock.	EN .....	D .....	Variable
Pygmy sperm whale ( <i>Kogia breviceps</i> ).	Deep waters off the shelf.	579 (271)—California/Oregon/Washington stock.	NL .....	NC .....	No information available
Dwarf sperm whale ( <i>Kogia sima</i> ).	Deep waters off the shelf.	NA—California/Oregon/Washington stock.	NL .....	NC .....	No information available
Cuvier's beaked whale ( <i>Ziphius cavirostris</i> ).	Pelagic .....	2,143 (1,298)—California/Oregon/Washington stock.	NL .....	NC .....	No information available
Baird's beaked whale ( <i>Berardius bairdii</i> ).	Pelagic .....	907 (615)—California/Oregon/Washington stock.	NL .....	NC .....	No information available
Mesoplodon beaked whale (includes Blainville's beaked whale [ <i>M. densirostris</i> ], Perrin's beaked whale [ <i>M. perrini</i> ], Lesser beaked whale [ <i>M. peruvianis</i> ], Stejneger's beaked whale [ <i>M. stejnegeri</i> ], Ginkgo-toothed beaked whale [ <i>M. ginkgodens</i> ], Hubbs' beaked whale [ <i>M. carlhubbsi</i> ]).	Pelagic .....	1,204 (576)—California/Oregon/Washington stock.	NL .....	NC .....	No information available
Bottlenose dolphin ( <i>Tursiops truncatus</i> ).	Coastal, oceanic, shelf break.	1,006 (684)—California/Oregon/Washington stock 323 (290)—California Coastal stock.	NL .....	NC D—Western North Atlantic coastal.	No information available Stable
Striped dolphin ( <i>Stenella coeruleoalba</i> ).	Off continental shelf .....	10,908 (8,231)—California/Oregon/Washington stock.	NL .....	NC .....	Unable to determine
Short-beaked common dolphin ( <i>Delphinus delphis</i> ).	Shelf, pelagic, seamounts.	411,211 (343,990)—California/Oregon/Washington stock.	NL .....	NC .....	Variable with oceanographic conditions
Long-beaked common dolphin ( <i>Delphinus capensis</i> ).	Coastal, on continental shelf.	27,046 (17,127)—California stock.	NL .....	NC .....	No information available, variable with oceanographic conditions
Pacific white-sided dolphin ( <i>Lagenorhynchus obliquidens</i> ).	Offshore, slope .....	26,930 (21,406)—California/Oregon/Washington stock.	NL .....	NC .....	No information available
Northern right whale dolphin ( <i>Lissodelphis borealis</i> ).	Slope, offshore waters	8,334 (6,019)—California/Oregon/Washington stock.	NL .....	NC .....	Unable to determine
Risso's dolphin ( <i>Grampus griseus</i> ).	Deep water, seamounts	6,272 (4,913)—California/Oregon/Washington stock.	NL .....	NC .....	Unable to determine
Killer whale ( <i>Orcinus orca</i> ) ....	Pelagic, shelf, coastal ..	240 (162)—Eastern North Pacific Off-shore stock 346 (346)—Eastern North Pacific Transient stock 354 (354)—West Coast Transient stock.	NL EN—Southern resident.	NC D—Southern resident, AT1 transient.	No information available, No information available, Declining, Increased and slowing
Short-finned pilot whale ( <i>Globicephala macrorhynchus</i> ).	Pelagic, shelf coastal ...	760 (465)—California/Oregon/Washington stock.	NL .....	NC .....	Unable to determine
Harbor porpoise ( <i>Phocoena phocoena</i> ).	Coastal and inland waters.	2,044 (1,478)—Morro Bay stock.	NL .....	NC .....	Increasing
Dall's porpoise ( <i>Phocoenoides dalli</i> ).	Shelf, slope, offshore ...	42,000 (32,106)—California/Oregon/Washington stock.	NL .....	NC .....	No information available
Pinnipeds:					
California sea lion ( <i>Zalophus californianus</i> ).	Coastal, shelf .....	296,750 (153,337)—U.S. stock.	NL .....	NC .....	Increasing
Steller sea lion ( <i>Eumetopias jubatus</i> ).	Coastal, shelf .....	49,685 (42,366)—Western stock 58,334 to 72,223 (52,847)—Eastern stock.	T .....	D .....	Decreasing in California



Species	Habitat	Population estimate <sup>3</sup> (minimum)	ESA <sup>1</sup>	MMPA <sup>2</sup>	Population trend <sup>3</sup>
Guadalupe fur seal ( <i>Arctocephalus townsendi</i> ).	Coastal, shelf .....	7,408 (3,028)—Mexico stock.	T .....	D .....	Increasing
Northern fur seal ( <i>Callorhinus ursinus</i> ).	Pelagic, offshore .....	9,968 (5,395)—San Miguel Island stock.	NL .....	D .....	Increasing
Northern elephant seal ( <i>Mirounga angustirostris</i> ).	Coastal, pelagic in migration.	124,000 (74,913)—California Breeding stock.	NL .....	NC .....	Increasing
Pacific harbor seal ( <i>Phoca vitulina richardsi</i> ).	Coastal .....	30,196 (26,667)—California stock.	NL .....	NC .....	Increasing
Fissipeds: Southern sea otter ( <i>Enhydra lutris nereis</i> ).	Coastal .....	2,711—California stock	T .....	D .....	Increasing

NA = Not available or not assessed.

<sup>1</sup> U.S. Endangered Species Act: EN = Endangered, T = Threatened, DL = Delisted, NL = Not listed.

<sup>2</sup> U.S. Marine Mammal Protection Act: D = Depleted, NC = Not Classified.

<sup>3</sup> NMFS Stock Assessment Reports.

In the Pacific Ocean, harbor porpoises are found in coastal and inland waters from California to Alaska and across to Kamchatka and Japan (Gakin, 1984). Harbor porpoises appear to have more restricted movements along the western coast of the continental United States, than along the eastern coast, with some regional differences within California. Based on genetic differences that showed small-scale subdivision within the U.S. portion of its range, California coast stocks were re-evaluated and the stock boundaries were revised. The boundaries (i.e., range) for the Morro Bay stock of harbor porpoises are from Point Sur to Point Conception, California. The vast majority of harbor porpoise in California are within the 0 to 92 m (0 to 301.8 ft) depth, however, a smaller percentage can be found between the 100 to 200 m (328 to 656.2 ft) isobaths. A systematic ship survey of depth strata out to 90 m (295.3 ft) in northern California showed that harbor porpoise abundance declined significantly in waters deep than 60 m (196.9 ft) (Caretta *et al.*, 2001b). Additionally, individuals of the Morro Bay stock appear to be concentrated at significantly higher densities in one specific area of their overall range, which NMFS is referring to as their “core range,” and density is much lower to both the North and South of this area. This core range has the larger number of harbor porpoise sightings and the largest number of harbor porpoise individuals observed during line-transect surveys and is defined for the purposes of this analysis from 34.755° through 35.425° North latitude (see transects 3 to 6 in Table 1 of Appendix B of the IHA application). For the Morro Bay stock, the best estimate of abundance is 2,044 animals and the minimum population estimate is 1,478 animals. There has been an increasing trend in harbor porpoise abundance in Morro Bay since 1988. The observed increase in abundance estimates for this stock since 1988 implies an annual growth rate of

approximately 13%. Appendix B of the IHA application includes more detailed information on the density figures and calculations for the Morro Bay stock of harbor porpoise. Figure 1 of Appendix B shows the fine-scale density (including core habitat of higher density) as well as the proposed tracklines of Survey Box 4 and Survey Box 2.

Refer to sections 3 and 4 of L-DEO and PG&E’s application for detailed information regarding the abundance and distribution, population status, and life history and behavior of these other marine mammal species and their occurrence in the proposed project area. The application also presents how L-DEO and PG&E 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 or more of the following: tolerance, masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson *et al.*, 1995; Gordon *et al.*, 2004; Nowacek *et al.*, 2007; Southall *et al.*, 2007). Permanent hearing impairment, 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, especially for the Morro Bay harbor porpoise stock, which could potentially be displaced from their core habitat during all or part of the seismic survey or longer. A more comprehensive review of these issues can be found in the “Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement prepared for Marine Seismic Research that is funded by the National Science Foundation and conducted by the U.S. Geological Survey” (NSF/USGS, 2011).

*Tolerance*

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

relative responsiveness of baleen and toothed whales are quite variable.

### Masking

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; Nieuwkirk *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 North Atlantic 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). Dilorio and Clark (2009) found evidence of increased calling by blue whales during operations by a lower-energy seismic source (i.e., sparker). 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.

Pinnipeds have the most sensitive hearing and/or produce most of their

sounds at frequencies higher than the dominant components of airgun sound, but there is some overlap in the frequencies of the airgun pulses and the calls. However, the intermittent nature of airgun pulses presumably reduces the potential for masking

Marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior through shifting call frequencies, increasing call volume, and increasing vocalization rates. For example, blue whales are found to increase call rates when exposed to noise from seismic surveys in the St. Lawrence Estuary (Dilorio and Clark, 2009). The North Atlantic right whales (*Eubalaena glacialis*) exposed to high shipping noise increased call frequency (Parks *et al.*, 2007), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller *et al.*, 2000). In general, NMFS expects the masking effects of seismic pulses to be minor, given the normally intermittent nature of seismic pulses.

### Behavioral Disturbance

Marine mammals may behaviorally react to sound when exposed to anthropogenic noise. 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). These behavioral reactions are often shown as: Changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (e.g., pinnipeds flushing into the water from haul-outs or rookeries). 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).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification could be expected to be biologically significant if the change affects growth, survival, and/or reproduction. Some of these significant behavioral modifications include:

- Change in diving/surfacing patterns (such as those thought to be causing beaked whale stranding due to exposure to military mid-frequency tactical sonar);
- Habitat abandonment due to loss of desirable acoustic environment; and
- Cessation of feeding or social interaction.

The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Richardson *et al.*, 1995; Southall *et al.*, 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 sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically-important manner.

*Baleen Whales*—Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable (reviewed in Richardson *et al.*, 1995; Gordon *et al.*, 2004). Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the cases of migrating gray and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals (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  $\mu$ Pa (rms) 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 4 to 15 km (2.2 to 8.1 nmi) 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 have shown that some species of baleen whales, notably bowhead, gray, and humpback whales, at times, show strong avoidance at received levels lower than 160 to 170 dB re 1  $\mu$ Pa (rms).

Researchers have studied the responses of humpback whales to seismic surveys during migration, feeding during the summer months, breeding while offshore from Angola, and wintering offshore from Brazil. McCauley *et al.* (1998, 2000a) studied the responses of humpback whales off western Australia to a full-scale seismic survey with a 16 airgun array (2,678 in<sup>3</sup>) and to a single airgun (20 in<sup>3</sup>) with source level of 227 dB re 1  $\mu$ Pa (p-p). In the 1998 study, they documented that avoidance reactions began at 5 to 8 km (2.7 to 4.3 nmi) from the array, and that those reactions kept most pods approximately 3 to 4 km (1.6 to 2.2 nmi) from the operating seismic boat. In the 2000 study, they noted localized displacement during migration of 4 to 5 km (2.2 to 2.7 nmi) by traveling pods and 7 to 12 km (3.8 to 6.5 nmi) 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  $\mu$ Pa (rms) for humpback pods containing females, and at the mean closest point of approach distance the received level was 143 dB re 1  $\mu$ Pa (rms). The initial avoidance response generally occurred at distances of 5 to 8 km (2.7 to 4.3 nmi) from the airgun array and 2 km (1.1 nmi) 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  $\mu$ Pa (rms).

Data collected by observers during several seismic surveys in the Northwest Atlantic showed that sighting rates of humpback whales were significantly greater during non-seismic periods compared with periods when a full array was operating (Moulton and

Holst, 2010). In addition, humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic vs. non-seismic periods (Moulton and Holst, 2010).

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<sup>3</sup>) airgun (Malme *et al.*, 1985). Some humpbacks seemed "startled" at received levels of 150 to 169 dB re 1  $\mu$ Pa. 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  $\mu$ Pa (rms). However, Moulton and Holst (2010) reported that humpback whales monitored during seismic surveys in the Northwest Atlantic had lower sighting rates and were most often seen swimming away from the vessel during seismic periods compared with periods when airguns were silent.

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).

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<sup>3</sup> 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  $\mu$ Pa on an (approximate) rms basis, and that 10 percent of feeding whales interrupted feeding at received levels of 163 dB re 1  $\mu$ Pa (rms). Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast (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 ensounded 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; Castellote *et al.*, 2010). 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). Castellote *et al.* (2010) reported that singing fin whales in the Mediterranean moved away from an operating airgun array.

Ship-based monitoring studies of baleen whales (including blue, fin, sei, minke, and humpback whales) in the Northwest Atlantic found that overall, this group had lower sighting rates during seismic vs. non-seismic periods (Moulton and Holst, 2010). Baleen whales as a group were also seen significantly farther from the vessel during seismic compared with non-seismic periods, and they were more often seen to be swimming away from the operating seismic vessel (Moulton and Holst, 2010). Blue and minke whales were initially sighted significantly farther from the vessel during seismic operations compared to non-seismic periods; the same trend was observed for fin whales (Moulton and Holst, 2010). Minke whales were most often observed to be swimming away from the vessel when seismic operations were underway (Moulton and Holst, 2010).

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; Allen and Angliss, 2010). The history of coexistence between seismic surveys and baleen whales suggests that brief exposures to sound pulses from any single seismic survey are unlikely to result in prolonged effects.

**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 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; Moulton and Holst, 2010).

Seismic operators and PSOs 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, 1996 a,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; Barkaszi *et al.*, 2009; Moulton and Holst, 2010). 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; Barry *et al.*, 2010; Moulton and Holst, 2010). In most cases, the avoidance radii for delphinids appear to be small, on the order of one km or less, and some individuals show no apparent avoidance.

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 show stronger avoidance of seismic operations than do Dall's porpoises (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. 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. In fact, Moulton and Holst (2010) reported 15 sightings of beaked whales during seismic studies in the Northwest Atlantic; seven of those sightings were made at times when at least one airgun was operating. There was little evidence to indicate that beaked whale behavior was affected by airgun operations; sighting rates and distances were similar during seismic and non-seismic periods (Moulton and Holst, 2010).

There are increasing indications that some beaked whales tend to strand when naval exercises involving mid-frequency sonar operation are ongoing nearby (e.g., Simmons 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, seem to be confined to a smaller radius than has been observed for the more responsive of some mysticetes. However, other data suggest that some odontocete species, including harbor porpoises, may be more responsive than might be expected given their poor low-frequency hearing. Reactions at longer distances may be particularly likely when sound propagation conditions are conducive to transmission of the higher frequency components of airgun sound to the animals' location (DeRuiter *et al.*, 2006; Goold and Coates, 2006; Tyack *et al.*, 2006; Potter *et al.*, 2007).

**Pinnipeds**—Pinnipeds are not likely to show a strong avoidance reaction to the airgun array. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behavior. In the Beaufort Sea, some ringed seals avoided an area of 100 m to (at most) a few hundred meters around seismic vessels, but many seals remained within 100 to 200 m (328 to 656 ft) of the trackline as the operating airgun array passed by (e.g., Harris *et al.*, 2001; Moulton and Lawson, 2002; Miller *et al.*, 2005). Ringed seal sightings averaged somewhat farther away from the seismic vessel when the airguns

were operating than when they were not, but the difference was small (Moulton and Lawson, 2002). Similarly, in Puget Sound, sighting distances for harbor seals and California sea lions tended to be larger when airguns were operating (Calambokidis and Osmeck, 1998). Previous telemetry work suggests that avoidance and other behavioral reactions may be stronger than evident to date from visual studies (Thompson *et al.*, 1998).

During seismic exploration off Nova Scotia, gray seals (*Halichoerus grypus*) exposed to noise from airguns and linear explosive charges did not react strongly (J. Parsons in Greene *et al.*, 1985). Pinnipeds, in both water and air, sometimes tolerate strong noise pulses from non-explosive and explosive scaring devices, especially if attracted to the area for feeding and reproduction (Mate and Harvey, 1987; Reeves *et al.*, 1996). Thus, pinnipeds are expected to be rather tolerant of, or habituate to, repeated underwater sounds from distant seismic sources, at least when the animals are strongly attracted to the area.

#### *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 (above) presents the estimated distances from the *Langseth's* airguns at which the received energy level (per pulse, flat-weighted) would be expected to be greater than or equal to 180 or 190 dB re 1  $\mu$ Pa (rms).

To avoid the potential for injury, NMFS (1995, 2000) concluded that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding 180 and 190 dB re 1  $\mu$ Pa (rms), respectively. NMFS believes that to avoid the potential for Level A harassment, cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding 180 and 190 dB re 1  $\mu$ Pa (rms), respectively. The established 180 and 190 dB (rms) criteria are not considered to be the levels above which TTS might occur. Rather, they are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements for marine mammals started to become available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. NMFS also assumes that cetaceans and pinnipeds exposed to levels exceeding 160 dB re 1  $\mu$ Pa (rms) may experience Level B harassment.

For toothed whales, researchers have derived TTS information for odontocetes from studies on the bottlenose dolphin and beluga. The experiments show that exposure to a single impulse at a received level of 207 kPa (or 30 psi, p-p), which is equivalent to 228 dB re 1 Pa (p-p), resulted in a 7 and 6 dB TTS in the beluga whale at 0.4 and 30 kHz, respectively. Thresholds returned to within 2 dB of the pre-exposure level within 4 minutes of the exposure (Finneran *et al.*, 2002). 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 than those of odontocetes (Southall *et al.*, 2007).

In pinnipeds, researchers have not measured TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound. Initial evidence from more prolonged (non-pulse) exposures suggested that some pinnipeds (harbor seals in particular) incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak *et al.*, 1999, 2005; Ketten *et al.*, 2001). The TTS threshold for pulsed sounds has been indirectly estimated as being an SEL of approximately 171 dB re 1  $\mu$ Pa<sup>2</sup>-s (Southall *et al.*, 2007) which would be equivalent to a single pulse with a received level of approximately 181 to 186 dB re 1  $\mu$ Pa (rms), or a series of pulses for which the highest rms values are a few dB lower. Corresponding values for California sea lions and northern elephant seals are likely to be higher (Kastak *et al.*, 2005).

**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. 372ff; 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 (Southall *et al.*, 2007). PTS might occur at a received sound level at least several dBs above that inducing mild TTS if the animal were exposed to strong sound pulses with rapid rise times. 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 6 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. Some pinnipeds show avoidance reactions to airguns, but their avoidance reactions are generally not as strong or consistent as those of cetaceans, and occasionally they seem to be attracted to operating seismic vessels (NMFS, 2010).

**Stranding and Mortality**—When a living or dead marine mammal swims or floats onto shore and becomes “beached” or incapable of returning to sea, the event is termed a “stranding” (Geraci *et al.*, 1999; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007). The legal definition for a stranding under the MMPA is that “(A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance.”

Marine mammals are known to strand for a variety of reasons, such as infectious agents, biotoxigenesis, starvation, fishery interaction, ship strike, unusual oceanographic or weather events, sound exposure, or combinations of these stressors sustained concurrently or in series. However, the cause or causes of most

strandings are unknown (Geraci *et al.*, 1976; Eaton, 1979; Odell *et al.*, 1980; Best, 1982). Numerous studies suggest that the physiology, behavior, habitat relationships, age, or condition of cetaceans may cause them to strand or might pre-dispose them to strand when exposed to another phenomenon. These suggestions are consistent with the conclusions of numerous other studies that have demonstrated that combinations of dissimilar stressors commonly combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other does not produce the same result (Chroussos, 2000; Creel, 2005; DeVries *et al.*, 2003; Fair and Becker, 2000; Foley *et al.*, 2001; Moberg, 2000; Relyea, 2005a, 2005b; Romero, 2004; Sih *et al.*, 2004).

**Strandings Associated with Military Active Sonar**—Several sources have published lists of mass stranding events of cetaceans in an attempt to identify relationships between those stranding events and military active sonar (Hildebrand, 2004; IWC, 2005; Taylor *et al.*, 2004). For example, based on a review of stranding records between 1960 and 1995, the International Whaling Commission (2005) identified ten mass stranding events and concluded that, out of eight stranding events reported from the mid-1980s to the summer of 2003, seven had been coincident with the use of mid-frequency active sonar and most involved beaked whales.

Over the past 12 years, there have been five stranding events coincident with military mid-frequency active sonar use in which exposure to sonar is believed to have been a contributing factor to strandings: Greece (1996); the Bahamas (2000); Madeira (2000); Canary Islands (2002); and Spain (2006). Refer to Cox *et al.* (2006) for a summary of common features shared by the strandings events in Greece (1996), Bahamas (2000), Madeira (2000), and Canary Islands (2002); and Fernandez *et al.*, (2005) for an additional summary of the Canary Islands 2002 stranding event.

**Potential for Stranding from Seismic Surveys**—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 in marine waters for commercial seismic surveys or (with rare exceptions) for seismic research. These methods 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 (non-pulse sound) and, in one case, the co-occurrence of an L-DEO seismic survey (Malakoff, 2002; Cox *et al.*, 2006), has raised the possibility that beaked whales exposed to strong “pulsed” sounds could also be susceptible to injury and/or behavioral reactions that can lead to stranding (e.g., Hildebrand, 2005; Southall *et al.*, 2007).

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 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. 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 2 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 expect that the same to marine mammals will result from military sonar

and seismic surveys. 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 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 in the Gulf of California, Mexico, when the L-DEO vessel R/V *Maurice Ewing* was operating a 20 airgun (8,490 in<sup>3</sup>) array 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, and

(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, some odontocetes, and some pinnipeds, are especially unlikely to incur non-auditory physical effects.

#### *Potential Effects of Other Acoustic Devices*

##### Multibeam Echosounder

L-DEO and PG&E will operate the Kongsberg EM 122 multibeam echosounder from the source vessel during the planned study. Sounds from the multibeam echosounder are very short pulses, occurring for 2 to 15 ms once every 5 to 20 s, depending on water depth. Most of the energy in the sound pulses emitted by this multibeam echosounder is at frequencies near 12 kHz, and the maximum source level is 242 dB re 1  $\mu$ Pa (rms). 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 (in water 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 a multibeam echosounder 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 multibeam echosounder. The area of possible influence of the multibeam echosounder 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 and PG&E'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 a multibeam echosounder on marine mammals are described below.

*Masking*—Marine mammal communications will not be masked appreciably by the multibeam echosounder 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 multibeam echosounder 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 (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  $\mu$ Pa, gray whales reacted by orienting slightly away from the source and being deflected from their course by approximately 200 m (656.2 ft) (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 multibeam echosounder used by L-DEO and PG&E, 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 a multibeam echosounder.

Very few data are available on the reactions of pinnipeds to echosounder sounds at frequencies similar to those used during seismic operations. Hastie and Janik (2007) conducted a series of behavioral response tests on two captive gray seals to determine their reactions to underwater operation of a 375 kHz multibeam imaging echosounder that included significant signal components down to 6 kHz. Results indicated that the two seals reacted to the signal by significantly increasing their dive durations. Because of the likely brevity of exposure to the multibeam echosounder sounds, pinniped reactions are expected to be limited to startle or otherwise brief responses of no lasting consequences to the animals.

**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 multibeam echosounder proposed for use by L-DEO and PG&E is quite different than sonar used for Navy operations. Pulse duration of the multibeam echosounder is very short relative to the naval sonar. Also, at any given location, an individual marine mammal would be in the beam of the multibeam echosounder 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 multibeam echosounder 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 multibeam echosounder is not likely to result in the harassment of marine mammals.

#### Sub-Bottom Profiler

L-DEO and PG&E will also operate a sub-bottom profiler from the source

vessel during the proposed survey. Sounds from the sub-bottom profiler are very short pulses, occurring for 1 to 4 ms once every second. Most of the energy in the sound pulses emitted by the sub-bottom profiler 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  $\mu$ Pa. 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 a sub-bottom profiler more powerful than that on the *Langseth*. If the animal was in the area, it would have to pass the transducer at close range in order to be subjected to sound levels that could cause TTS.

**Masking**—Marine mammal communications will not be masked appreciably by the sub-bottom profiler 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 sub-bottom profiler 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 sub-bottom profiler are likely to be similar to those for other pulsed sources if received at the same levels. However, the pulsed signals from the sub-bottom profiler are considerably weaker than those from the multibeam echosounder. 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 sub-bottom profiler 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 sub-bottom profiler is usually operated simultaneously with other higher-power acoustic sources, including airguns. 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 sub-bottom profiler.

#### Vessel Movement and Collisions

Vessel movement in the vicinity of marine mammals has the potential to result in either a behavioral response or a direct physical interaction. Both scenarios are discussed below in this section.

**Behavioral Responses to Vessel Movement**—There are limited data concerning marine mammal behavioral responses to vessel traffic and vessel noise, and a lack of consensus among scientists with respect to what these responses mean or whether they result in short-term or long-term adverse effects. In those cases where there is a busy shipping lane or where there is a large amount of vessel traffic, marine mammals (especially low frequency specialists) may experience acoustic masking (Hildebrand, 2005) if they are present in the area (e.g., killer whales in Puget Sound; Foote *et al.*, 2004; Holt *et al.*, 2008). In cases where vessels actively approach marine mammals (e.g., whale watching or dolphin watching boats), scientists have documented that animals exhibit altered behavior such as increased swimming speed, erratic movement, and active avoidance behavior (Bursk, 1983; Acevedo, 1991; Baker and MacGibbon, 1991; Trites and Bain, 2000; Williams *et al.*, 2002; Constantine *et al.*, 2003), reduced blow interval (Ritcher *et al.*, 2003), disruption of normal social behaviors (Lusseau, 2003, 2006), and the shift of behavioral activities which may increase energetic costs (Constantine *et al.*, 2003, 2004). A detailed review of marine mammal reactions to ships and boats is available in Richardson *et al.*, (1995). For each of the marine mammal taxonomy groups, Richardson *et al.*, (1995) provides the following assessment regarding reactions to vessel traffic:

**Toothed whales**—“In summary, toothed whales sometimes show no avoidance reaction to vessels, or even approach them. However, avoidance can occur, especially in response to vessels of types used to chase or hunt the animals. This may cause temporary displacement, but we know of no clear evidence that toothed whales have abandoned significant parts of their range because of vessel traffic.”

**Baleen whales**—“When baleen whales receive low-level sounds from distant or stationary vessels, the sounds often seem to be ignored. Some whales approach the sources of these sounds. When vessels approach whales slowly and non-aggressively, whales often exhibit slow and inconspicuous avoidance maneuvers. In response to strong or rapidly changing vessel noise, baleen whales often interrupt their normal behavior and swim rapidly away. Avoidance is especially strong when a boat heads directly toward the whale.”

Behavioral responses to stimuli are complex and influenced to varying degrees by a number of factors, such as



species, behavioral contexts, geographical regions, source characteristics (moving or stationary, speed, direction, etc.), prior experience of the animal and physical status of the animal. For example, studies have shown that beluga whales' reaction varied when exposed to vessel noise and traffic. In some cases, beluga whales exhibited rapid swimming from ice-breaking vessels up to 80 km (43.2 nmi) away, and showed changes in surfacing, breathing, diving, and group composition in the Canadian high Arctic where vessel traffic is rare (Finley *et al.*, 1990). In other cases, beluga whales were more tolerant of vessels, but responded differentially to certain vessels and operating characteristics by reducing their calling rates (especially older animals) in the St. Lawrence River where vessel traffic is common (Blane and Jaakson, 1994). In Bristol Bay, Alaska, beluga whales continued to feed when surrounded by fishing vessels and resisted dispersal even when purposefully harassed (Fish and Vania, 1971).

In reviewing more than 25 years of whale observation data, Watkins (1986) concluded that whale reactions to vessel traffic were "modified by their previous experience and current activity: Habituation often occurred rapidly, attention to other stimuli or preoccupation with other activities sometimes overcame their interest or wariness of stimuli." Watkins noticed that over the years of exposure to ships in the Cape Cod area, minke whales changed from frequent positive interest (e.g., approaching vessels) to generally uninterested reactions; fin whales changed from mostly negative (e.g., avoidance) to uninterested reactions; fin whales changed from mostly negative (e.g., avoidance) to uninterested reactions; right whales apparently continued the same variety of responses (negative, uninterested, and positive responses) with little change; and humpbacks dramatically changed from mixed responses that were often negative to reactions that were often strongly positive. Watkins (1986) summarized that "whales near shore, even in regions with low vessel traffic, generally have become less wary of boats and their noises, and they have appeared to be less easily disturbed than previously. In particular locations with intense shipping and repeated approaches by boats (such as the whale-watching areas of Stellwagen Bank), more and more whales had positive reactions to familiar vessels, and they also occasionally approached other boats and yachts in the same ways."

Although the radiated sound from the *Langseth* and support vessels will be audible to marine mammals over a large distance, it is unlikely that marine mammals will respond behaviorally (in a manner that NMFS would consider harassment under the MMPA) to low-level distant shipping noise as the animals in the area are likely to be habituated to such noises (Nowacek *et al.*, 2004). In light of these facts, NMFS does not expect the *Langseth's* movements to result in Level B harassment.

**Vessel Strike**—Ship strikes of cetaceans can cause major wounds, which may lead to the death of the animal. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist *et al.*, 2001; Vanderlaan and Taggart, 2007).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., the sperm whale). In addition, some baleen whales, such as the North Atlantic right whale, seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek *et al.*, 2004). These species are primarily large, slow moving whales. Smaller marine mammals (e.g., bottlenose dolphin) move quickly through the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death (Knowlton and Kraus, 2001; Laist *et al.*, 2001; Jensen and Silber, 2003; Vanderlaan and Taggart, 2007). In assessing records in which vessel speed was known, Laist *et al.* (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 kts (24.1 km/hr, 14.9 mph).

L-DEO and PG&E's proposed operation of one source vessel and support vessels for the proposed survey is relatively small in scale compared to the number of commercial ships transiting at higher speeds in the same areas on an annual basis. The probability of vessel and marine

mammal interactions occurring during the proposed survey is unlikely due to the *Langseth's* and support vessels slow operational speed, which is typically 4.6 kts (8.5 km/hr, 5.3 mph). Outside of seismic operations, the *Langseth's* cruising speed would be approximately 10 kts (18.5 km/hr, 11.5 mph), which is generally below the speed at which studies have noted reported increases of marine mammal injury or death (Laist *et al.*, 2001).

As a final point, the *Langseth* has a number of other advantages for avoiding ship strikes as compared to most commercial merchant vessels, including the following: the *Langseth's* bridge offers good visibility to visually monitor for marine mammal presence; PSOs posted during operations scan the ocean for marine mammals and must report visual alerts of marine mammal presence to crew; and the PSOs receive extensive training that covers the fundamentals of visual observing for marine mammals and information about marine mammals and their identification at sea.

#### Entanglement

Entanglement can occur if wildlife becomes immobilized in survey lines, cables, nets, or other equipment that is moving through the water column. The proposed seismic survey would require towing approximately 6.4 km<sup>2</sup> (1.9 nmi<sup>2</sup>) of equipment and cables. This large of an array carries the risk of entanglement for marine mammals. Wildlife, especially slow moving individuals, such as large whales, have a low probability of becoming entangled due to slow speed of the survey vessel and onboard monitoring efforts. The NSF has no recorded cases of entanglement of marine mammals during any of their 160,934 km (86,897.4 nmi) of seismic surveys. In May, 2011, there was one recorded entanglement of an olive ridley sea turtle (*Lepidochelys olivacea*) in the *Langseth's* barovanes after the conclusion of a seismic survey off Costa Rica. There have been cases of baleen whales, mostly gray whales (Heyning, 1990), becoming entangled in fishing lines. The probability for entanglement of marine mammals is considered not significant because of the vessel speed and the monitoring efforts onboard the survey vessel.

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 impact on affected marine mammal species and stocks.

#### Anticipated Effects on Marine Mammal Habitat

The proposed seismic survey is not anticipated to have 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). Additionally, no physical damage to any habitat is anticipated as a result of conducting the proposed seismic survey. 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 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 in any particular area of the approximately 740.5 km<sup>2</sup> proposed project area, previously discussed in this notice. The next section discusses the potential impacts of anthropogenic sound sources on common marine mammal prey in the proposed survey area (i.e., fish and invertebrates).

#### 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 and invertebrate populations is limited. 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. This makes drawing conclusions about impacts on fish problematic because, ultimately, the most important issues concern effects on marine fish populations, their viability, and their availability to fisheries.

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 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. 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 L-DEO, PG&E, and NMFS 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*) 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 nine 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 (Urlick, 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).

An experiment of the effects of a single 700 in<sup>3</sup> airgun was conducted in Lake Meade, Nevada (USGS, 1999). The data were used in an Environmental Assessment of the effects of a marine reflection survey of the Lake Meade

fault system by the National Park Service (Paulson *et al.*, 1993, in USGS, 1999). The airgun was suspended 3.5 m (11.5 ft) above a school of threadfin shad in Lake Meade and was fired three successive times at a 30 second interval. Neither surface inspection nor diver observations of the water column and bottom found any dead fish.

For a proposed seismic survey in Southern California, USGS (1999) conducted a review of the literature on the effects of airguns on fish and fisheries. They reported a 1991 study of the Bay Area Fault system from the continental shelf to the Sacramento River, using a 10 airgun (5,828 in<sup>3</sup>) array. Brezzina and Associates were hired by USGS to monitor the effects of the surveys, and concluded that airgun operations were not responsible for the death of any of the fish carcasses observed, and the airgun profiling did not appear to alter the feeding behavior of sea lions, seals, or pelicans observed feeding during the seismic surveys.

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.

**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.

The Minerals Management Service (MMS, 2005) assessed the effects of a proposed seismic survey in Cook Inlet. The seismic survey proposed using three vessels, each towing two, four-airgun arrays ranging from 1,500 to 2,500 in<sup>3</sup>. MMS noted that the impact to fish populations in the survey area and adjacent waters would likely be very low and temporary. MMS also concluded that seismic surveys may displace the pelagic fishes from the area temporarily when airguns are in use. However, fishes displaced and avoiding the airgun noise are likely to backfill the survey area in minutes to hours after cessation of seismic testing. Fishes not dispersing from the airgun noise (e.g., demersal species) may startle and move short distances to avoid airgun emissions.

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).

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 F of NSF's EA.

**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. Tenera Environmental (2011b) reported that Norris and Mohl (1983, summarized in Mariyasu *et al.*, 2004) observed lethal effects in squid (*Loligo vulgaris*) at levels of 246 to 252 dB after 3 to 11 minutes.

Andre *et al.* (2011) exposed four species of cephalopods (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Ilex coindetii*), primarily cuttlefish, to two hours of continuous 50 to 400 Hz sinusoidal wave sweeps at 157+/- 5 dB re 1 µPa while captive in relatively small tanks. They reported morphological and ultrastructural evidence of massive acoustic trauma (i.e., permanent and substantial alterations [lesions] of statocyst sensory hair cells) to the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low frequency sound. The received SPL was reported as 157+/- 5 dB re 1 µPa, with peak levels at 175 dB re 1 µPa. As in the McCauley *et al.* (2003) paper on sensory hair cell damage in pink snapper as a result of exposure to seismic sound, the cephalopods were subjected to higher sound levels than they would be under natural conditions, and they were unable to swim away from the sound source.

**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). It was noted however, that no behavioral impacts were exhibited by crustaceans (Christian *et al.*, 2003, 2004; DFO, 2004). 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 (Andrighetto-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 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 and PG&E have reviewed the following source documents and have incorporated a suite of appropriate mitigation measures into their project description.

(1) Protocols used during previous NSF and USGS-funded seismic research cruises as approved by NMFS and detailed in the recently completed Final Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey;

(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, PG&E and/or its designees have proposed to implement the following mitigation measures for marine mammals:

- (1) Vessel-based Marine Wildlife Contingency Plan;
- (2) Scheduling to avoid areas of high marine mammal activity;
- (3) Speed and course alterations;
- (4) Proposed exclusion zones around the sound source;
- (5) Power-down procedures;
- (6) Shut-down procedures;
- (7) Ramp-up procedures; and
- (8) Morro Bay stock harbor porpoise mitigation, monitoring, and adaptive management that will detect significant impacts to harbor porpoises in real time in order to trigger appropriate mitigation measures (e.g., suspension of seismic operations).

**Vessel-based Marine Wildlife Contingency Plan**—The vessel-based seismic operations of the PG&E's Marine Wildlife Contingency Plan are designed to meet the anticipated Federal and State regulatory requirements. The objectives of the program will be:

- To minimize any potential disturbance to marine mammals and ensure all regulatory requirements are followed;
  - To document observations of the proposed seismic survey on marine mammals; and
  - To collect baseline data on the occurrence and distribution of marine mammals in the proposed study area.
- Proposed survey design features include:
- Timing and locating seismic operations to avoid potential interference with the annual peak of the gray whale migration period;
  - Limiting the size of the seismic sound source to minimize energy introduced into the marine environment; and
  - Establishing buffer and exclusion zones radii based on modeling results of the proposed sound sources.

The Marine Wildlife Contingency Plan will be implemented by a team of NMFS-qualified PSOs. PSOs will be stationed aboard the source and support vessels through the duration of the proposed project. Reporting of the results of the vessel-based mitigation and monitoring program will include the estimation of the number of takes.

The vessel-based work will provide:

- Information needed to estimate the number of potential takes of marine mammals by harassment, which must be reported to NMFS and USFWS;
- Data on the occurrence, distribution, and activities of marine mammals in the areas where the proposed seismic operations are conducted; and
- Information to compare the distances, distributions, behavior, and movements of marine mammals relative

to the source vessel at times with and without airgun activity.

**Scheduling to Avoid Areas of High Marine Mammal Activity**—PG&E proposes to conduct offshore seismic surveys from October 15 through December 31, 2012, with airgun operations taking place from November 1 through December 31, 2012, to coincide with the reduced number of cetaceans in the area, and outside the peak gray whale annual migration period. This timeframe also is outside the breeding and pupping periods for the Pacific harbor seal (March to June) and California sea lion (May to late July), both of which have rookeries inshore, but adjacent to the proposed project area. No other pinnipeds breed in the project area. The 2012 survey timing has also been refined to address the breeding activity of the resident Morro Bay stock of harbor porpoises. As such, active use of airguns will not be started until November 1, 2012, which will minimize exposure of nursing harbor porpoise to seismic operations.

**Speed and Course Alterations**—If a marine mammal is detected outside the exclusion zone and, based on its position and direction of travel, is likely to enter the exclusion zone, changes of the vessel's speed and course will be considered if this does not compromise operational safety. For marine seismic surveys towing large streamer arrays, however, course alterations are not typically implemented due to the vessel's limited maneuverability. After any such speed and/or course alteration is begun, the marine mammal activities and movements relative to the seismic vessel will be closely monitored to ensure that the marine mammal does not approach within the exclusion zone. If the marine mammal appears likely to enter the exclusion zone, further mitigation actions will be taken, including a power-down and/or shut-down of the airgun(s).

**Proposed Exclusion Zones**—L-DEO and PG&E use radii to designate exclusion and buffer zones and to estimate take for marine mammals. Table 1 (presented earlier in this document) shows the distances at which one would expect to receive three sound levels (160, 180, and 190 dB) from the 18 airgun array and a single airgun. The 180 dB and 190 dB level shut-down criteria are applicable to cetaceans and pinnipeds, respectively, as specified by NMFS (2000). L-DEO and PG&E used these levels to establish the exclusion and buffer zones.

If the PSVO detects marine mammal(s) within or about to enter the appropriate exclusion zone, the *Langseth* crew will immediately power-

down the airgun array, or perform a shut-down if necessary (see "Shut-down Procedures"). Table 1 summarizes the calculated distances at which sound levels (160, 180, and 190 dB [rms]) are expected to be received from the 18 airgun array operating in upslope, downslope, and alongshore depths (although only the upslope radii will be used for the 160 and 180 dB isopleths and the alongshore radii will be used for the 190 dB isopleth, as these are considered the most conservative) and the single airgun operating in shallow, intermediate, and deep water depths (all survey boxes are within water depths of 400 m or less). Received sound levels have been calculated by L-DEO, in relation to distance and direction from the airguns, for the 18 airgun array and for the single 1900LL 40 in<sup>3</sup> airgun, which will be used during power-downs.

A detailed description of the modeling effort for the 18 airgun array by Greeneridge Sciences, Inc. is presented in Appendix A of the IHA application and NSF EA. Modeled received sound levels prepared by L-DEO will be used for the single airgun.

If the PSVO detects marine mammal(s) within or about to enter the appropriate exclusion zone, the airguns will be powered-down (or shut-down, if necessary) immediately.

At the initiation of the 3D seismic survey, direct measurements will be taken of the received levels of underwater sound versus distance and direction from the airgun source vessel using calibrated hydrophones (i.e., a sound source verification test). The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to verify and adjust the buffer and exclusion zone distances. The field report will be made available to NMFS and PSOs within 120 hours of completing the measurements.

To augment visual observations on the *Langseth*, two scout vessels with a minimum of three NMFS-qualified PSOs onboard each, shall be positioned adjacent to the *Langseth* to monitor the buffer and exclusion zones for mitigation-monitoring purposes. The PSOs onboard the scout vessels will report to the PSOs onboard the *Langseth* if any marine mammals are observed.

**Power-down Procedures**—A power-down involves decreasing the number of airguns in use to one airgun, such that the radius of the 180 dB (or 190 dB) zone is decreased to the extent that the observed marine mammal(s) are no longer in or about to enter the exclusion zone for the full airgun array. A power-down of the airgun array can also occur when the vessel is moving from the end

of one seismic trackline to the start of the next trackline. During a power-down for mitigation, L-DEO and PG&E will operate one airgun. The continued operation of one airgun is intended to (a) alert marine mammals to the presence of the seismic vessel in the area; and, (b) retain the option of initiating a ramp-up to full operations under poor visibility conditions. In contrast, a shut-down occurs when all airgun activity is suspended.

If the PSVO detects a marine mammal outside the exclusion zone and is likely to enter the exclusion zone, L-DEO and PG&E will power-down the airguns to reduce the size of the 180 dB exclusion zone before the animal is within the exclusion zone. Likewise, if a mammal is already within the exclusion zone, when first detected L-DEO and PG&E will power-down the airguns immediately. During a power-down of the airgun array, L-DEO and PG&E will operate the single 40 in<sup>3</sup> airgun, which has a smaller exclusion zone. If the PSVO detects a marine mammal within or near the smaller exclusion zone around that single airgun (see Table 1), L-DEO and PG&E will shut-down the airgun (see next section).

Following a power-down, the *Langseth* will not resume full airgun activity until the marine mammal has cleared the 180 or 190 dB exclusion zone (see Table 1). The PSO will consider the animal to have cleared the exclusion zone if:

- The observer has visually observed the animal leave the exclusion zone, or
- An observer has not sighted the animal within the exclusion zone for 15 minutes for species with shorter dive durations (i.e., small odontocetes or pinnipeds), or 30 minutes for species with longer dive durations (i.e., mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales); or
- The vessel has transited outside the original 180 dB exclusion zone after an 8 minute period minute wait period.

The *Langseth* crew will resume operating the airguns at full power after 15 minutes of sighting any species with short dive durations (i.e., small odontocetes or pinnipeds). Likewise, the crew will resume airgun operations at full power after 30 minutes of sighting any species with longer dive durations (i.e., mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales).

Because the vessel has transited away from the vicinity of the original sighting during the 8 minute period, implementing ramp-up procedures for the full array after an extended power-down (i.e., transiting for an additional

35 minutes from the location of initial sighting) would not meaningfully increase the effectiveness of observing marine mammals approaching or entering the exclusion zone for the full source level and would not further minimize the potential for take. The *Langseth's* PSOs are continually monitoring the exclusion zone for the full source level while the mitigation airgun is firing. On average, PSOs can observe to the horizon (10 km or 5.4 nmi) from the height of the *Langseth's* observation deck and should be able to state with a reasonable degree of confidence whether a marine mammal would be encountered within this distance before resuming airgun operations at full power.

**Shut-down Procedures**—L-DEO and PG&E will shut-down the operating airgun(s) if a marine mammal is seen within or approaching the exclusion zone for the single airgun. L-DEO will implement a shut-down:

(1) If an animal enters the exclusion zone of the single airgun after L-DEO has initiated a power-down; or

(2) If an animal is initially seen within the exclusion zone of the single airgun when more than one airgun (typically the full airgun array) is operating (and it is not practical or adequate to reduce exposure to less than 180 dB [rms]).

Considering the conservation status for the North Pacific right whale, the airguns will be shut-down immediately in the unlikely event that this species is observed, regardless of the distance from the *Langseth*. Ramp-up will only begin if the North Pacific right whale has not been seen for 30 minutes.

Following a shut-down in excess of 8 minutes, the *Langseth* crew will initiate a ramp-up with the smallest airgun in the array (40 in<sup>3</sup>). The crew will turn on additional airguns in a sequence such that the source level of the array will increase in steps not exceeding 6 dB per five-minute period over a total duration of approximately 30 minutes. During ramp-up, the PSOs will monitor the exclusion zone, and if he/she sights a marine mammal, the *Langseth* crew will implement a power-down or shut-down as though the full airgun array were operational.

During periods of active seismic operations, there are occasions when the *Langseth* crew will need to temporarily shut-down the airguns due to equipment failure or for maintenance. In this case, if the airguns are inactive longer than eight minutes, the crew will follow ramp-up procedures for a shut-down described earlier and the PSOs will monitor the full exclusion zone and will implement a power-down or shut-down if necessary.

If the full exclusion zone is not visible to the PSO for at least 30 minutes prior to the start of operations in either daylight or nighttime, the *Langseth* crew will not commence ramp-up unless at least one airgun (40 in<sup>3</sup> or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the vessel's crew will not ramp-up the airgun array from a complete shut-down at night or in thick fog, because the outer part of the 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. The vessel's crew will not initiate ramp-up of the airguns if a marine mammal is sighted within or near the applicable exclusion zones during the day or close to the vessel at night.

**Ramp-up Procedures**—Ramp-up of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns firing until the full volume of the airgun array is achieved. The purpose of a ramp-up is to "warn" marine mammals in the vicinity of the airguns, and to provide the time for them to leave the area and thus avoid any potential injury or impairment of their hearing abilities. L-DEO and PG&E will follow a ramp-up procedure when the airgun array begins operating after an 8 minute period without airgun operations or when a power-down shut down has exceeded that period. L-DEO and PG&E considered proposing that, for the present cruise, this period would be approximately two minutes. Since from a practical and operational standpoint this time period is considered too brief, L-DEO and PG&E propose to use 8 minutes, which is a time period used during previous 2D surveys. L-DEO has used similar periods (approximately 8 to 10 min) during previous L-DEO surveys.

Ramp-up will begin with the smallest airgun in the array (40 in<sup>3</sup>). 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 to 35 minutes. During ramp-up, the PSOs will monitor the exclusion zone, 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 exclusion zone has not been visible for at least 30 minutes 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<sup>3</sup> 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 exclusion 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 and PG&E will not initiate a ramp-up of the airguns if a marine mammal is sighted within or near the applicable exclusion zones.

#### *Use of a Small-Volume Airgun During Turns and Maintenance*

Throughout the seismic survey, particularly during turning movements, and short-duration equipment maintenance activities, L-DEO and PG&E will employ the use of a small-volume airgun (i.e., mitigation airgun) to deter marine mammals from being within the immediate area of the seismic operations. The mitigation airgun would be operated at approximately one shot per minute and would not be operated for longer than three hours in duration (turns may last two to three hours for the proposed project).

During turns or brief transits (e.g., less than 2 hours) between seismic tracklines, one airgun will continue operating. The ramp-up procedure will still be followed when increasing the source levels from one airgun to the full airgun array. However, keeping one airgun firing will avoid the prohibition of a "cold start" during darkness or other periods of poor visibility. Through use of this approach, seismic operations may resume without the 30 minute observation period of the full exclusion zone required for a "cold start," and without ramp-up if operating with the mitigation airgun for under 8 minutes, or with ramp-up if operating with the mitigation airgun over 8 minutes. PSOs will be on duty whenever the airguns are firing during daylight, and at night during the 30 minute periods prior to ramp-ups as well as during ramp-ups or when the Protected Species Acoustic Observer detects the presence of marine mammals within the exclusion zone.

### Nighttime Survey Areas

Nighttime operations will be restricted to areas in which marine mammal abundance is low based on daytime observations (i.e., vessel and period aerial data) and historical distribution patterns. Data collection along inshore tracklines and near Church Rock (35° 20.675' North, 120° 59.049' West) will be done during daylight hours to the extent possible. If nighttime survey operations are located within the 40 m (131 ft) depth contour, PSOs will visually monitor the area forward of the vessel with the aid of binoculars, and the forward-looking infrared system available on the *Langseth*.

### Harbor Porpoise Mitigation, Monitoring, and Adaptive Management Plan

Because of heightened concern over impacts from seismic operations to harbor porpoises from the proposed action, NMFS coordinated closely with PG&E to develop a comprehensive and precautionary monitoring, mitigation, and adaptive management framework. This plan, which PG&E has agreed to operationally and financially support, is designed to detect significant responses of harbor porpoises to the activity that can be used to trigger management actions in real-time and allow the activity to proceed in a cautious manner in light of some uncertainty regarding how this species will respond to the activity. Additional measures include:

- Implementation of an extended initial ramp-up (around the length of time it takes to run the first transect of the aerial survey) at the beginning of each of the two survey boxes.
- Ensuring that airgun operations for each survey box begin in the daylight.

Data collected during pre-activity survey operations and on-going operational monitoring activities will be used during the proposed seismic operations to adjust or redirect seismic operations should significant adverse impacts be observed to marine mammals in the proposed project area. The Adaptive Management Plan will be finalized in consultation with resource agencies involved in the permitting and monitoring activities associated with the proposed 2012 seismic operations. Information sources used as part of this plan will include, but not be limited to the following:

- Pre-activity and weekly aerial surveys (see Appendix G of the IHA application);
- Sound source verification study;
- Visual monitoring by PSOs onboard vessels;
- NMFS Morro Bay stock of Harbor Porpoise Monitoring Program (see

Appendix D of the IHA application), which will use aerial surveys, C-PODS (passive acoustic devices tuned to detect high frequency harbor porpoise vocalizations), and moored hydrophones (tuned to identify received levels of seismic signals) to detect broader scale harbor porpoise responses to seismic surveys; and

- Marine Mammal Stranding Response Plan (see Appendix F of the IHA application), which will utilize response personnel and necessary equipment to monitor the action area for behaviors suggestive of stranding responses, and subsequently run appropriate tests if an event occurs.

*Triggers for Adaptive Management*—Below are the situations in which suspension of seismic airgun operations would be required. Following suspension of activities for any of the situations outlined below, NMFS and our stranding network partners will further evaluate available information, including new information collected while seismic operations are suspended, and NMFS will coordinate with PG&E and L-DEO to determine if and how seismic operations may continue. The triggers that have been identified are as follows:

- The seismic survey will be suspended if the aerial surveys or acoustic detections show that moderate to large numbers of the Morro Bay stock of harbor porpoises, have been pushed out of their primary (core) habitat and/or outside of their normal stock range. Numerical thresholds for this, including (a) decreased densities in core habitat and/or (b) increased densities in secondary habitat (or beyond, e.g., Point Conception) will have to be identified based in part on the fine-scale “baseline” surveys planned for October, before seismic operations start, and NMFS’s knowledge about their core habitat from the coarser historical aerial survey data.

• The seismic survey will be suspended if unusual behavior for harbor porpoises is observed that would suggest there is severe disturbance or stress/injury. Details of this criterion are difficult to predict, but harbor porpoises usually occur in loosely aggregated groups of 1 to 5 individuals, with characteristic surfacing behaviors. So, for example, a large, tight group of 50 to 100 individuals rafting or bunched in an unusual area would be of concern.

- A mass stranding (i.e., 2 or more animals that simultaneously strand, other than cow-calf pairs) or unusual nearshore milling (“near mass stranding”) of any cetacean species. At a minimum, the shut-down of all seismic airgun operations would

continue until the disposition of the animals was complete; this could involve herding offshore, refloating/transporting/herding, transport to rehabilitation, euthanasia, or any combination of the above. Shut-down procedures will remain in effect until NMFS determines that, and advises PG&E that, all live animals have left the geographic area (either of their volition or following herding).

- If 2 cetaceans within one day, 3 or more cetaceans within a week, or 5 or more pinniped within a week are newly detected stranded (sick, injured, in need of medical attention, or dead) on the beach or floating incapacitated or dead within the impact zone during the period of seismic operations, the following would occur:

- For live stranded animals, the stranding team would attempt to capture the animals and perform a Phase 1 examination, including auditory evoked potential (AEP) testing of all odontocetes, and any clinical tests deemed necessary by the attending veterinarian. If the animal(s) are determined to be candidates for immediate release (either from the original stranding location or following transport to a new location), shut-down may be needed until the release is complete. If the animal is determined to be a candidate for rehabilitation and the initial examination is inconclusive regarding a reason for stranding, Phase 2 investigations will be conducted.

- For all dead stranded animals, the stranding team would attempt to recover the carcass(es) and perform a detailed necropsy with diagnostic imaging scans to rule out obvious cause of death (e.g., a Phase 1 investigation), as appropriate given the decomposition rate of the animal and other logistical constraints (size, weight, location, etc.). Then, if Phase 1 tests are inconclusive and the animal(s) is (are) in good body condition, Phase 2 investigations will be conducted.

- In either case, if Phase 2 investigations are warranted for enough animals to meet the initial numerical criteria, seismic operations will be suspended.

- Strandings of single marine mammals with signs of acoustic trauma or barotrauma without another etiology would require a suspension of seismic operations.

- A ship-strike of a marine mammal by any of the vessels involved in the seismic survey (including chase/support vessels) would result in a suspension of seismic operations.

Data from the proposed seismic operations 2012 may also be used to revise proposed survey operations

within Survey Box 1, or associated mitigation and monitoring, which have been proposed to be conducted in 2013 as a result of consultation under the MMPA with NMFS.

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. NMFS's 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.

#### 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.

#### Proposed Monitoring

L-DEO and PG&E propose to sponsor marine mammal monitoring during the proposed 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 and PG&E's proposed "Monitoring Plan" is described below this section. L-DEO and PG&E understand 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 and PG&E are prepared to discuss coordination of their monitoring program with any related work that might be done by

other groups insofar as this is practical and desirable.

#### Aerial Surveys

PG&E proposes to conduct aerial surveys for large cetaceans in conjunction with the proposed seismic survey operations and in accordance with the requirements established by the California State Lands Commission Environmental Impact Report mitigation measures. In addition to the PG&E aerial surveys focusing on large cetaceans (flying above 305 m [1,000 ft]), NMFS/USFWS will be conducting low level aerial surveys designed to monitor southern sea otter and the Morro Bay stock of harbor porpoise movements through a separate project funded by PG&E. These NMFS/USFWS aerial survey operations will be conducted in close coordination with the PG&E aerial surveys, but under existing permits. The information generated by these two aerial survey operations will be used to inform the proposed project's Adaptive Management Plan. Discussions between PG&E and NMFS/USFWS are currently ongoing regarding the coordination of the aerial surveys and the potential for NMFS/USFWS to undertake all aerial survey operations. More information regarding the NMFS/USFWS aerial survey operations are provided in Appendix D and E of the IHA application. Two PSO's will be used on all aerial surveys. Aerial survey data and observations noted by PSOs will be provided to the agencies for review and consideration of potential refinements to mitigation measures. The general purpose of these aerial survey efforts are to:

- Identify direction of travel and corridors utilized by marine mammals relative to the proposed survey area;
- Identify locations within the proposed survey area that support aggregations of marine mammals;
- Identify the relative abundance of marine mammals within the proposed survey area; and
- Document changes in the behavior and distribution of marine mammals in the area before, during and after the proposed seismic operations.

With the proposed timing of the seismic operations, aerial surveys will be conducted prior to the initiation of, during, and after the proposed project. The aerial surveys will pay particular attention will be directed to the identification of the presence of large cetaceans (i.e., blue, fin, and humpback whales) due to the likelihood that those species will be present in the project area. Aerial survey operations focused on large cetaceans will include the following components:

- Approximately 5 to 10 days prior to the start of seismic operations, an aerial survey will be flown to establish a baseline for numbers and distribution of marine mammals in the project area;

- Aerial surveys will be conducted weekly during the seismic operations to assist in the identification of marine mammals within the project buffer and exclusion zones. Aerial monitors will be in direct communications with ship-based monitors to assess the effectiveness of monitoring operations. Based on the results of these coordinated monitoring efforts, the need for additional aerial surveys will be evaluated; and

- Approximately 5 to 10 days following the completion of the offshore seismic operations, a final aerial survey will be conducted to document the number and distribution of marine mammals in the project area. These data will be used in comparison with original survey data completed prior to the seismic operations.

A copy of the draft Aerial Survey Plan, that focuses particular attention on the presence of large cetaceans, is provided in Appendix G of the IHA application.

#### 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 ramp-ups of the airguns at night. PSVOs will also watch for marine mammals near the seismic vessel for at least 30 minutes prior to the start of airgun operations after an extended shut-down (i.e., greater than approximately 8 minutes for this proposed cruise). When feasible, 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 exclusion zone. The exclusion zone is a region in which a possibility exists of adverse effects on animal hearing or other physical effects.

During seismic operations off the central coast of California, at least five PSOs (PSVO and/or Protected Species Acoustic Observer [PSAO]) will be based aboard the *Langseth*. In addition, three PSO's will be positioned on each of the survey/chase vessels (which at this time is anticipated to be two vessels). L-DEO will appoint the PSOs with NMFS's concurrence. Observations



will take place during ongoing daytime operations and nighttime ramp-ups of the airguns. During the majority of seismic operations, two PSVOs will be on duty from the observation tower (i.e., the best available vantage point on the source vessel) to monitor marine mammals near the seismic vessel. Use of two simultaneous PSVOs will increase the effectiveness of detecting animals near the source vessel. However, during meal times and bathroom breaks, it is sometimes difficult to have two PSVOs on effort, but at least one PSVO will be on duty. PSVO(s) will be on duty in shifts no longer than 4 hours in duration.

Two PSVOs will also be on visual watch during all daytime ramp-ups of the seismic airguns. A third PSAO 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 PSAO on PAM. Other crew will also be instructed to assist in detecting marine mammals and implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew will be given additional instruction on how to do so.

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 PSVO 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 x 50 Fujinon), Big-eye binoculars (25 x 150), and with the naked eye. 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.

When marine mammals are detected within or about to enter the designated exclusion zone, the airguns will immediately be powered-down or shut-down if necessary. The PSVO(s) will continue to maintain watch to determine when the animal(s) are outside the exclusion zone by visual confirmation. Airgun operations will not resume until the animal is confirmed to have left the exclusion zone, or if not observed after 15 minutes for species with shorter dive durations (small odontocetes and pinnipeds) or 30 minutes for species with longer dive

durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales).

#### Vessel-Based Passive Acoustic Monitoring

Vessel-based, towed 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. Passive acoustical monitoring can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. The passive 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 PSVOs can be advised when cetaceans are detected.

The PAM system consists of hardware (i.e., hydrophones) and software. The "wet end" of the system consists of a towed hydrophone array that is connected to the vessel by a tow cable. The tow cable is 250 m (820.2 ft) long, and the hydrophones are fitted in the last 10 m (32.8 ft) of cable. A depth gauge is attached to the free end of the cable, and the cable is typically towed at depths less than 20 m (65.6 ft). The array will be deployed from a winch located on the back deck. A deck cable will connect from the winch to the main computer laboratory where the acoustic station, signal conditioning, and processing system will be located. The acoustic signals received by the hydrophones are amplified, digitized, and then processed by the Panguard software. The system can detect marine mammal vocalizations at frequencies up to 250 kHz.

One PSAO, an expert bioacoustician in addition to the four PSVOs, with primary responsibility for PAM, will be onboard the *Langseth*. The towed hydrophones will ideally be monitored by the PSAO 24 hours per day while at the proposed seismic survey area during airgun operations, and during most periods when the *Langseth* is underway while the airguns are not operating. However, PAM may not be possible if damage occurs to the array or back-up systems during operations. 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. One PSAO will monitor the acoustic detection system by listening to the signals from two channels via headphones and/or speakers and watching the real-time spectrographic display for frequency ranges produced by cetaceans. The PSAO monitoring the acoustical data will be on shift for one to six hours at a time. All PSOs are expected to rotate through the PAM position, although the expert PSAO will be on PAM duty more frequently.

When a vocalization is detected while visual observations (during daylight) are in progress, the PSAO will contact the 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. When bearings (primary and mirror-image) to calling cetacean(s) are determined, the bearings will be related to the PSVO(s) to help him/her sight the calling animal. During non-daylight hours, when a cetacean is detected by acoustic monitoring and may be close to the source vessel, the *Langseth* crew will be notified immediately so that the proper mitigation measure may be implemented.

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.

#### PSO 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 exclusion zone. Observations will also be made during daytime periods when the *Langseth* is underway without seismic operations. There will also be opportunities to collect baseline

biological data during the transits to, from, and through the study area.

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 ramp-ups, power-downs or shut-downs will be recorded in a standardized format. The PSOs will record this information onto datasheets. During periods between watches and periods when operations are suspended, those data will be entered into a laptop computer running a custom computer 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. Quality control of the data will be facilitated by (a) The start-of survey training session; (b) subsequent supervision by the onboard lead PSO; and (c) ongoing data checks during the seismic survey.

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 in the area where the seismic study is conducted.

4. Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity.

5. Data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity.

Throughout the seismic survey, PSOs will prepare a report each day or at such

other intervals as required by NMFS, USFWS, the U.S. Army Corps of Engineers, California State Lands Commission, California Coastal Commission, or PG&E, summarizing the recent results of the monitoring program. The reports will summarize the species and numbers of marine mammals sighted. These reports will be provided to NMFS as well as PG&E, L-DEO, and NSF.

In addition to the vessel-based monitoring, L-DEO and PG&E will submit reports outlining the monitoring results of the aerial survey for large cetaceans, the aerial survey for harbor porpoises and other small cetaceans, and any marine mammals stranding response activities.

L-DEO and PG&E will submit a comprehensive 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 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 (i.e., dates, times, locations, activities, associated seismic survey activities, and associated PAM detections). The report will minimally include:

- Summaries of monitoring effort—total hours, total distances, and distribution of marine mammals through the study period accounting for sea state and other factors affecting visibility and detectability of marine mammals;
- Analyses of the effects of various factors influencing detectability of marine mammals including sea state, number of PSOs, and fog/glare;
- Species composition, occurrence, and distribution of marine mammals sightings including date, water depth, numbers, age/size/gender, and group sizes; and analyses of the effects of seismic operations;
- Sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability);
- Initial sighting distances versus airgun activity state;
- Closes point of approach versus airgun activity state;
- Observed behaviors and types of movements versus airgun activity state;
- Numbers of sightings/individuals seen versus airgun activity state; and
- Distribution around the source vessel versus airgun activity state.

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. After the report is considered final, it will be publicly available on the NMFS and NSF Web sites at: <http://www.nmfs.noaa.gov/pr/permits/incidental.htm#iha> and <http://www.nsf.gov/geo/oce/encomp/index.jsp>.

#### **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].

Level B harassment is anticipated and proposed to be authorized as a result of the proposed marine seismic survey off the central coast of California. Acoustic stimuli (i.e., increased underwater sound) generated during the operation of the seismic airgun array are expected to result in the behavioral disturbance of some marine mammals, and potentially the temporary displacement of some of the Morro Bay stock of harbor porpoises from their preferred, or core, habitat area. There is no evidence that the planned activities could result in injury, serious injury, or mortality for which L-DEO and PG&E seeks the IHA. The required mitigation and monitoring measures will minimize any potential risk for injury, serious injury, or mortality.

The following sections describe L-DEO and PG&E’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 seismic program along the central coast of California. The estimates are based on a consideration of the number of marine mammals that could be harassed by seismic operations with the 18 airgun array to be used. The size of the proposed 3D seismic survey area in 2012 is approximately 740.52 km<sup>2</sup> (285.9 nmi<sup>2</sup>) and located adjacent to the coastline and extending from 11 to 21 km (5.9 to 11.3 nmi) offshore, as depicted in Figure 2 of the IHA application.

L-DEO and PG&E assume that, during simultaneous operations of the airgun array and the other sources, any marine mammals close enough to be affected by the multibeam echosounder and sub-

bottom profiler 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 multibeam echosounder and sub-bottom profiler 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 and PG&E provide no additional allowance for animals that could be affected by sound sources other than airguns.

Density estimates are based on the best available peer-reviewed scientific data, specifically, the NMFS online marine mammal database (Barlow *et al.*, 2009). These data are supplemented with non-published survey data obtained from the proposed project area during an earlier low-energy 3D survey (Padre Associates, Inc., 2011b). The low-energy 3D seismic surveys were conducted on 76 days between October 24, 2010 and February 5, 2011. The principal source of density information is the Strategic Environmental Research and Development Program (SERDP)–SDSS Marine Animal Model Mapper on the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS–SEAMAP) Web site (Barlow *et al.*, 2009), which was recommended by NMFS staff at the Southwest Regional Office. A second density dataset was prepared by Padre Associates, Inc. (2011b) based on marine mammal sightings recorded during a seismic survey conducted between October, 2010 and February, 2011. The Padre Associates, Inc. dataset is from the southern portion of the proposed survey area, and contained densities for marine mammal species for which data were sparse or absent from the NOAA database.

The Padre Associates, Inc. dataset was compiled from a series of daily marine mammal monitoring reports, and the data were not originally collected for the

purposes of developing density estimates. Further, all survey data are subject to detectability and availability biases. Detectability bias is associated with diminishing sightability of marine mammals with increasing lateral distances from the survey trackline ( $f(0)$ ). Availability bias is due to the fact that not all marine mammals are at the surface at all times, and, as such, there is less than 100 percent probability of detecting animals along the survey trackline  $f(0)$ , and it is measured by  $g(0)$ .

Within Table 3 (Tables 7 and 8 of the IHA application), marine mammal densities were calculated based on available density or survey data. PG&E and the NMFS Office of Protected Resources worked with the NMFS Southwest Fisheries Science Center (SWFSC) and Southwest Regional Office to identify the preferred method of acquiring density data was the SERDP sponsored by the Department of Defense (DOD) with mapping provided by OBIS–SEAMAP. Within the mapping program density data are available by strata or density models (indicated with a superscripted lower case “a” (a)).

For density models, the Geographic Information Systems (GIS) shapefile of the proposed project area (tracklines [referred to as “race track” in the IHA application] with the 160 dB buffer zone) was uploaded into the program and densities for the ensonified area were calculated using available NMFS data within the uploaded project area. Density data calculated using this method was indicated with a superscript “1” (1). All densities calculated using this model were from summer data (defined as July to December). For density data indicated with a superscript “2” (2), stratum density data was used within the same SERDP marine mammal mapper; however, a different layer of the mapping program were utilized. The stratum layer provides limited density data for the region the species occurs within. This density number within the stratum layer is static for the region.

For Padre Associates, Inc. densities indicated with an uppercase superscript “B” (B), data were acquired between October, 2010 and February, 2011 during seismic surveys. The data used to acquire the densities were collected from daily monitoring logs where species were observed and recorded when navigating survey tracklines and transiting to and from the survey area. The density was calculated based on a 305 m (1,000 ft) visibility in each direction of the observer/vessel by the distance of tracklines or transits conducted during the survey period. These density data were used as supplemental information based on the lack of density models of species within the SERDP.

For harbor porpoise density data indicated with superscripted “c” (c), NMFS SWFSC staff worked with NMFS Office of Protected Resources to construct fine-scale density estimates based on aerial surveys of the central coast conducted between 2002 and 2011. NMFS SWFSC provided latitude coordinates of density changes for the harbor porpoise were inserted into GIS to delineate the associated polygon within the project survey boxes. The corrected density data were extracted for the project site within the 160 dB ensonified areas of Survey Boxes 2 and 4. The density data are variable based on the location within the project site, with the San Luis Bay having the highest density. Because of the variable densities used to extract the estimated number of individuals within the project site, the densities within Tables 7 and 8 of the IHA application are broad categorical densities for their corresponding survey box. Additionally, the offshore portion (greater than 92 m [301.8 ft]) of the harbor porpoise density is a stock-wide density used in Caretta *et al.* (2009) and also within the data provided by the NMFS SWFSC. An additional figure illustrating the fine scale densities used to calculate the take numbers is available in Appendix B of the IHA application.

TABLE 3—ESTIMATED DENSITIES OF MARINE MAMMAL SPECIES IN THE PROPOSED SURVEY OFF THE CENTRAL COAST OF CALIFORNIA, NOVEMBER TO DECEMBER, 2012

Species	NOAA density <sup>a</sup> (#/km <sup>2</sup> )		Padre Associates, Inc. density <sup>b</sup> (#/km <sup>2</sup> )	
	Box 2 minimum maximum mean	Box 4 minimum maximum mean	Transit	Transect
Mysticetes:				
North Pacific right whale <sup>2</sup> .....	0.000061 .....	0.000061 .....	NA .....	NA.
	0.000061 .....	0.000061 .....		
	0.000061 .....	0.000061 .....		

TABLE 3—ESTIMATED DENSITIES OF MARINE MAMMAL SPECIES IN THE PROPOSED SURVEY OFF THE CENTRAL COAST OF CALIFORNIA, NOVEMBER TO DECEMBER, 2012—Continued

Species	NOAA density <sup>a</sup> (#/km <sup>2</sup> )		Padre Associates, Inc. density <sup>b</sup> (#/km <sup>2</sup> )	
	Box 2 minimum maximum mean	Box 4 minimum maximum mean	Transit	Transect
Gray whale .....	NA .....	NA .....	0.0154 .....	0.0211.
	NA .....	NA .....		
	NA .....	NA .....		
Humpback whale <sup>1</sup> .....	0.000088 .....	0.00117 .....	0.0028 .....	0.0065.
	0.005781 .....	0.00635 .....		
	0.002349 .....	0.003243 .....		
Minke whale <sup>2</sup> .....	0.000276 .....	0.000276 .....	0.0007 .....	0.0008.
	0.000276 .....	0.000276 .....		
	0.000276 .....	0.000276 .....		
Sei whale <sup>2</sup> .....	0.000086 .....	0.000086 .....	NA .....	NA.
	0.000086 .....	0.000086 .....		
	0.000086 .....	0.000086 .....		
Fin whale <sup>1</sup> .....	0.000142 .....	0.00239 .....	NA .....	NA.
	0.01083 .....	0.0113 .....		
	0.004385 .....	0.006177 .....		
Blue whale <sup>1</sup> .....	0.0001 .....	0.001254 .....	NA .....	NA.
	0.006603 .....	0.006777 .....		
	0.002652 .....	0.003579 .....		
Odontocetes:				
Sperm whale <sup>1</sup> .....	0.000009 .....	0.000187 .....	NA .....	NA.
	0.000723 .....	0.000768 .....		
	0.000297 .....	0.000436 .....		
<i>Kogia</i> spp. (Pygmy and dwarf sperm whale) <sup>2</sup> .	0.001083 .....	0.001083 .....	NA .....	NA.
	0.001083 .....	0.001083 .....		
	0.001083 .....	0.001083 .....		
Baird's beaked whale <sup>1</sup> .....	0.000016 .....	0.000244 .....	NA .....	NA.
	0.001148 .....	0.001148 .....		
	0.000467 .....	0.000638 .....		
Small ( <i>Mesoplodon</i> and Cuvier's) beaked whale <sup>1c</sup> .	0.000042 .....	0.000813 .....	NA .....	NA.
	0.003347 .....	0.003422 .....		
	0.001363 .....	0.001952 .....		
Bottlenose dolphin <sup>2</sup> .....	Coastal <sup>4</sup> .....	Coastal <sup>4</sup> .....	NA .....	NA.
	0.361173 .....	0.361173 .....		
	0.361173 .....	0.361173 .....		
	0.361173 .....	0.361173 .....		
	Offshore—Winter .....	Offshore—Winter .....		
	0.000616 .....	0.000616 .....		
	0.000616 .....	0.000616 .....		
	0.000616 .....	0.000616 .....		
Striped dolphin <sup>1</sup> .....	0.000039 .....	0.000943 .....	NA .....	0.0081.
	0.0033 .....	0.003448 .....		
	0.001379 .....	0.002075 .....		
Short-beaked common dolphin <sup>1</sup> .....	0.01203 .....	0.1612 .....	0.0252 .....	0.0836.
	0.8019 .....	0.8285 .....		
	0.3252 .....	0.4443 .....		
Long-beaked common dolphin <sup>2</sup> .....	0.018004 .....	0.018004 .....	NA .....	NA.
	0.018004 .....	0.018004 .....		
	0.018004 .....	0.018004 .....		
Pacific white-sided dolphin <sup>1</sup> .....	0.001027 .....	0.01856 .....	NA .....	NA.
	0.08342 .....	0.0896 .....		
	0.03364 .....	0.04786 .....		
Northern right whale dolphin <sup>1</sup> .....	0.00066 .....	0.0112 .....	NA .....	NA.
	0.0503 .....	0.05254 .....		
	0.02038 .....	0.02867 .....		
Risso's dolphin <sup>1</sup> .....	0.000672 .....	0.007767 .....	0.0063 .....	0.2881.
	0.04279 .....	0.04545 .....		
	0.001721 .....	0.02316 .....		
Killer whale <sup>2</sup> .....	Summer .....	Summer .....	Summer NA .....	Summer NA.
	0.000709 .....	0.000709 .....		
	0.000709 .....	0.000709 .....		
	0.000709 .....	0.000709 .....		
	Winter .....	Winter .....	Winter NA .....	Winter 0.0016.
	0.000246 .....	0.000246 .....		
	0.000246 .....	0.000246 .....		
	0.000246 .....	0.000246 .....		
Short-finned pilot whale <sup>2</sup> .....	0.000307 .....	0.000307 .....	NA .....	NA.
	0.000307 .....	0.000307 .....		
	0.000307 .....	0.000307 .....		

TABLE 3—ESTIMATED DENSITIES OF MARINE MAMMAL SPECIES IN THE PROPOSED SURVEY OFF THE CENTRAL COAST OF CALIFORNIA, NOVEMBER TO DECEMBER, 2012—Continued

Species	NOAA density <sup>a</sup> (#/km <sup>2</sup> )		Padre Associates, Inc. density <sup>b</sup> (#/km <sup>2</sup> )	
	Box 2 minimum maximum mean	Box 4 minimum maximum mean	Transit	Transect
Harbor porpoise <sup>3</sup>	Morro Bay Inshore ..... 0.43 ..... 4.17 ..... 1.83 .....	Morro Bay Inshore ..... 0.43 ..... 1.42 ..... 1.22 .....	Morro Bay Inshore 0.0259.	Morro Bay Inshore 0.0016
	Morro Bay Offshore ... 0.062 ..... 0.062 ..... 0.062 .....	Morro Bay Offshore ... 0.062 ..... 0.062 ..... 0.062 .....	Morro Bay Offshore NA.	Morro Bay Offshore NA
Dall's porpoise <sup>1</sup>	0.000441 ..... 0.03504 ..... 0.01433 .....	0.008552 ..... 0.0396 ..... 0.0209 .....	NA .....	0.0081.
Pinnipeds:				
California sea lion	NA ..... NA ..... NA .....	NA ..... NA ..... NA .....	NA .....	NA.
Steller sea lion	NA ..... NA ..... 0.00001 .....	NA ..... NA ..... 0.00001 .....	NA .....	NA.
Guadalupe fur seal	NA ..... NA ..... 0.00001 .....	NA ..... NA ..... 0.00001 .....	NA .....	NA.
Northern fur seal	NA ..... NA ..... 0.00001 .....	NA ..... NA ..... 0.00001 .....	NA .....	NA.
Northern elephant seal	NA ..... NA ..... 0.00001 .....	NA ..... NA ..... 0.00001 .....	NA .....	NA.
Pacific harbor seal	NA ..... NA ..... NA .....	NA ..... NA ..... NA .....	0.0166 .....	0.0089.

NA = Not available or not assessed.

<sup>a</sup>Barlow *et al.* (2009) average density used in calculation.

<sup>1</sup>Density data based on density models of survey area in SERDP program.

<sup>2</sup>Density data based on stratums within SERDP program.

<sup>3</sup>Density data from Caretta *et al.* (2009).

<sup>4</sup>Density data based on stratums within SERDP program with only area ensonified within 1 km from shore calculated.

<sup>b</sup>Padre Associates, Inc. (2011b) (Highest density between transit and track data used).

<sup>c</sup>SERDP Marine Mammal Mapper categorizes small beaked whales as both *Mesoplodon* and *Ziphiidae* genera; whereas, the NMFS Stock Assessment Report has *Ziphiidae* genera whale as their own species assessment and combines only *Mesoplodon* species together.

The proposed 3D survey area varies by survey box (see Table 3 or Table 6 of the IHA application). The anticipated area ensonified by the sound levels of greater than or equal to 160 dB (rms), based on the calculations provided by Greeneridge Scientific, Inc., is a 6.21 km (3.35 nmi) radius extending from each point of the survey area perimeter

(hereafter called the buffer zone). This results in a maximum total area as shown in Table 3 (Table 6 and depicted on Figures 11 to 12 of the IHA application). The approach for estimating take by Level B harassment (described in more detail below) was taken because closely spaced survey tracklines and large cross-track

distances of the greater than or equal to 160 dB (rms) radii result in repeated exposure of the same area of water. Excessive amounts of repeated exposure probably results in an overestimate of the number of animals "taken" by Level B harassment.

TABLE 4—SURVEY AREAS AND SURVEY AREAS WITH 160 dB BUFFER ZONE

Survey box	Survey area (km <sup>2</sup> [nmi <sup>2</sup> ])	Survey area with 160 dB buffer zone (km <sup>2</sup> [nmi <sup>2</sup> ])
2 .....	406.0 (118.4)	1,272.3 (370.9)
4 .....	334.5 (97.5)	784.5 (228.7)

L-DEO and PG&E 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 (rms) 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 repeat 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, excluding areas of overlap. Some individuals may be exposed multiple times since the survey tracklines are spaced close together, however, 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 (rms) was calculated by multiplying:

(1) The expected species density (in number/km<sup>2</sup>), times

(2) The anticipated area (in Survey Boxes 2 and 4 separately) to be ensonified to that level during airgun operations excluding overlap.

Areas of overlap within each survey box (because of lines being closer together than the 160 dB radius) were combined into one ensonified area estimate and included only once when estimating the number of individuals exposed. However, the full area of each of the two survey boxes were separately used in the take calculations as described below.

Applying the approach described above, approximately 1,237 km<sup>2</sup> (360.7 nmi<sup>2</sup>) for Survey Box 2 and 784.5 km<sup>2</sup> (228.7 nmi<sup>2</sup>) for Survey Box 4 would be within the 160 dB isopleth on one or more occasions during the survey. The take calculations within a given survey box do not explicitly add animals to account for the fact that new animals are not accounted for in the initial density snapshot and animals could also approach and enter the area ensonified above 160 dB; however, studies suggest that many marine mammals will avoid exposing themselves to sounds at this

level, which suggests that there would not necessarily be a large number of new animals entering the area once the seismic survey started. Additionally, separate take estimates were calculated for each survey box, and the two survey boxes do overlap over a relatively large area. This approach for calculating take estimates considers the fact that new animals could have moved into the area, which means that it also considers the fact that new animals could have moved into the area in the time between the end of Survey Box 4 seismic operations and the beginning of Survey Box 2 seismic operations.

L-DEO and PG&E's estimates of exposures to various sound levels assume that the proposed surveys will be carried out in full (i.e., approximately 10 and 14 days of seismic airgun operations for Survey Box 4 and Survey Box 2, respectively), however, the ensonified areas calculated using the planned number of line-kilometers have been increased by 25% to accommodate lines that may need to be repeated, equipment testing, account for repeat exposure, etc. As is typical during offshore ship surveys, inclement weather and equipment malfunctions are likely to cause delays and may limit the number of useful line-kilometers of seismic operations that can be undertaken.

Table 5 (Table 7 and 8 of the IHA application) shows the estimates of the number of different individual marine mammals anticipated to be exposed to greater than or equal to 160 dB re 1 μPa (rms) during the seismic survey. For the species that a density was not reported (Barlow *et al.*, 2009), a minimum

density of (0.00001/km<sup>2</sup>) was used for low probability for chance encounters.

The estimate of the number of individual cetaceans and pinnipeds that could be exposed to seismic sounds with received levels greater than or equal to 160 dB re 1 μPa (rms) during the proposed survey is 2,329 and 511, respectively (2,606 and 639 with 25% contingency) (see Table 14 of the IHA application). That total (with 25% contingency) includes 83 baleen whales, with estimates of 55 gray, 7 humpback, 13 fin, and 8 blue whales, which should represent 0.3, 0.3, 0.4, and 0.3% of the affected populations or stocks, respectively. In addition, 3 dwarf/pygmy sperm whales, 5 killer whales, and 6 beaked whales, (including Cuvier's, Baird's, and *Mesoplodon* beaked whales) could be taken by Level B harassment during the proposed seismic survey. Most of the cetaceans potentially taken by Level B harassment are delphinids; short-beaked common, long-beaked common, Pacific white-sided, northern right whale, bottlenose, and Risso's dolphins, and harbor and Dall's porpoises are estimated to be the most common species in the area, with estimates of 953, 47, 100, 60, 40, 50, 1,513, and 43, which would represent 0.2, 0.2, 0.4, 0.7, 0.1/9.6, 0.8, 74, 0.1% of the regional populations or stocks, respectively. The most common pinniped species estimated to be potentially taken by Level B harassment are California sea lions and Pacific harbor seals, with estimates of 597 and 34, which would represent 0.2 and 0.1% of the affected populations or stocks, respectively.

TABLE 5—ESTIMATES OF THE POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO SOUND LEVELS ≥160 dB DURING L-DEO AND PG&E'S PROPOSED SEISMIC SURVEYS OFF THE CENTRAL COAST OF CALIFORNIA DURING NOVEMBER TO DECEMBER, 2012

Species	Requested take authorization [i.e., estimated number of individuals exposed to sound levels ≥ 160 dB re 1 μPa] for Box 2 Box 4 (total for Boxes 2 and 4)	Requested take authorization with additional 25% for Box 2 Box 4 (total for Boxes 2 and 4)	Approximate percentage of best population estimate of stock (with additional 25%) <sup>1</sup>
Mysticetes:			
North Pacific right whale .....	0 .....	0 .....	0 (0).
	0 .....	0.	
	(0) .....	(0).	
Gray whale .....	27 .....	.....	0.2 (0.3).
	17 .....	34	
	(44) .....	21.	
		(55).	
Humpback whale .....	3 .....	4 .....	0.3 (0.3).
	3 .....	3.	
	(6) .....	(7).	
Minke whale .....	0 .....	0 .....	0 (0.0).
	0 .....	0.	
	(0) .....	(0).	

TABLE 5—ESTIMATES OF THE POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO SOUND LEVELS ≥160 dB DURING L-DEO AND PG&E'S PROPOSED SEISMIC SURVEYS OFF THE CENTRAL COAST OF CALIFORNIA DURING NOVEMBER TO DECEMBER, 2012—Continued

Species	Requested take authorization [i.e., estimated number of individuals exposed to sound levels ≥ 160 dB re 1 μPa] for Box 2 Box 4 (total for Boxes 2 and 4)	Requested take authorization with additional 25% for Box 2 Box 4 (total for Boxes 2 and 4)	Approximate percentage of best population estimate of stock (with additional 25%) <sup>1</sup>
Fin whale	6 5 (11)	7 6 (13)	0.4 (0.4).
Sei whale	0 0 (0)	0 0 (0)	0 (0).
Blue whale	3 3 (6)	4 4 (8)	0.2 (0.3).
Odontocetes:			
Sperm whale	0 0 (0)	0 0 (0)	0 (0).
<i>Kogia</i> spp. (Pygmy and dwarf sperm whale)	1 1 (2)	2 1 (3)	0.3 (0.5)—Pygmy sperm whale NA—Dwarf sperm whale.
Baird's beaked whale	1 1 (2)	1 1 (2)	0.2 (0.2).
Small beaked whale (Cuvier's and <i>Mesoplodon</i> beaked whale).	2 2 (4)	2 2 (4)	0.2 (0.2)—Cuvier's beaked whale 0.3 (0.3)— <i>Mesoplodon</i> beaked whale.
Bottlenose dolphin	14—Coastal 1—Offshore Winter 17—Coastal 0—Offshore Winter (31—Coastal) (1—Offshore Winter)	18—Coastal 1 Offshore Winter 21—Coastal 0—Offshore Winter (39—Coastal) (1—Offshore Winter)	0.1 (0.1)—CA/OR/WA stock 9.6 (12.1)—California Coastal stock.
Striped dolphin	2 2 (4)	2 2 (4)	<0.1 (<0.1).
Short-beaked common dolphin	414 349 (763)	517 436 (953)	0.2 (0.2).
Long-beaked common dolphin	23 14 (37)	29 18 (47)	0.1 (0.2).
Pacific white-sided dolphin	43 38 (81)	53 47 (100)	0.3 (0.4).
Northern right whale dolphin	26 22 (48)	32 28 (60)	0.6 (0.7).
Risso's dolphin	22 18 (40)	27 23 (50)	<0.6 (0.8).
Killer whale	2 1 (3) 3 2 (5).	1.2 (2.1)—Eastern North Pacific Offshore stock. 0.9 (1.5)—Eastern North Pacific Transient stock. 0.9 (1.4)—West Coast Transient stock..	
Short-finned pilot whale	0 0 (0)	0 0 (0)	0.0 (0.0).
Harbor porpoise	895 315 (1,210)	1,119 394 (1,513)	59.2 (74).
Dall's porpoise	18 16 (34)	23 20 (43)	0.1 (0.1).
Pinnipeds:			

TABLE 5—ESTIMATES OF THE POSSIBLE NUMBERS OF MARINE MAMMALS EXPOSED TO SOUND LEVELS ≥160 dB DURING L-DEO AND PG&E'S PROPOSED SEISMIC SURVEYS OFF THE CENTRAL COAST OF CALIFORNIA DURING NOVEMBER TO DECEMBER, 2012—Continued

Species	Requested take authorization [i.e., estimated number of individuals exposed to sound levels ≥ 160 dB re 1 μPa] for Box 2 Box 4 (total for Boxes 2 and 4)	Requested take authorization with additional 25% for Box 2 Box 4 (total for Boxes 2 and 4)	Approximate percentage of best population estimate of stock (with additional 25%) <sup>1</sup>
California sea lion	295 182 (477)	369 228. (597).	0.2 (0.2).
Steller sea lion	0 0 (0)	0 0. (0).	0 (0).
Guadalupe fur seal	0 0 (0)	0 0. (0).	0 (0).
Northern fur seal	0 0 (0)	0 0. (0).	0 (0).
Northern elephant seal	0 0 (0)	0 0. (0).	(0).
Pacific harbor seal	21 13 (34)	26 16. (42).	0.1 (0.1).

NA = Not available or not assessed.

<sup>1</sup> Stock sizes are best populations from NMFS Stock Assessment Reports (see Table 2 in above).

**Encouraging and Coordinating Research**

L-DEO and PG&E will cooperate with external entities (i.e., agencies, universities, non-governmental organizations) to manage, understand, and communicate information about environmental impacts related to the seismic activities provided an acceptable methodology and business relationship can be agreed upon. PG&E is currently working with a number of agencies and groups to implement monitoring programs to address potential short-term and long-term effects on marine resources within the project area. These study programs include:

- Monitoring activities associated with the California Department of Fish and Game Scientific Collection Permit for Point Buchon Marine Protected Area;
- Nature Conservancy Remotely Operated Vehicle (ROV) Monitoring Program;
- California Collaborative Fisheries Research Program;

**Negligible Impact 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 evaluated factors such as:

- (1) The number of anticipated injuries, serious injuries, or mortalities;
- (2) The number, nature, and intensity, and duration of Level B harassment (all relatively limited); and
- (3) The context in which the takes occur (i.e., impacts to areas of significance, impacts to local populations, and cumulative impacts when taking into account successive/ contemporaneous actions when added to baseline data);
- (4) The status of stock or species of marine mammals (i.e., depleted, not depleted, decreasing, increasing, stable, impact relative to the size of the population);
- (5) Impacts on habitat affecting rates of recruitment/survival; and
- (6) The effectiveness of monitoring and mitigation measures.

As described above and based on the following factors, the specified activities associated with the marine seismic survey are not likely to cause PTS, or other non-auditory injury, serious injury, or death. The factors include:

- (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 potential for temporary or permanent hearing impairment is relatively low and would likely be

avoided through the implementation of the power-down and shut-down measures;

(3) The Morro Bay Stock of Harbor Porpoise Monitoring Plan and Stranding Response Plan will provide real-time data (via aerial surveys and beach monitors) allowing for the early detection of marine mammal (and especially harbor porpoise) behaviors that may indicate an increased potential for stranding. This information will be used to modify, in real-time, any aspect of the activity that could contribute to a marine mammal stranding (e.g., suspension of seismic airgun operations) and the additional evaluation of the situation that will minimize the likelihood of injury or death resulting from the proposed activity;

(4) The Morro Bay stock of Harbor Porpoise Monitoring Plan will also use a combination of aerial and acoustic data to detect whether moderate to large numbers of harbor porpoises have been displaced from their core habitat which could result in serious energetic impacts to individuals if it continued longer than a short time. This information will be used to modify, in real-time, any aspect of the activity (e.g., suspension of seismic airgun operations) that could result in impacts of a more serious nature (e.g., mortality);

No injuries, serious injuries, or mortalities are anticipated to occur as a result of the L-DEO and PG&E's



planned marine seismic surveys, and none are proposed to be authorized by NMFS. Table 5 of this document outlines the number of requested Level B harassment takes that are anticipated as a result of these activities. Due to the nature, degree, and context of Level B (behavioral) harassment anticipated and described (see "Potential Effects on Marine Mammals" section above) in this notice, the activity is not expected to impact rates of annual recruitment or survival for any affected species or stock, particularly given the NMFS and the applicant's proposal to implement a rigorous mitigation, monitoring, and stranding response plans to minimize impacts to the Morro Bay stock of harbor porpoise.

The proposed seismic operations will occur throughout a large portion of the range of the Morro Bay stock of harbor porpoises (i.e., Point Sur to Point Conception, California), and cover much of the core range and optimal habitat for this stock for the duration of the seismic survey. Sighting rates outside of the operational area are much lower, indicating sub-optimal habitat. Studies have shown that harbor porpoises are sensitive to underwater sound and will move long distances away from a loud sound source; and the Morro Bay stock may be forced to move to sub-optimal habitat at the ends of (North or South), or outside their normal range for days to weeks, which may affect foraging success which could in turn have energetic impacts that effect reproduction or survival. This is a coastal species that is primarily found in shallow water within the approximate 100 m (328 ft) isobath and does not move offshore as this is not suitable habitat, and the seismic airgun operations will ensonify a large area that reaches from land to offshore past where harbor porpoises are typically found. This small-bodied species has a high metabolic rate (Spitz *et al.*, 2010) requiring regular caloric intake to maintain fitness and health; therefore, there is a potential for adverse health effects if an animal were forced into an area offering sub-optimal habitat for an extended period of time.

The November to December, 2012, timeframe of the seismic operations will avoid the peak of their breeding season and after the first few months that are critical to nursing mothers and dependent calves. The phased approach, as suggested by NMFS and agreed to by the applicant, of conducting seismic operations within the survey boxes (i.e., Survey Box 4 first, Survey Box 2 second in 2012) over multiple years (i.e., Survey Box 1 planned for 2013) has significantly

reduced the anticipated energetic impacts within a given year by spreading them over two years. Further, the required monitoring plans will allow us to assess the degree to which, and in part the amount of time, harbor porpoises may be displaced from their core habitat (and potentially crowded into sub-optimal habitat and adjust, in real time L-DEO and PG&E's activity to minimize the likelihood of population level effects. Silent periods (i.e., no active use of airguns) between conducting seismic operations for Survey Box 4 and Survey Box 2 should allow any displaced animals to return to optimal habitat for foraging and feeding that are necessary for reproduction, nursing, and survivorship; and the required monitoring will allow NMFS to detect whether or not this happens and make a decision about whether PG&E may conduct the second survey (i.e., Survey Box 2) this year.

For the other marine mammal species that may occur within the proposed action area, there are no known designated or important feeding and/or reproductive areas. The gray whale, which has an annual migration route along the coastline, has the potential to occur in the action area during the proposed seismic survey. The southward migration along the West Coast of North America from summer feeding areas in the north generally occurs from November/December through February, while the northward migration from winter breeding areas in the south generally occurs from mid-February through May (with a peak in March). During the southward migration, animals do not approach as close to the coastline and the area of the seismic surveys than they would during the northward migration (especially cows and calves). The proposed end of the seismic survey is designed to coincide with the approximate start of the peak of the annual southward gray whale migration (December 15, 2012), therefore most of the animals will start traveling through after the seismic operations have concluded. Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (i.e., 24 hr cycle). Behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.*, 2007). While seismic operations are anticipated to occur on consecutive days, they are broken into two sections of approximately 10 and 14 days, and

the monitoring and mitigation is designed such that if serious impacts of a nature expected to have adverse effects on reproduction or survival were detected and thought to be occurring to a significant number of individuals, the second portion of the survey would proceed. Additionally, the seismic survey will be increasing sound levels in the marine environment in a relatively small area surrounding the vessel (compared to the range of the animals), which is constantly travelling over distances, and some animals may only be exposed to and harassed by sound for shorter less than day.

Of the 36 marine mammal species under NMFS jurisdiction that are known to or likely to occur in the study area, eight are listed as threatened or endangered under the ESA: North Pacific right, humpback, sei, fin, blue, and sperm whales as well as Steller sea lions and Guadalupe fur seals. These species are also considered depleted under the MMPA. Of these ESA-listed species, incidental take has been requested to be authorized for humpback, fin, blue, and sperm whales. There is generally insufficient data to determine population trends for the other depleted species in the study area. To protect these animals (and other marine mammals in the study area), L-DEO and PG&E must cease or reduce airgun operations if animals enter designated zones. No injury, serious injury, or mortality is expected to occur and due to the nature, degree, and context of the Level B harassment anticipated, the activity is not expected to impact rates of recruitment or survival.

As mentioned previously, NMFS estimates that 25 species of marine mammals under its jurisdiction could be potentially affected by Level B harassment over the course of the IHA. The population estimates for the marine mammal species that may be taken by Level B harassment were provided in Table 5 of this document.

NMFS's practice has been to apply the 160 dB re 1  $\mu$ Pa (rms) received level threshold for underwater impulse sound levels to determine whether take by Level B harassment occurs. Southall *et al.* (2007) provide a severity scale for ranking observed behavioral responses of both free-ranging marine mammals and laboratory subjects to various types of anthropogenic sound (see Table 4 in Southall *et al.* [2007]).

NMFS has preliminarily determined, provided that the aforementioned mitigation and monitoring measures are implemented, that for species other than the Morro Bay stock of harbor porpoise, the impact of conducting a marine

seismic survey off the central coast of California, November to December, 2012, may result, at worst, in a modification in behavior and/or low-level physiological effects (Level B harassment) 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 for species other than the Morro Bay stock of harbor porpoises and the short and sporadic duration of the research activities, have led NMFS to preliminary determine that the taking by Level B harassment from the specified activity will have a negligible impact on the affected species in the specified geographic region. Although NMFS anticipates the potential for more serious impacts to harbor porpoises, as described above, NMFS believes that the reduced length of the seismic survey (accomplished through the splitting of the originally planned survey over a two year period), the requirement to implement mitigation measures (e.g., shut-down of seismic operations), and the inclusion of the comprehensive monitoring and stranding response plans, will reduce the amount and severity of the harassment from the activity to the degree that it will have a negligible impact on the Morro Bay stock of harbor porpoise.

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

Section 101(a)(5)(D) of the MMPA also requires NMFS to determine that the authorization will not have an unmitigable adverse effect on the availability of marine mammal species or stocks for subsistence use. There are no relevant subsistence uses of marine mammals in the study area (off the central coast of California) that implicate MMPA section 101(a)(5)(D).

#### **Endangered Species Act**

Of the species of marine mammals that may occur in the proposed survey area, several are listed as endangered under the ESA, including the North Pacific right, humpback, sei, fin, blue, and sperm whales. Two pinniped species, the Guadalupe fur seal and eastern stock of Steller sea lion are listed as threatened under the ESA. L-DEO and PG&E did not request take of endangered North Pacific right whales due to the low likelihood of encountering this species during the cruise. Under section 7 of the ESA, NSF has initiated formal consultation with the NMFS, Office of Protected Resources, Endangered Species Act Interagency Cooperation Division, on this proposed seismic survey. NMFS's Office of Protected Resources, Permits and Conservation Division, has initiated formal consultation under section 7 of the ESA with NMFS's Office of Protected Resources, Endangered Species Act Interagency Cooperation 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, NSF and L-DEO and PG&E, 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's Biological Opinion issued to both NSF and NMFS's Office of Protected Resources.

#### **National Environmental Policy Act**

With L-DEO and PG&E's complete application, NSF provided NMFS a draft "Environmental Assessment Pursuant to the National Environmental Policy Act, 42 U.S.C. 4321 *et seq.* Marine Seismic Survey in the Pacific Ocean off Central California, 2012," which incorporates a draft "Environmental Assessment of

Marine Geophysical Surveys by the R/V *Marcus G. Langseth* for the Central Coastal California Seismic Imaging Project," prepared by Padre Associates, Inc. on behalf of NSF, L-DEO, and PG&E. The EA analyzes the direct, indirect, and cumulative environmental impacts of the proposed specified activities on marine mammals including those listed as threatened or endangered under the ESA. Prior to making a final decision on the IHA application, NMFS will either prepare an independent EA, or, after review and evaluation of the NSF EA for consistency with the regulations published by the Council of Environmental Quality (CEQ) and NOAA Administrative Order 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act, adopt the NSF EA and make a decision of whether or not to issue a Finding of No Significant Impact (FONSI).

#### **Proposed Authorization**

NMFS proposes to issue an IHA to PG&E for conducting a marine seismic survey off the central coast of California, 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's 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: September 13, 2012.

**Helen M. Golde,**

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

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