diseases, mass coral bleaching induced by rising sea surface temperatures, and hurricanes occurring with escalating frequency and severity. The petition alleges these threats continue to occur and are accompanied by coastal development, boat and diver damage, siltation, damaging fishing practices, predation, competition, pollution, global climate change resulting in elevated sea surface temperatures, and inadequacy of regulatory mechanisms. The petition concludes that because of the interrelated nature and synergistic effects of these threats, addressing each threat individually will not be sufficient to preserve these species.

Petition Finding

Based on the above information and the criteria specified in 50 CFR 424.14(b)(2), NMFS finds that the petition presents substantial scientific and commercial information indicating listing of the three acroporids may be warranted. Under section 4(b)(3)(A) of the ESA, this finding requires NMFS to commence a status review on the three species. NMFS is now initiating this review. These three species are now considered to be candidate species (69 FR 19976; April 15, 2004). Within 1 year of the receipt of the petition (March 4, 2005), NMFS must make a finding as to whether listing the elkhorn coral, staghorn coral, or fused-staghorn coral as endangered or threatened under the ESA is warranted, as required by section 4(b)(3)(B) of the ESA. If warranted, NMFS will publish a proposed rule and take public comment before developing and publishing a final rule.

Listing Factors and Basis for Determination

Under section 4(a)(1) of the ESA, a species shall be listed if it is determined to be threatened or endangered as a result of any one of the following factors: (1) Present or threatened destruction, modification, or curtailment of habitat or range; (2) over-utilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or manmade factors affecting its continued existence. Listing determinations are made solely on the basis of the best scientific and commercial data available, after conducting a review of the status of the species and taking into account efforts made by any state or foreign nation to protect such species.

Information Solicited

To ensure the status review is completed in a timely manner and based on the best available scientific and commercial data, NMFS is soliciting information on whether the elkhorn coral, staghorn coral, or fused-staghorn coral are endangered or threatened based on the above listing factors. Specifically, NMFS is soliciting information in the following areas: (1) Historical and current distribution and abundance of these three acroporids throughout the Gulf of Mexico, tropical portions of the Atlantic Ocean, and the Caribbean Sea (specifically in the southern Bahamas), Nicaragua, Pedro Banks, northern Cuba, Virgin Gorda, Antigua, banks off Turks and Caicos, Saba Banks, Trinidad and Tobago, and eastern Caribbean; (2) historic and current condition; (3) population status and trends; (4) information on any current or planned activities that may adversely impact the three acroporids, especially related to the five listing factors identified above; and (5) ongoing efforts to protect the three acroporids and their habitat. NMFS requests that all information be accompanied by: (1) Supporting documentation such as maps, bibliographic references, or reprints of pertinent publications; and (2) the submitter's name, address, and any association, institution, or business that the person represents.

Critical Habitat

NMFS is also requesting information on areas that may qualify as critical habitat for the three acroporids. Areas that include the physical and biological features essential to the conservation of the species should be identified. Areas outside the present range should also be identified if such areas are essential to the conservation of the species. Essential features may include, but are not limited to: (1) space for individual growth and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for reproduction and development of offspring; and (5) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of the species (50 CFR 424.12(b)).

For areas potentially qualifying as critical habitat, NMFS requests information describing: (1) the activities that affect the essential features or that could be affected by the designation, and (2) the economic costs and benefits of management measures likely to result from the designation. NMFS is required to consider the probable economic and other impacts on proposed or ongoing activities in making a final critical habitat designation (50 CFR 424.19).

Peer Review

On July 1, 1994, NMFS, jointly with the U.S. Fish and Wildlife Service, published a series of policies regarding listings under the ESA, including a policy for peer review of scientific data (59 FR 34270). The intent of the peer review policy is to ensure listings are based on the best scientific and commercial data available. NMFS is soliciting the names of recognized experts in the field that could take part in the peer review process for this status review (see **ADDRESSES**). Independent peer reviewers will be selected from the academic and scientific community, tribal and other Native American groups, Federal and state agencies, the private sector, and public interest groups.

Authority: 16 U.S.C. 1531 *et seq.*

Dated: June 17, 2004.

William T. Hogarth,

Assistant Administrator for Fisheries, National Marine Fisheries Service.

[FR Doc. 04–14244 Filed 6–22–04; 8:45 am]

BILLING CODE 3510–22–S

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[I.D. 051704A]

Small Takes of Marine Mammals Incidental to Specified Activities; Marine Seismic Survey in the Gulf of Alaska, Northeastern Pacific Ocean

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

ACTION: Notice of receipt of application and proposed incidental take authorization; request for comments.

SUMMARY: NMFS has received an application from the Lamont-Doherty Earth Observatory (L-DEO), a part of Columbia University, for an Incidental Harassment Authorization (IHA) to take small numbers of marine mammals, by harassment, incidental to conducting oceanographic seismic surveys in the Gulf of Alaska (GOA). Under the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an authorization to L-DEO to incidentally take, by harassment, small numbers of several species of cetaceans and pinnipeds for a limited period of time within the next year.

DATES: Comments and information must be received no later than July 23, 2004.

ADDRESSES: Comments on the application should be addressed to P.

Michael Payne, Chief, Marine Mammal Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910–3225, or by telephoning the contact listed here. The mailbox address for providing email comments is *PR2.051704A@noaa.gov*. Include in the subject line of the e-mail comment the following document identifier: 051704A. Comments sent via e-mail, including all attachments, must not exceed a 10–megabyte file size. A copy of the application containing a list of the references used in this document may be obtained by writing to this address or by telephoning the contact listed here and is also available at: *http://www.nmfs.noaa.gov/prot__res/PR2/Small__Take/smalltake__info.htm#applications*

FOR FURTHER INFORMATION CONTACT: Kenneth Hollingshead, Office of Protected Resources, NMFS, (301) 713–2322, ext 128.

SUPPLEMENTARY INFORMATION:

Background

Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review.

Permission may 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 and that the permissible methods of taking and requirements pertaining to the monitoring and reporting of such takings are set forth. 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. Under section 3(18)(A), 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].

Section 101(a)(5)(D) establishes a 45–day time limit for NMFS review of an application followed by a 30–day public notice and comment period on any proposed authorizations for the incidental harassment of marine mammals. Within 45 days of the close of the comment period, NMFS must either issue or deny issuance of the authorization.

Summary of Request

On April 19, 2004, NMFS received an application from L-DEO for the taking, by harassment, of several species of marine mammals incidental to conducting a seismic survey program during a four-week period within a general time window from late July to October 2004. The purpose of the seismic survey is to locate sedimentary records of environmental change in the GOA, including Holocene climate variability, anthropogenic warming and glacier melting of the past century, and dynamics of erosion and deposition associated with glaciation. This research has important implications for understanding long-term variability of North Pacific ecosystems, with relevance towards managing fisheries, marine mammals and other species. Geophysical site survey and safety information will be used to optimally locate coring sites and to understand regional sedimentation patterns. The marine paleoclimatic record in this region has received relatively little study because very few suitable sediment cores have been taken. Nevertheless, enough basic knowledge of fjord sedimentation processes exists to support a strategy of targeting deep-silled basins of fjords with adequate connections to the open ocean, as well as shelf and slope sediments in the open ocean. Fjord basins likely contain a rich array of biogenic and sedimentologic evidence for regional climate change. Regions of turbidite sedimentation (i.e., coarse sediments transported down-slope in turbidity currents) will be documented using shipboard geophysical sensing and sedimentological proxies in recovered sediments and will be avoided during coring. However, if some isolated turbidites are present, this may present an opportunity to examine seismically triggered events that provide useful synchronous stratigraphic markers.

Description of the Activity

The proposed seismic survey will involve one vessel, the *R/V Maurice Ewing (Ewing*). The Ewing will deploy a pair of low-energy Generator-Injector (GI) airguns as an energy source (each with a discharge volume of 105 in3). The energy to the airguns will be compressed air supplied by compressors on board the source vessel. Seismic pulses will be emitted at intervals of 6–10 seconds. This spacing corresponds to a shot interval of approximately 16–26 m (52–85 ft). The *Ewing* will also tow a hydrophone streamer that is up to 1500 m (4922 ft) long. As the airguns are operated along the survey lines, the hydrophone receiving system will receive and record the returning acoustic signals. In constrained fjord settings, only part of the streamer may be deployed, or a shorter streamer may be used, to increase the maneuverability of the ship.

The program will consist of approximately 1779 km (960 nm) of surveys, not including transits. Water depths within the seismic survey area are approximately 30 3000 m (98 9843 ft). There will be additional operations associated with airgun testing, start-up, line changes, and repeat coverage of any areas where initial data quality is sub-standard.

The GOA research will consist of four different stages of seismic surveys interspersed with coring operations in 4 general areas. The 4 different stages are outlined here in the order that they are currently planned to take place. Transit time between areas and between lines is not included in the estimates of survey time below, because the seismic source will generally not be operating during transits.

Stage 1–Prince of Wales Island. During this stage, 4 short seismic surveys will be completed in conjunction with 4 coring sites that will be sampled. Each of the 4 surveys, including seismic lines and coring, will take 9–14 hr and cover 17.7- 45.3 nm (32.9–83.8 km), for a total of 229 km (124 nm). All lines will be conducted in water depths less than 100 m (328 ft). A total of 13 lines will be shot around the 4 coring stations. Stage 1 will take approximately 50 hr of survey time over approximately 3 days to complete.

Stage 2–Baranof Island. During this stage, five short seismic surveys will be completed in conjunction with 6 coring sites that will be sampled. Each of the 5 surveys, including seismic lines and coring, will take approximately 6–17 hr and cover 4.1–54.5 nm (7.6–101.0 km), for a total of 109 km (59 nm) of which 25 km (13.5 nm) will be conducted in waters less than 100 m (328 ft) deep and 84 km (45 nm) will be in waters from 100 to 1000 m (328–3281 ft) deep. Stage 2 will take approximately 45 hr of survey time over approximately 4.5 days to complete.

Stage 3–Juneau (Southeast Alaska Inland Waters). During Stage 3, 3 short seismic surveys will be completed in conjunction with four coring sites that will be sampled. Each survey, including seismic lines and coring, will take approximately 8–21 hr and will cover 15.1–104.1 nm (27.7–192.9 km), for a total of 249 km (134 nm) conducted in water 100 m (328 ft) to 1000 m (3281 ft) deep. Stage 3 will take approximately 38 hr of survey time over 2.5 days to complete.

Stage 4–Glacier Bay, Yakutat Bay, Icy Bay, Prince William Sound, and Gulf of Alaska. During Stage 4, 14 seismic surveys will be conducted in conjunction with 16 coring sites that will be sampled. Surveys during Stage 4, including seismic lines and coring, will range in length from 5.3 - 111.2 nm (9.8–205.9 km),km), for a total of 1192 km (644 nm) of which 382 km (206 nm) will be conducted in waters less than 100 m (328 ft) deep, 453 km (245 nm) will be in waters from 100 to 1000 m (328 -3281 ft) deep and 357 km (187 nm) will be in waters deeper than 1000 m (3281 ft). Stage 4 will take approximately 72 h or survey time over approximately 13 days to complete.

In the event that one or more of the planned sites are unavailable due to poor weather conditions, ice conditions, unsuitable geology (shallow sediments), or other reasons, contingency sites (alternative seismic survey and coring locations) will be substituted. Alternative research sites (see Fig. 6 in the L-DEO application) will only be undertaken by L-DEO as replacements for the planned sites, and their use will not substantially change the total length or duration of the proposed seismic surveys. Seismic survey lines have not been selected or plotted by L-DEO for some contingency core sites. However, L-DEO anticipates that each contingency core site would require approximately 40 km (22 nm) of seismic surveying to locate optimal coring locations. It is highly unlikely that all contingency sites will be used. To the extent that contingency sites are used, a similar number of ''primary'' sites will be dropped from the project.

General-Injector Airguns

Two GI-airguns will be used from the Ewing during the proposed program. These 2 GI-airguns have a zero to peak (peak) source output of 237 dB re 1 microPascal-m (7.2 bar-m) and a peak-to-peak (pk-pk) level of 243 dB (14.0 bar-m). However, these downward-directed source levels do not represent actual sound levels that can be measured at any location in the water. Rather, they represent the level that would be found 1 m (3.3 ft) from a hypothetical point source emitting the same total amount of sound as is emitted by the combined airguns in the airgun array. The actual received level at any location in the water near the airguns will not exceed the source level of the strongest individual source. In this case, that will be about 231 dB re 1 microPa-m peak, or 237 dB re 1 microPa-m pk-pk. Actual levels experienced by any organism more than 1 m (3.3 ft) from either GI gun will be significantly lower.

Further, the root mean square (rms) received levels that are used as impact criteria for marine mammals (see Richardson et al., 1995) are not directly comparable to these peak or pk-pk values that are normally used to characterize source levels of airgun arrays. The measurement units used to describe airgun sources, peak or pk-pk decibels, are always higher than the rms decibels referred to in biological literature. For example, a measured received level of 160 decibels rms in the far field would typically correspond to a peak measurement of about 170 to 172 dB, and to a pk-pk measurement of about 176 to 178 decibels, as measured for the same pulse received at the same location (Greene, 1997; McCauley *et al.* 1998, 2000). The precise difference between rms and peak or pk-pk values depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or pk-pk level for an airgun-type source.

The depth at which the sources are towed has a major impact on the maximum near-field output, because the energy output is constrained by ambient pressure. The normal tow depth of the sources to be used in this project is 3 m (9.8 ft), where the ambient pressure is 3 decibars. This also limits output, as the 3 decibars of confining pressure cannot fully constrain the source output, with the result that there is loss of energy at the sea surface. Additional discussion of the characteristics of airgun pulses is provided later in this document.

For the 2 GI-airguns, the sound pressure field has been modeled by L-DEO in relation to distance and direction from the airguns, and in relation to depth. Table 1 shows the maximum distances from the airguns where sound levels of 190-, 180-, 170- and 160–dB re 1 microPa (rms) are predicted to be received. Empirical data concerning the 180, 170 and 160 dB distances have been acquired based on measurements during an acoustic verification study conducted by L-DEO in the northern Gulf of Mexico from 27 May to 3 June 2003 (Tolstoy *et al.*, 2004). Although the results are limited, the data showed that radii around the airguns where the received level would be 180 dB re 1 microPa (rms), NMFS' current injury threshold safety criterion applicable to cetaceans (NMFS, 2000), varies with water depth. Similar depth-related variation is likely in the 190–dB distances applicable to pinnipeds. The proposed L-DEO study area will occur in water approximately 30 3000 m (98 9843 ft).

TABLE 1. Estimated distances to which sound levels ≥190, 180, 170 and 160 dB re 1 μPa (rms) might be received from two 105 in^3 GI guns that will be used during the seismic survey in the GOA during 2004. Distance estimates are given for operations in deep, intermediate, and shallow water. The 180- and 190-dB distances are the safety radii to be used during the survey.

Water depth	Estimated Distances at Received Levels (m)			
	190 dB	180 dB	170 dB	160 dB
>1000 m	17	54	175	510
100–1000 m	26	81	263	765
<100 m	250	400	750	1500

Bathymetric Sonar, Sub-bottom Profiler, and Pinger

In addition to the 2 GI-airguns, a multibeam bathymetric sonar and a low-energy 3.5–kHz sub-bottom profiler will be used during the seismic profiling and continuously when underway. While on station for coring, a 12–kHz pinger will be used to monitor the depth of coring devices relative to the sea floor.

Bathymetric Sonar-Atlas Hydrosweep– The 15.5–kHz Atlas Hydrosweep sonar is mounted on the hull of the *Maurice Ewing*, and it operates in three modes, depending on the water depth. There is one shallow water mode and two deep-water modes: an Omni mode (similar to the shallow-water mode but with a source output of 220 dB (rms)) and a Rotational Directional Transmission (RDT) mode. The RDT mode is normally used during deep-water operation and has a 237–dB rms source output. In the RDT mode, each ''ping'' consists of five successive transmissions, each ensonifying a beam that extends 2.67 degrees fore-aft and approximately 30 degrees in the cross-track direction. The five successive transmissions (segments) sweep from port to starboard with minor overlap, spanning an overall cross-track angular extent of about 140 degrees, with small (much less than 1 millisec) gaps between the pulses for successive 30–degree segments. The total duration of the ''ping'' including all five successive segments, varies with water depth, but is 1 millisec in water depths less than 500 m and 10 millisec in the deepest water. For each segment, ping duration is 1/5 of these values or 2/5 for a receiver in the overlap area ensonified by two beam segments. The ''ping'' interval during RDT operations depends on water depth and varies from once per second in less than 500 m (1640.5 ft) water depth to once per 15 seconds in the deepest water. During the proposed project, the Atlas Hydrosweep will generally be used in waters greater than 800 m (2624.7 ft), but whenever water depths are less than 400 m (1312 ft) the source output is 210 dB re 1 microPa-m (rms) and a single 1–ms pulse or ''ping'' per second is transmitted.

Bathymetric Sonar-EM1002 Portable Sonar – The EM1002 is a compact high-resolution multibeam echo sounder that operates at a frequency of 92 to 98 kHz in water depths from 10 to 800 m (33 2625 ft). The EM1002 will be used instead of the Atlas Hydrosweep in waters <800 m deep. The EM1002 will be pole mounted on the *Ewing*, either over the side or through a well. The system operates with one of three different pulselengths: 0.2, 0.7 and 2 ms. Pulselength increases with increased water depth. Overall angular coverage of the transmitted beam is 3 degrees along the fore-aft axis and 150 degrees (7.4 times the water depth) along the cross-track axis when operating in the shallowest mode. Maximum ping rate is 10/sec (in shallow water) with the ping rate decreasing with increasing water depth. Maximum output using long pulses in 800 m (2624.7 ft) water depth is 226 dB re 1 microPa, although operations in shallower depths, including most of the work in these surveys, will use significantly lower output levels.

Sub-bottom Profilers – The sub-bottom profiler is normally operated to provide information about the sedimentary features and the bottom topography that is simultaneously being mapped by the Hydrosweep. The energy from the EDO Corporation's (EDO) sub-bottom profiler is directed downward by a 3.5–kHz transducer mounted in the hull of the *Ewing*. The output varies with water depth from 50 watts in shallow water to 800 watts in deep water. Pulse interval is 1 second (s) but a common mode of operation is to broadcast five pulses at 1–s intervals followed by a 5–s pause. The beamwidth is approximately 30o and is directed downward. Maximum source output is 204 dB re 1 microPa (800 watts) while nominal source output is 200 dB re 1 microPa (500 watts). Pulse duration will be 4, 2, or 1 ms, and the bandwith of pulses will be 1.0 kHz, 0.5 kHz, or 0.25 kHz, respectively.

An ODEC Bathy 2000P ''chirp'' sonar may be used instead of the EDO sub-bottom profiler. This sonar transmits a 50–ms pulse during which the frequency is swept from 4 to 7 kHz. The transmission rate is variable from 1 to 10 seconds, and the maximum output power is 2 kW. This sonar uses a transducer array very similar to that used by the 3.5 kHz sub-bottom profiler.

The EDO sub-bottom profiler on the *Ewing* has a stated maximum source level of 204 dB re 1 microPa and a nominal source level of 200 dB. Although the sound levels have not been measured directly for the sub-bottom profilers used by the Ewing, Burgess and Lawson (2000) measured sounds propagating more or less horizontally from a sub-bottom profiler similar to the EDO unit with similar source output (i.e., 205 dB re 1 microPa m). For that profiler, the 160 and 180 dB re 1 microPa (rms) radii in the horizontal direction were estimated to be, respectively, near 20 m (66 ft) and 8 m (26 ft) from the source, as measured in 13 m or 43 ft water depth. The corresponding distances for an animal in the beam below the transducer would be greater, on the order of 180 m (591 ft) and 18 m (59 ft) respectively, assuming spherical spreading. Thus the received level for the EDO sub-bottom profiler would be expected to decrease to 160 and 180 dB about 160 m (525 ft) and 16 m (52 ft) below the transducer, respectively, assuming spherical spreading. Corresponding distances in the horizontal plane would be lower, given the directionality of this source (300 beamwidth) and the measurements of Burgess and Lawson (2000).

12 kHz Pinger – A 12–kHz pinger will be used only during coring operations, to monitor the depth of the coring apparatus relative to the sea floor. The pinger is a battery-powered acoustic beacon that is attached to a wire just above the corehead. The pinger produces an omnidirectional 12 kHz signal with a source output of 193 dB re 1 microPa-m. The pinger produces a 2 ms pulse every second.

Characteristics of Airgun Pulses

Airguns function by venting high-pressure air into the water. 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 oscillation of the resulting air bubble. The resulting downward-directed pulse has a duration of only 10 to 20 ms, with only one strong positive and one strong negative peak pressure (Caldwell and Dragoset, 2000). Most energy emitted from airguns is at relatively low frequencies. For example, typical high-energy airgun arrays emit most energy at 10–120 Hz. However, the pulses contain some energy up to 500–1000 Hz and above (Goold and Fish, 1998).

The pulsed sounds associated with seismic exploration have higher peak levels than other industrial sounds to which whales and other marine mammals are routinely exposed. As mentioned previously, the pk-pk source levels of the 2 GI-gun array that will be used for the GOA project is 231 dB re 1 microPa (peak) and 237 dB re 1 microPa (pk-pk). However, the effective source level for horizontal propagation will be lower and actual levels experienced by any marine mammal more than 1 m (3.3 ft) from either GI-gun will be significantly lower.

Several important factors need are considered when assessing airgun impacts on the marine environment: (1) Airgun arrays produce intermittent sounds, involving emission of a strong sound pulse for a small fraction of a second followed by several seconds of near silence. In contrast, some other acoustic sources produce sounds with lower peak levels, but their sounds are continuous or discontinuous but continuing for much longer durations than seismic pulses. (2) Airgun arrays are designed to transmit strong sounds downward through the seafloor, and the amount of sound transmitted in near-horizontal directions is considerably reduced. Nonetheless, they also emit sounds that travel horizontally toward non-target areas. (3) An airgun array is a distributed source, not a point source. The nominal source level is an estimate of the sound that would be measured from a theoretical point source emitting the same total energy as the airgun array. That figure is useful in calculating the expected received levels in the far field (i.e., at moderate and long distances). Because the airgun array is not a single point source, there is no one location within the near field (or anywhere else) where the received level is as high as the nominal source level.

The strengths of airgun pulses can be measured in different ways, and it is important to know which method is being used when interpreting quoted source or received levels. Geophysicists usually quote pk-pk levels, in bar-meters or dB re 1 microPa-m. The peak level for the same pulse is typically about 6 dB less. In the biological literature, levels of received airgun pulses are often described based on the ‘‘average’’ or ‘‘root-mean-square’’ (rms) level over the duration of the pulse. The rms value for a given pulse is typically about 10 dB lower than the peak level, and 16 dB lower than the Pk-pk value (Greene, 1997; McCauley *et al.*, 1998; 2000). A fourth measure that is being used more frequently is the energy level, in dB re 1 microPa^2·s. Because the pulses are less than 1 sec in duration, the numerical value of the energy is lower than the rms pressure level, but the units are different. Because the level of a given pulse will differ substantially depending on which of these measures is being applied, it is important to be aware which measure is in use when interpreting any quoted pulse level. NMFS commonly references the rms levels when discussing levels of pulsed sounds that might harass marine mammals.

Seismic sound received at any given point will arrive via a direct path, indirect paths that include reflection from the sea surface and bottom, and often indirect paths including segments through the bottom sediments. Sounds propagating via indirect paths travel longer distances and often arrive later than sounds arriving via a direct path. These variations in travel time have the effect of lengthening the duration of the received pulse. At the source, seismic pulses are about 10 to 20 ms in duration. In comparison, the pulse duration as received at long horizontal distances can be much greater.

Another important aspect of sound propagation is that received levels of low-frequency underwater sounds diminish close to the surface because of pressure-release and interference phenomena that occur at and near the surface (Urick, 1983, Richardson *et al.*, 1995). Paired measurements of received airgun sounds at depths of 3 m (9.8 ft) vs. 9 or 18 m (29.5 or 59 ft) have shown that received levels are typically several decibels lower at 3 m (9.8. ft)(Greene and Richardson, 1988). For a mammal whose auditory organs are within 0.5 or 1 m (1.6 or 3.3 ft) of the surface, the received level of the predominant low-frequency components of the airgun pulses would be further reduced.

Pulses of underwater sound from open-water seismic exploration are often detected 50 to 100 km (30 to 54 nm) from the source location (Greene and Richardson, 1988; Burgess and Greene, 1999). At those distances, the received levels on an approximate rms basis are low (below 120 dB re 1 microPa). However, faint seismic pulses are sometimes detectable at even greater ranges (e.g., Bowles *et al.*, 1994; Fox *et al.*, 2002). Considerably higher levels can occur at distances out to several kilometers from an operating airgun array. Additional information is contained in the L-DEO application, especially in Appendix A.

Description of Habitat and Marine Mammals Affected by the Activity

A detailed description of the GOA area and its associated marine mammals can be found in the L-DEO application and a number of documents referenced in the L-DEO application, and is not repeated here. A total of 18 cetacean species, 3 species of pinnipeds, and the sea otter are known to or may occur in SE Alaska (Rice, 1998; Angliss and Lodge, 2002). The marine mammals that occur in the proposed survey area belong to four taxonomic groups: odontocetes (sperm whales (*Physeter macrocephalus*), beaked whales (Cuvier's (*Ziphius cavirostris*), Baird's (*Berardius bairdii*), and Stejneger's (*Mesoplodon stejnegeri*)), beluga (*Delphinapterus leucas*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), Risso's dolphin (*Grampus griseus*), killer whale (*Orcinus orca*), short-finned pilot whale (*Globicephala macrorhynchus*), harbor porpoise* (*Phocoena phocoena*), and Dall's porpopise (*Phocoenoides dalli*)), mysticetes (North Pacific right whales (*Eubalaena japonica*), gray whales (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae*), minke whales (*Balaenoptera acutorostrata*), sei whales (*Balaenoptera borealis*), fin whales (*Balaenoptera physalus*), and blue whales ((*Balaenoptera musculus*)), pinnipeds (Steller sea lion (*Eumetopias jubatus*), harbor seal (*Phoca vitulina*) and northern fur seal (*Callorhinus ursinus*)), and fissipeds (sea otter (*Enhydra lutris*)). Of the 18 cetacean species in the area, nine are commonly found in the activity area (see Table 2) and may be affected by the proposed acitivty. Of the three species of pinnipeds that could potentially occur in SE Alaska, only the Steller sea lion and harbor seal are likely to be present. The northern fur seal inhabits the Bering Sea during the summer and is generally found in SE Alaska in low numbers during the winter, and during the northward migration in spring. Sea otters generally inhabit coastal waters within the 40–m (131–ft) depth contour (Riedman and Estes, 1990) and may be encountered in coastal areas of the study area. More detailed information on these species is contained in the L-DEO application and additional information is contained in Angliss and Lodge, 2002 which are available at: *http://www.nmfs.noaa.gov/prot__res/PR2/Small__Take/smalltake__info.htm#applications,* and *http://www.nmfs.noaa.gov/prot__res/PR2/Stock__Assessment__Program/sars.html*, respectively.

Potential Effects on Marine Mammals

As outlined in several previous NMFS documents, the effects of noise on marine mammals are highly variable, and can be categorized as follows (based on Richardson *et al.*, 1995):

(1) The noise may be too weak to be heard at the location of the animal (i.e., lower than the prevailing ambient noise level, the hearing threshold of the animal at relevant frequencies, or both);

(2) The noise may be audible but not strong enough to elicit any overt behavioral response;

(3) The noise may elicit reactions of variable conspicuousness and variable relevance to the well being of the marine mammal; these can range from temporary alert responses to active avoidance reactions such as vacating an area at least until the noise event ceases;

(4) Upon repeated exposure, a marine mammal may exhibit diminishing responsiveness (habituation), or disturbance effects may persist; the latter is most likely with sounds that are highly variable in characteristics, infrequent and unpredictable in occurrence, and associated with situations that a marine mammal perceives as a threat;

(5) Any anthropogenic noise that is strong enough to be heard has the potential to reduce (mask) the ability of a marine mammal to hear natural sounds at similar frequencies, including calls from conspecifics, and underwater environmental sounds such as surf noise;

(6) If mammals remain in an area because it is important for feeding, breeding or some other biologically important purpose even though there is chronic exposure to noise, it is possible that there could be noise-induced physiological stress; this might in turn have negative effects on the well-being or reproduction of the animals involved; and

(7) Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity. In terrestrial mammals, and presumably marine mammals, received sound levels must far exceed the animal's hearing threshold for there to be any temporary threshold shift (TTS) in its hearing ability. For transient sounds, the sound level necessary to cause TTS is inversely related to the duration of the sound. Received sound levels must be even higher for there to be risk of permanent hearing impairment. In addition, intense acoustic or explosive events may cause trauma to tissues associated with organs vital for hearing, sound production, respiration and other functions. This trauma may include minor to severe hemorrhage.

Effects of Seismic Surveys on Marine Mammals

The L-DEO application provides the following information on what is known about the effects on marine mammals of the types of seismic operations planned by L-DEO. The types of effects considered here are (1) masking, (2) disturbance, and (3) potential hearing impairment and other physical effects. Additional discussion on species specific effects can be found in the L-DEO application.

Masking

Masking effects of pulsed sounds on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data on this. Seismic sounds are short pulses generally occurring for less than 1 sec every 20 or 60–90 sec during this project. Sounds from the multibeam sonar are very short pulses, occurring for 1–10 msec once every 1 to 15 sec, depending on water depth. (During operations in deep water, the duration of each pulse from the multibeam sonar as received at any one location would actually be only 1/5 or at most 2/5 of 1–10 msec, given the segmented nature of the pulses.) Some whales are known to continue calling in the presence of seismic pulses. Their calls can be heard between the seismic pulses (Richardson *et al.*, 1986; McDonald *et al.*, 1995, Greene *et al.*, 1999). Although there has been one report that sperm whales cease calling when exposed to pulses from a very distant seismic ship (Bowles *et al.*, 1994), a recent study reports that sperm whales continued calling in the presence of seismic pulses (Madsen *et al.*, 2002). Given the small source planned for use during this survey, there is even less potential for masking of sperm whale calls during the present study than in most seismic surveys. Masking effects of seismic pulses are expected to be negligible in the case of the smaller odontocete cetaceans, given the intermittent nature of seismic pulses and the relatively low source level of the airguns to be used in the GOA. Also, the sounds important to small odontocetes are predominantly at much higher frequencies than are airgun sounds.

Most of the energy in the sound pulses emitted by airgun arrays is at low frequencies, with strongest spectrum levels below 200 Hz and considerably lower spectrum levels above 1000 Hz. These frequencies are mainly used by mysticetes, but not by odontocetes or pinnipeds. An industrial sound source will reduce the effective communication or echolocation distance only if its frequency is close to that of the cetacean signal. If little or no overlap occurs between the industrial noise and the frequencies used, as in the case of many marine mammals vs. airgun sounds, communication and echolocation are not expected to be disrupted. Furthermore, the discontinuous nature of seismic pulses makes significant masking effects unlikely even for mysticetes.

A few cetaceans are known to increase the source levels of their calls in the presence of elevated sound levels, or possibly to shift their peak frequencies in response to strong sound signals (Dahlheim, 1987; Au, 1993; Lesage *et al.*, 1999; Terhune, 1999; as reviewed in Richardson *et al.*, 1995). These studies involved exposure to other types of anthropogenic sounds, not seismic pulses, and it is not known whether these types of responses ever occur upon exposure to seismic sounds. If so, these adaptations, along with directional hearing, pre-adaptation to tolerate some masking by natural sounds (Richardson *et al.*, 1995) and the relatively low-power acoustic sources being used in this survey, would all reduce the importance of masking marine mammal vocalizations.

Disturbance by Seismic Surveys

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous dramatic changes in activities, and displacement.

However, there are difficulties in defining which marine mammals should be counted as ''taken by harassment''. For many species and situations, scientists do not have detailed information about their reactions to noise, including reactions to seismic (and sonar) pulses. Behavioral reactions of marine mammals to sound are difficult to predict. Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors. If a marine mammal does react to an underwater sound by changing its behavior or moving a small distance, the impacts of the change may not rise to the level of a disruption of a behavioral pattern. However, if a sound source would displace marine mammals from an important feeding or breeding area for a prolonged period, such a disturbance would constitute Level B harassment. Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, scientists often resort to estimating how many mammals may be present within a particular distance of industrial activities or exposed to a particular level of industrial sound. This likely overestimates the numbers of marine mammals that are affected in some biologically important manner.

The sound criteria used to estimate how many marine mammals might be harassed behaviorally by the seismic survey are based on behavioral observations during studies of several species. However, information is lacking for many species. More detailed information on potential disturbance effects on baleen whales, toothed whales, and pinnipeds can be found on pages 36–38 and Appendix A in L-DEO's application.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds, but there has been no specific documentation of this for marine mammals exposed to airgun pulses. Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds ≥180 and 190 dB re 1 microPa (rms), respectively (NMFS, 2000). Those criteria have been used in defining the safety (shut down) radii for seismic surveys. However, those criteria were established before there were any data on the minimum received levels of sounds necessary to cause auditory impairment in marine mammals. As discussed in the L-DEO application and summarized here,

1. The 180 dB criterion for cetaceans is probably quite precautionary, i.e., lower than necessary to avoid TTS let alone permanent auditory injury, at least for delphinids.

2. The minimum sound level necessary to cause permanent hearing impairment is higher, by a variable and generally unknown amount, than the level that induces barely-detectable TTS.

3. The level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage.

Because of the small size of the GI airguns, along with the planned monitoring and mitigation measures, there is little likelihood that any marine mammals will be exposed to sounds sufficiently strong to cause even the mildest (and reversible) form of hearing impairment. Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the 2 GI-airguns (and multibeam bathymetric sonar), and to avoid exposing them to sound pulses that might cause hearing impairment. In addition, many cetaceans are likely to show some avoidance of the area with ongoing seismic operations. In these cases, the avoidance responses of the animals themselves will reduce or avoid the possibility of hearing impairment.

Non-auditory physical effects may also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that theoretically might occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds. However, L-DEO believes that it is especially unlikely that any of these non-auditory effects would occur during the proposed survey given the small size of the sources, the brief duration of exposure of any given mammal, and the planned mitigation and monitoring measures. The following paragraphs discuss the possibility of TTS, permanent threshold shift (PTS), and non-auditory physical effects.

TTS

TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter, 1985). When an animal experiences TTS, its hearing threshold rises and a sound must be stronger in order to be heard. TTS can last from minutes or hours to (in cases of strong TTS) days. Richardson *et al.* (1995) notes that the magnitude of TTS depends on the level and duration of noise exposure, among other considerations. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. Little data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals.

For toothed whales exposed to single short pulses, the TTS threshold appears to be, to a first approximation, a function of the energy content of the pulse (Finneran *et al.*, 2002). Given the available data, the received level of a single seismic pulse might need to be on the order of 210 dB re 1 microPa rms (approx. 221 226 dB pk pk) in order to produce brief, mild TTS. Exposure to several seismic pulses at received levels near 200 205 dB (rms) might result in slight TTS in a small odontocete, assuming the TTS threshold is (to a first approximation) a function of the total received pulse energy (Finneran *et al.*, 2002). Seismic pulses with received levels of 200 205 dB or more are usually restricted to a zone of no more than 100 m (328 ft) around a seismic vessel operating a large array of airguns. Such sound levels would be limited to distances within a few meters of the small airgun source to be used during this project.

There are no data, direct or indirect, on levels or properties of sound that are required to induce TTS in any baleen whale. However, TTS is not expected to occur during this survey given the small size of the source, and the strong likelihood that baleen whales would avoid the approaching airguns (or vessel) before being exposed to levels high enough for there to be any possibility of TTS.

TTS thresholds for pinnipeds exposed to brief pulses (single or multiple) have not been measured, although exposures up to 183 db re 1 microPa (rms) have been shown to be insufficient to induce TTS in California sea lions (Finneran *et al.* (2003). However, prolonged exposures show that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak *et al.*, 1999; Ketten *et al.*, 2001; Au *et al.*, 2000).

A marine mammal within a zone of ≤100 m (≤ 328 ft) around a typical large array of operating airguns might be exposed to a few seismic pulses with levels of ≥205 dB, and possibly more pulses if the mammal moved with the seismic vessel. Also, around smaller arrays, such as the 2 GI-airgun proposed for use during this survey, a marine mammal would need to be even closer to the source to be exposed to levels >205 dB, at least in waters greater than 100 m (328 ft) deep. However, as noted previously, most cetacean species tend to avoid operating airguns, although not all individuals do so. In addition, ramping up airgun arrays, which is standard operational protocol for L-DEO and other seismic operators, should allow cetaceans to move away from the seismic source and to avoid being exposed to the full acoustic output of the airgun array. It is unlikely that these cetaceans would be exposed to airgun pulses at a sufficiently high level for a sufficiently long period to cause more than mild TTS, given the relative movement of the vessel and the marine mammal. However, TTS would be more likely in any odontocetes that bow-ride or otherwise linger near the airguns. While bow-riding, odontocetes would be at or above the surface, and thus not exposed to strong sound pulses given the pressure-release effect at the surface. However, bow-riding animals generally dive below the surface intermittently. If they did so while bow-riding near airguns, they would be exposed to strong sound pulses, possibly repeatedly. If some cetaceans did incur TTS through exposure to airgun sounds, this would very likely be a temporary and reversible phenomenon.

Currently, NMFS believes that, whenever possible to avoid Level A harassment, cetaceans should not be exposed to pulsed underwater noise at received levels exceeding 180 dB re 1 microPa (rms). The corresponding limit for pinnipeds has been set at 190 dB. The predicted 180- and 190–dB distances for the airgun arrays operated by L-DEO during this activity are summarized elsewhere in this document. These sound levels are not considered to be the levels at or 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 (at a time 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. As noted here, TTS data that are now available imply that, at least for dolphins, TTS is unlikely to occur unless the dolphins are exposed to airgun pulses substantially stronger that 180 dB re 1 microPa (rms).

It has also been shown that most whales tend to avoid ships and associated seismic operations. Thus, whales will likely not be exposed to such high levels of airgun sounds. Because of the slow ship speed, any whales close to the trackline could move away before the sounds become sufficiently strong for there to be any potential for hearing impairment. Therefore, there is little potential for whales being close enough to an array to experience TTS. In addition, as mentioned previously, ramping up the 2 GI-airgun array, which has become standard operational protocol for many seismic operators including L-DEO, should allow cetaceans to move away from the seismic source and to avoid being exposed to the full acoustic output of the GI airguns.

Permanent Threshold Shift (PTS)

When PTS occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, while in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges. Physical damage to a mammal's hearing apparatus can occur if it is exposed to sound impulses that have very high peak pressures, especially if they have very short rise times (time required for sound pulse to reach peak pressure from the baseline pressure). Such damage can result in a permanent decrease in functional sensitivity of the hearing system at some or all frequencies.

Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage in terrestrial mammals. However, very prolonged exposure to sound strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold, can cause PTS, at least in terrestrial mammals (Kryter, 1985). 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. The low-to-moderate levels of TTS that have been induced in captive odontocetes and pinnipeds during recent controlled studies of TTS have been confirmed to be temporary, with no measurable residual PTS (Kastak *et al.*, 1999; Schlundt *et al.*, 2000; Finneran *et al.*, 2002; Nachtigall *et al.*, 2003). In terrestrial mammals, the received sound level from a single non-impulsive sound exposure must be far above the TTS threshold for any risk of permanent hearing damage (Kryter, 1994; Richardson *et al.*, 1995). For impulse sounds with very rapid rise times (e.g., those associated with explosions or gunfire), a received level not greatly in excess of the TTS threshold may start to elicit PTS. Rise times for airgun pulses are rapid, but less rapid than for explosions.

Some factors that contribute to onset of PTS are as follows: (1) exposure to single very intense noises, (2) repetitive exposure to intense sounds that individually cause TTS but not PTS, and (3) recurrent ear infections or (in captive animals) exposure to certain drugs.

Cavanagh (2000) has reviewed the thresholds used to define TTS and PTS. Based on his review and SACLANT (1998), it is reasonable to assume that PTS might occur at a received sound level 20 dB or more above that which induces mild TTS. However, for PTS to occur at a received level only 20 dB above the TTS threshold, it is probable that the animal would have to be exposed to the strong sound for an extended period.

Sound impulse duration, peak amplitude, rise time, and number of pulses are the main factors thought to determine the onset and extent of PTS. Based on existing data, Ketten (1994) has noted that the criteria for differentiating the sound pressure levels that result in PTS (or TTS) are location and species-specific. PTS effects may also be influenced strongly by the health of the receiver's ear.

Given that marine mammals are unlikely to be exposed to received levels of seismic pulses that could cause TTS, it is highly unlikely that they would sustain permanent hearing impairment. If we assume that the TTS threshold for exposure to a series of seismic pulses may be on the order of 220 dB re 1 microPa (pk-pk) in odontocetes, then the PTS threshold might be about 240 dB re 1 microPa (pk-pk). In the units used by geophysicists, this is 10 bar-m. Such levels are found only in the immediate vicinity of the largest airguns (Richardson et al., 1995; Caldwell and Dragoset, 2000). However, it is very unlikely that an odontocete would remain within a few meters of a large airgun for sufficiently long to incur PTS. The TTS (and thus PTS) thresholds of baleen whales and pinnipeds may be lower, and thus may extend to a somewhat greater distance. However, baleen whales generally avoid the immediate area around operating seismic vessels, so it is unlikely that a baleen whale could incur PTS from exposure to airgun pulses. Some pinnipeds do not show strong avoidance of operating airguns. In summary, it is highly unlikely that marine mammals could receive sounds strong enough (and over a sufficient period of time) to cause permanent hearing impairment during this project. In the proposed project, marine mammals are unlikely to be exposed to received levels of seismic pulses strong enough to cause TTS and because of the higher level of sound necessary to cause PTS, it is even less likely that PTS could occur. This is due to the fact that even levels immediately adjacent to the 2 GI-airguns may not be sufficient to induce PTS because the mammal would not be exposed to more than one strong pulse unless it swam alongside an airgun for a period of time.

Strandings and Mortality

Marine mammals close to underwater detonations of high explosives can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten *et al.*, 1993; Ketten, 1995). Airgun pulses are less energetic and have slower rise times. While there is no documented evidence that airgun arrays can cause serious injury, death, or stranding, the association of mass strandings of beaked whales with naval exercises and, recently, an L-DEO seismic survey have raised the possibility that beaked whales may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds.

In March 2000, several beaked whales that had been exposed to repeated pulses from high intensity, mid-frequency military sonars stranded and died in the Providence Channels of the Bahamas Islands, and were subsequently found to have incurred cranial and ear damage (NOAA and USN, 2001). Based on post-mortem analyses, it was concluded that an acoustic event caused hemorrhages in and near the auditory region of some beaked whales. These hemorrhages occurred before death. They would not necessarily have caused death or permanent hearing damage, but could have compromised hearing and navigational ability (NOAA and USN, 2001). The researchers concluded that acoustic exposure caused this damage and triggered stranding, which resulted in overheating, cardiovascular collapse, and physiological shock that ultimately led to the death of the stranded beaked whales. During the event, five naval vessels used their AN/SQS–53C or -56 hull-mounted active sonars for a period of 16 hours. The sonars produced narrow (<100 Hz) bandwidth signals at center frequencies of 2.6 and 3.3 kHz (-53C), and 6.8 to 8.2 kHz (-56). The respective source levels were usually 235 and 223 dB re 1 μ Pa, but the -53C briefly operated at an unstated but substantially higher source level. The unusual bathymetry and constricted channel where the strandings occurred were conducive to channeling sound. This, and the extended operations by multiple sonars, apparently prevented escape of the animals to the open sea. In addition to the strandings, there are reports that beaked whales were no longer present in the Providence Channel region after the event, suggesting that other beaked whales either abandoned the area or perhaps died at sea (Balcomb and Claridge, 2001).

Other strandings of beaked whales associated with operation of military sonars have also been reported (e.g., Simmonds and Lopez-Jurado, 1991; Frantzis, 1998). In these cases, it was not determined whether there were noise-induced injuries to the ears or other organs. Another stranding of beaked whales (15 whales) happened on 24–25 September 2002 in the Canary Islands, where naval maneuvers were taking place. Jepson et al. (2003) concluded that cetaceans might be subject to decompression injury in some situations. If so, this might occur if the mammals ascend unusually quickly when exposed to aversive sounds. Previously, it was widely assumed that diving marine mammals are not subject to the bends or air embolism.

It is important to note that seismic pulses and mid-frequency sonar pulses are quite different. Sounds produced by the types of airgun arrays used to profile sub-sea geological structures are broadband with most of the energy below 1 kHz. Typical military mid-frequency sonars operate at frequencies of 2 to 10 kHz, generally with a relatively narrow bandwidth at any one time (though the center frequency may change over time). Because seismic and sonar sounds have considerably different characteristics and duty cycles, it is not appropriate to assume that there is a direct connection between the effects of military sonar and seismic surveys on marine mammals. However, evidence that sonar pulses can, in special circumstances, lead to hearing damage and, indirectly, mortality suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity pulsed sound.

In addition to the sonar-related strandings, there was a September, 2002 stranding of two Cuvier's beaked whales in the Gulf of California (Mexico) when a seismic survey by the *Ewing* was underway in the general area (Malakoff, 2002). The airgun array in use during that project was the *Ewing*'s 20–gun 8490–in^3 array. This might be a first indication that seismic surveys can have effects, at least on beaked whales, similar to the suspected effects of naval sonars. However, the evidence linking the Gulf of California strandings to the seismic surveys is inconclusive, and to date is not based on any physical evidence (Hogarth, 2002; Yoder, 2002). The ship was also operating its multi-beam bathymetric sonar at the same time but this sonar had much less potential than these naval sonars to affect beaked whales. Although the link between the Gulf of California strandings and the seismic (plus multi-beam sonar) survey is inconclusive, this plus the various incidents involving beaked whale strandings associated with naval exercises suggests a need for caution in conducting seismic surveys in areas occupied by beaked whales.

Non-auditory Physiological Effects

Possible types of non-auditory physiological effects or injuries that might theoretically occur in marine mammals exposed to strong underwater sound might include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage. There is no evidence that any of these effects occur in marine mammals exposed to sound from airgun arrays. However, there have been no direct studies of the potential for airgun pulses to elicit any of these effects. If any such effects do occur, they would probably be limited to unusual situations when animals might be exposed at close range for unusually long periods.

Long-term exposure to anthropogenic noise may have the potential to cause physiological stress that could affect the health of individual animals or their reproductive potential, which could theoretically cause effects at the population level (Gisner (ed.), 1999). However, there is essentially no information about the occurrence of noise-induced stress in marine mammals. Also, it is doubtful that any single marine mammal would be exposed to strong seismic sounds for sufficiently long that significant physiological stress would develop. This is particularly so in the case of broad-scale seismic surveys where the tracklines are generally not as closely spaced as in many industry seismic surveys.

Gas-filled structures in marine animals have an inherent fundamental resonance frequency. If stimulated at this frequency, the ensuing resonance could cause damage to the animal. There may also be a possibility that high sound levels could cause bubble formation in the blood of diving mammals that in turn could cause an air embolism, tissue separation, and high, localized pressure in nervous tissue (Gisner (ed), 1999; Houser et al., 2001). In 2002, NMFS held a workshop (Gentry (ed.) 2002) to discuss whether the stranding of beaked whales in the Bahamas in 2000 might have been related to air cavity resonance or bubble formation in tissues caused by exposure to noise from naval sonar. A panel of experts concluded that resonance in air-filled structures was not likely to have caused this stranding. Among other reasons, the air spaces in marine mammals are too large to be susceptible to resonant frequencies emitted by mid- or low-frequency sonar; lung tissue damage has not been observed in any mass, multi-species stranding of beaked whales; and the duration of sonar pings is likely too short to induce vibrations that could damage tissues (Gentry (ed.), 2002). Opinions were less conclusive about the possible role of gas (nitrogen) bubble formation/growth in the Bahamas stranding of beaked whales. Workshop participants did not rule out the possibility that bubble formation/growth played a role in the stranding and participants acknowledged that more research is needed in this area. The only available information on acoustically-mediated bubble growth in marine mammals is modeling that assumes prolonged exposure to sound.

In summary, little is known about the potential for seismic survey sounds to cause either auditory impairment or other non-auditory physical effects in marine mammals. Available data suggest that such effects, if they occur at all, would be limited to short distances from the sound source. However, the available data do not allow for meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in these ways. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, are unlikely to incur auditory impairment or other physical effects.

Possible Effects of Mid-frequency Sonar Signals

A multi-beam bathymetric sonar (Atlas Hydrosweep DS–2 (15.5–kHz) or Simrad EM1002 (95 kHz)) and a sub-bottom profiler will be operated from the source vessel essentially continuously during the planned survey. Details about these sonars were provided previously in this document.

Navy sonars that have been linked to avoidance reactions and stranding of cetaceans generally (1) are more powerful than the Atlas Hydrosweep or EM1002 sonars, (2) have a longer pulse duration, and (3) are directed close to horizontally (vs. downward for the Atlas Hydrosweep and EM1002). The area of possible influence for the *Ewing*'s sonars is much smaller – a narrow band below the source vessel. For the Hydrosweep there is no horizontal propagation as these signals project at an angle of approximately 45 degrees from the ship. For the deep-water mode, under the ship the 160- and 180–dB zones are estimated to be 3200 m (10500 ft) and 610 m (2000 ft), respectively. However, the beam width of the Hydrosweep signal is only 2.67 degrees fore and aft of the vessel, meaning that a marine mammal diving could receive at most 1–2 signals from the Hydrosweep and a marine mammal on the surface would be unaffected. Marine mammals that do encounter the bathymetric sonars at close range 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 and vessel speed. Therefore, as harassment or injury from pulsed sound is a function of total energy received, the actual harassment or injury threshold for the bathymetric sonar signals (approximately 10 ms) such sounds would be at a much higher dB level than that for longer duration pulses such as seismic signals. As a result, NMFS believes that marine mammals are unlikely to be harassed or injured from the multibeam sonar.

Masking by Mid-frequency Sonar Signals

Marine mammal communications will not be masked appreciably by the multibeam sonar signals or the sub-bottom profiler given the low duty cycle and directionality of the sonars and the brief period when an individual mammal is likely to be within its beam. Furthermore, in the case of baleen whales, the sonar signals from the Hydrosweep sonar do not overlap with the predominant frequencies in the calls, which would avoid significant masking. The 95–kHz pulses from the EM1002 sonar will be inaudible to baleen whales and pinnipeds.

For the sub-bottom profiler and 12–kHz pinger, marine mammal communications will not be masked appreciably because of their relatively low power output, low duty cycle, directionality (for the profiler), and the brief period when an individual mammal may be within the sonar's beam. In the case of most odonotocetes, the sonar signals from the profiler do not overlap with the predominant frequencies in their calls. In the case of mysticetes, the pulses from the pinger do not overlap with their predominant frequencies.

Behavioral Responses Resulting from Mid-Frequency Sonar Signals

Behavioral reactions of free-ranging marine mammals to military and other sonars 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. Also, Navy personnel have described observations of dolphins bow-riding adjacent to bow-mounted mid-frequency sonars during sonar transmissions. However, all of these observations are of limited relevance to the present situation. Pulse durations from these sonars were much longer than those of the L-DEO multibeam sonar, and a given mammal would have received many pulses from the naval sonars. During L-DEO's operations, the individual pulses will be very short, and a given mammal would not receive many of the downward-directed pulses as the vessel passes by.

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

L-DEO and NMFS are not aware of any data on the reactions of pinnipeds to sonar sounds at frequencies similar to those of the 15.5 kHz frequency of the Ewing's multibeam sonar. Based on observed pinniped responses to other types of pulsed sounds, and the likely brevity of exposure to the bathymetric sonar sounds, pinniped reactions are expected to be limited to startle or otherwise brief responses of no lasting consequences to the individual animals. As mentioned, the 95–kHz sounds from the EM1002 will be inaudible to pinnipeds and to baleen whales, so it will have no disturbance effects on those groups of mammals. The pulsed signals from the sub-bottom profiler and pinger are much weaker than those from the airgun array and the multibeam sonar. Therefore, significant behavioral responses are not expected.

Hearing Impairment and Other Physical Effects

Given recent stranding events that have been associated with the operation of naval sonar, there is much concern that sonar noise can cause serious impacts to marine mammals (for discussion see Effects of Seismic Surveys). However, the multi-beam sonars proposed for use by L-DEO are quite different than sonars used for navy operations. Pulse duration of the bathymetric sonars is very short relative to the naval sonars. Also, at any given location, an individual marine mammal would be in the beam of the multi-beam sonar for much less time given the generally downward orientation of the beam and its narrow fore-aft beam-width. (Navy sonars often use near-horizontally-directed sound.) These factors would all reduce the sound energy received from the multi-beam sonar rather drastically relative to that from the sonars used by the Navy. Therefore, hearing impairment by multi-beam bathymetric sonar is unlikely.

Source levels of the sub-bottom profiler are much lower than those of the airguns and the multi-beam sonar. Sound levels from a sub-bottom profiler similar to the one on the Ewing were estimated to decrease to 180 dB re 1 microPa (rms) at 8 m (26 ft) horizontally from the source (Burgess and Lawson, 2000), and at approximately 18 m downward from the source. Furthermore, received levels of pulsed sounds that are necessary to cause temporary or especially permanent hearing impairment in marine mammals appear to be higher than 180 dB (see earlier discussion). Thus, 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. 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. In the case of mammals that do not avoid the approaching vessel and its various sound sources, mitigation measures that would be applied to minimize effects of the higher-power sources would further reduce or eliminate any minor effects of the sub-bottom profiler.

The 12–kHz pinger is unlikely to cause hearing impairment or physical injuries even in an animal that is in a position near the source because is does not produce strong pulse levels.

Estimates of Take by Harassment for the Gulf of Alaska Seismic Survey

Although information contained in this document indicates that injury to marine mammals from seismic sounds potentially occurs at sound pressure levels significantly higher than 180 and 190 dB, NMFS' current criteria for onset of Level A harassment of cetaceans and pinnipeds from impulse sound are, respectively, 180 and 190 re 1 microPa rms. The rms level of a seismic pulse is typically about 10 dB less than its peak level and about 16 dB less than its pk-pk level (Greene, 1997; McCauley *et al.*, 1998; 2000a). The criterion for Level B harassment onset is 160 dB.

Given the proposed mitigation (see Mitigation later in this document), all anticipated takes involve a temporary change in behavior that may constitute Level B harassment. The proposed mitigation measures will minimize or eliminate the possibility of Level A harassment or mortality. L-DEO has calculated the ''best estimates'' for the numbers of animals that could be taken by level B harassment during the proposed GOA seismic survey using data on marine mammal density and abundance from marine mammal surveys in the region, and estimates of the size of the affected area, as shown in the predicted RMS radii table (see Table 1).

These estimates are based on a consideration of the number of marine mammals that might be exposed to sound levels greater than 160 dB, the criterion for the onset of Level B harassment, by operations with the 2 GI-gun array planned to be used for this project. The anticipated zone of influence of the multi-beam sonar is less than that for the airguns, so it is assumed that any marine mammals close enough to be affected by the multi-beam sonar would already be affected by the airguns. Therefore, no additional incidental takings are included for animals that might be affected by the multi-beam sonar.

Table 2 explains the corrected density estimates as well as the best estimate of the numbers of each species that would be exposed to seismic sounds greater than 160 dB. A detailed description on the methodology used by L-DEO to arrive at the estimates of Level B harassment takes that are provided in Table 2 can be found in L-DEO's IHA application for the GOA survey.

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TABLE 2. Estimates of the possible numbers of marine mammal exposures to the different sound levels, and the numbers of different individuals that might be exposed, during L-DEO's proposed seismic program in SE Alaska in late summer/autumn 2004. The proposed sound source consists of 2 GI airguns. Received levels of airgun sounds are expressed in dB re 1 µPa (rms, averaged over pulse duration). Not all marine mammals will change their behavior when exposed to these sound levels but, partially offsetting that, some may alter their behavior when levels are lower (see text). The column of numbers in boldface shows the numbers of "takes" for which L-DEO has requeste Level B take authorization.[a]

	Number of Exposures to Sound Levels ≥160 dB		Number of Individuals Exposed to Sound Levels ≥160 dB — Best Estimate			
Species	Best Estimate	Maximum Estimate	Number	% of Regional Pop'n[b]	Maximum Estimate	Requested Take Authori-zation
Physeteridae						
Sperm whale	*3*	*4*	*2*	*0.0*	*3*	*5*
Ziphiidae						
Cuvier's beaked whale	18	26	11	0.1	17	**26**
Baird's beaked whale	4	6	3	0.0	4	**6**
Stejneger's beaked whale	0	0	0	0.0	0	**5**
Monodontidae						
Beluga	0	0	0	0.0	0	**5**
Delphinidae						
Pacific white-sided dolphin	161	329	103	0.1	211	**329**
Risso's dolphin	0	0	0	0.0	0	**5**
Killer whale	65	97	42	0.2	62	**97**
Short-finned pilot whale	0	0	0	0.0	0	**10**
Phocoenidae						
Harbor porpoise	187	230	120	0.4	148	**230**
Dall's porpoise	5218	7828	3354	0.8	5031	**7828**
Balaenopteridae						
North Pacific right whale	*0*	*0*	0	*0.0*	*0*	***2***
Gray whale	0	0	0	0.0	0	**15**
Humpback whale	*105*	*157*	67	*1.1*	*101*	***157***
Minke whale	2	3	1	*0.0*	2	**8**
Fin whale	*144*	*216*	93	*0.8*	*139*	***216***
Blue whale	*0*	*0*	0	*0.0*	*0*	***5***
Pinnipeds						
Northern fur seal [c]			0		0	**5**
Harbor seal [c]			1498	4.0		**1498**
Steller sea lion	*712*		*458*	*1.0*		***458***
Fissipeds						
Sea Otter [d]			68	0.3	123	**123**

[a] Best estimate and maximum estimates of density are from Table 5 in L-DEO's application

[b] Regional population size estimates are from Table 2 in L-DEO's application.

[c] Estimates for seals are not based on direct calculations from density data (see L-DEO's application for explanation).

[d] Estimates for the sea otter are based on the encounter rate per linear kilometer, not densities.

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Conclusions

Effects on Cetaceans

Strong avoidance reactions by several species of mysticetes to seismic vessels have been observed at ranges up to 6–8 km (3.2–4.3 nm) and occasionally as far as 20–30 km (10.8–16.2 nm) from the source vessel. However, reactions at the longer distances appear to be atypical of most species and situations, particular when feeding whales are involved. Many of the mysticetes that will be encountered in SE Alaska at the time of the proposed seismic survey will be feeding. In addition, the estimated numbers presented in Table 2 are considered overestimates of actual numbers that may be harassed. The estimated 160–dB radii used here are probably overestimates of the actual 160–dB radii at water depths ≥100 m (ft) based on the few calibration data obtained in deep water (Tolstoy *et al.*, 2004).

Odontocete reactions to seismic pulses, or at least the reactions of dolphins, are expected to extend to lesser distances than are those of mysticetes. Odontocete low-frequency hearing is less sensitive than that of mysticetes, and dolphins are often seen from seismic vessels. In fact, there are documented instances of dolphins approaching active seismic vessels. However, dolphins as well as some other types of odontocetes sometimes show avoidance responses and/or other changes in behavior when near operating seismic vessels.

Taking into account the small size and the relatively low sound output of the 2 GI-guns to be used, and the mitigation measures that are planned, effects on cetaceans are generally expected to be limited to avoidance of a small area around the seismic operation and short-term changes in behavior, falling within the MMPA definition of Level B harassment. Furthermore, the estimated numbers of animals potentially exposed to sound levels sufficient to cause appreciable disturbance are very low percentages of the affected populations.

Based on the 160–dB criterion, the best estimates of the numbers of individual cetaceans that may be exposed to sounds >160 dB re 1 microPa (rms) represent 0 to 1.1 percent of the populations of each species in the North Pacific Ocean (Table 2). For species listed as endangered under the Endangered Species Act (ESA), this includes no North Pacific right whales or blue whales; ≤0.01 percent of the Northeast Pacific population of sperm whales; 1.1 percent of the humpback whale population; and 0.8 percent of the whale population (Table 2). In the cases of belugas, beaked whales, and sperm whales, these potential reactions are expected to involve no more than very small numbers (0 to 11) of individual cetaceans. Humpback and whales are the endangered species that are most likely to be exposed and their Northeast Pacific populations are approximately 6000 (Caretta *et al.*, 2002) and 10970 (Ohsumi and Wada, 1974), respectively.

It is highly unlikely that any North Pacific right whales will be exposed to seismic sounds ≥160 dB re 1 microPa (rms). This conclusion is based on the rarity of this species in SE Alaska and in the Northeast Pacific (less than 100, Carretta *et al.*, 2002), and that the remnant population of this species apparently migrates to more northerly areas during the summer. However, L-DEO has requested an authorization to expose up to two North Pacific right whales to ≥160 dB, given the possibility (however unlikely) of encountering one or more of this endangered species. If a right whale is sighted by the vessel-based observers, the 2 GI-airguns will be shut down (not just powered down) regardless of the distance of the whale from the airguns.

Substantial numbers of phocoenids and delphinids may be exposed to airgun sounds during the proposed seismic studies, but the population sizes of species likely to occur in the operating area are large, and the numbers potentially affected are small relative to the population sizes (Table 2). The best estimates of the numbers of individual Dall's and harbor porpoises that might be exposed to ≥160 dB represent 0.8 percent and 0.4 percent of their Northeast Pacific populations. The best estimates of the numbers of individual delphinids that might be exposed to sounds ≥170 dB re 1 μPa (rms) represents much less than 0.01 percent of the approximately 600,000 dolphins estimated to occur in the Northeast Pacific, and 0 to 0.2 percent of the populations of each species occurring there (Table 2).

Varying estimates of the numbers of marine mammals that might be exposed to sounds from the 2 GI-airguns during the 2004 seismic surveys off SW Alaska have been presented, depending on the specific exposure criteria, calculation procedures (exposures vs. individuals), and density criteria used (best vs. maximum). The requested ''take authorization'' for each species is based on the estimated maximum number of exposures to ≤160 dB re 1 microPa (rms). That figure likely overestimates (in most cases by a large margin) the actual number of animals that will be exposed to these sounds; the reasons for this have been discussed previously and in L-DEO's application. Even so, the estimates for the proposed surveys are quite low percentages of the population sizes. Also, these relatively short-term exposures are unlikely to result in any long-term negative consequences for the individuals or their populations.

Mitigation measures such as controlled speed, course alteration, observers, ramp ups, and shut downs when marine mammals are seen within deed ranges (see Mitigation) should further reduce short-term reactions, and minimize any effects on hearing sensitivity. In all cases, the effects are expected to be short-term, with no lasting biological consequence. In light of the type of take expected and the small percentages of affected stocks, the action is expected to have no more than a negligible impact on the affected species or stocks of marine mammals.

Effects on Pinnipeds

Two pinniped species, the Steller sea lion and the harbor seal, are likely to be encountered in the study area. In addition, it is possible (although unlikely) that a small number of northern fur seals may be encountered. An estimated 1498 harbor seals and 195 Steller sea lions (or 1 percent of the Northeast Pacific population) may be exposed to airgun sounds during the seismic survey. It is unknown how many of these would actually be disturbed, but most likely it would only be a small percentage of that population. Similar to cetaceans, the short-term exposures to airgun and sonar sounds are not expected to result in any long-term negative consequences for the individuals or their populations.

Potential Effects on Fissipeds

As indicated in Table 2, L-DEO estimates that 68 sea otters that could potentially be encountered during airgun operations with a maximum estimate of 123 sea otters. L-DEO believes these estimates are likely an overestimate of the number of otters affected, as there is little evidence that sea otters are disturbed by sounds from either a small airgun source or from a large array of airguns (Riedman 1983, 1984). However, sea otters are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). L-DEO is consulting with the USFWS regarding whether sea otters will be affected by the 2 GI-airguns being employed in the GOA project.

Potential Effects on Habitat

The proposed seismic survey will not result in any permanent impact on habitats used by marine mammals, or to the food sources they utilize. The main impact issue associated with the proposed activity will be temporarily elevated noise levels and the associated direct effects on marine mammals. The actual area that will be affected by coring operations will be a very small fraction of the marine mammal habitat and the habitat of their food species in the area; thus, any effects are expected to be highly localized and insignificant. Coring operations would result in no more than a negligible and highly localized short-term disturbance to sediments and benthic organisms. The area that might be disturbed is a very small fraction of the overall area occupied by a fish or marine mammal species.

One of the reasons for the adoption of airguns as the standard energy source for marine seismic surveys was that they (unlike the explosives used in the distant past) do not result in any appreciable fish kill. Various experimental studies showed that airgun discharges cause little or no fish kill, and that any injurious effects were generally limited to the water within a meter or so of an airgun. However, it has recently been found that injurious effects on captive fish, especially on fish hearing, may occur to somewhat greater distances than previously thought (McCauley *et al.*, 2000a,b, 2002; 2003). Even so, any injurious effects on fish would be limited to short distances. Also, many of the fish that might otherwise be within the injury-zone are likely to be displaced from this region prior to the approach of the airguns through avoidance reactions to the passing seismic vessel or to the airgun sounds as received at distances beyond the injury radius.

Fish often react to sounds, especially strong and/or intermittent sounds of low frequency. Sound pulses at received levels of 160 dB re 1 μPa (peak) may cause subtle changes in behavior. Pulses at levels of 180 dB (peak) may cause noticeable changes in behavior (Chapman and Hawkins, 1969; Pearson *et al.*, 1992; Skalski *et al.*, 1992). It also appears that fish often habituate to repeated strong sounds rather rapidly, on time scales of minutes to an hour. However, the habituation does not endure, and resumption of the disturbing activity may again elicit disturbance responses from the same fish. Fish near the airguns are likely to dive or exhibit some other kind of behavioral response. This might have short-term impacts on the ability of cetaceans to feed near the survey area. However, only a small fraction of the available habitat would be ensonified at any given time, and fish species would return to their pre-disturbance behavior once the seismic activity ceased. Thus, the proposed surveys would have little impact on the abilities of marine mammals to feed in the area where seismic work is planned. Some of the fish that do not avoid the approaching airguns (probably a small number) may be subject to auditory or other injuries.

Zooplankters that are very close to the source may react to the airgun's impulse. These animals have an exoskeleton and no air sacs; therefore, little or no mortality is expected. Many crustaceans can make sounds and some crustacea and other invertebrates have some type of sound receptor. However, the reactions of zooplankters to sound are not known. Some mysticetes feed on concentrations of zooplankton. A reaction by zooplankton to a seismic impulse would only be relevant to whales if it caused a concentration of zooplankton to scatter. Pressure changes of sufficient magnitude to cause this type of reaction would probably occur only very close to the source, so few zooplankton concentrations would be affected. Impacts on zooplankton behavior are predicted to be negligible, and this would translate into negligible impacts on feeding mysticetes.

Potential Effects on Subsistence Use of Marine Mammals

The proposed seismic project could potentially impact the availability of marine mammals for subsistence harvests in a very small area immediately around the *Ewing*, and for a very short time period while conducting seismic activities. However, considering the limited time and locations for the planned surveys, the proposed survey is not expected to have an unmitigable adverse impact on the availability of Steller sea lions, harbor seals or northern sea otters for subsistence harvests. Nevertheless, L-DEO plans to coordinate its activities with local subsistence communities so that seismic activities will be conducted outside subsistence hunting areas and times, if possible.

Mitigation

For the proposed seismic survey in the GOA, L-DEO will deploy 2 GI-airguns as an energy source, with a total discharge volume of 210 in3. The energy from the airguns will be directed mostly downward. The directional nature of the airguns to be used in this project is an important mitigating factor. This directionality will result in reduced sound levels at any given horizontal distance as compared with the levels expected at that distance if the source were omnidirectional with the stated nominal source level. Also, the small size of these airguns is an inherent and important mitigation measure that will reduce the potential for effects relative to those that might occur with large airgun arrays. This measure is in conformance with NMFS encouraging seismic operators to use the lowest intensity airguns practical to accomplish research objectives.

Proposed Safety Radii

Received sound levels have been modeled by L-DEO for the 2 GI-airguns, in relation to distance and direction from the airguns. The model does not allow for bottom interactions, and is most directly applicable to deep water. Based on the model, the distances from the 2 G-airguns where sound levels of 190 dB, 180 dB, 170 dB, and 160 dB re 1 microPa (rms) are predicted to be received are shown in the >1000 m (3281 ft) line of Table 1.

Empirical data concerning these safety radii have been acquired based on measurements during the acoustic verification study conducted by L-DEO in the northern Gulf of Mexico from 27 May to 3 June 2003 (see 68 FR 32460, May 30, 2003). Although the results are limited, L-DEO's analysis of the acoustic data from that study (Tolstoy *et al.*, 2004) indicate that the radii around the airguns where the received level would be 180 dB re 1 microPa (rms), the safety zone applicable to cetaceans, vary with water depth.

The proposed study area will occur in water approximately 30–3000 m (98–9843 ft) deep. In deep water (>1000 m (3281 ft)), the safety radii during airgun operations will be the values predicted by L-DEO's model (Table 1). Therefore, the assumed 180- and 190–dB radii are 54 m (177 ft) and 17 m (56 ft), respectively. For operations in shallow (<100 m (328 ft)) water, conservative correction factors were applied to the predicted radii for the 2 GI-airgun array. The 180- and 190–dB radii in shallow water are assumed to be 400 m (1312 ft) and 250 m (820 ft), respectively. In intermediate depths (100–1000 m (328–3281 ft)), a 1.5x correction factor was applied to the estimates provided by the model for deep water situations. The assumed 180- and 190–dB radii in intermediate-depth water are 81 m (266 ft) and 26 m (85 ft), respectively. The 2 GI-airguns will be immediately shutdown when cetaceans or pinnipeds are detected within or about to enter the appropriate 180- or 190–dB zone.

Additional Mitigation Measures

The following mitigation measures, as well as marine mammal visual monitoring (discussed later in this document), are proposed for the subject seismic surveys: (1) Speed and course alteration (provided that they do not compromise operational safety requirements); (2) shut-down procedures; and (3) avoid encroaching upon critical habitat around Steller sea lion rookeries and haulouts. As discussed elsewhere in this document, special mitigation measures will be implemented for the North Pacific right whale.

Although a ''power-down'' procedure is often applied by L-DEO during seismic surveys with larger arrays of airguns, L-DEO does not propose powering down to a single gun during this proposed project. Powering down from two guns to one gun would make only a small difference in the 180- or 190–dB zone, which is probably not enough distance to allow one-gun to continue operations if a mammal came within the safety zone for two guns.

At night, vessel lights and/or night-vision devices (NVDs) could be useful in sighting some marine mammals at the surface within a short distance from the ship (within the safety radii for the 2–GI guns in deep and intermediate waters). Thus, start up of the airguns may be possible at night in deep and intermediate waters, in situations when the entire safety zone is visible with vessel lights and NVDs. However, lights and NVDs will probably not be very effective for monitoring the larger safety radii around the 2 GI-airguns operating in shallow water. In shallow water, therefore, nighttime start ups of the airguns are not proposed to be authorized.

Speed and Course Alteration

If a marine mammal is detected outside the safety zone and, based on its position and the relative motion, is likely to enter the safety zone, the vessel's speed and/or direct course may, when practical and safe, be changed in a manner that also minimizes the effect to the planned science objectives. 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 safety zone. If the mammal appears likely to enter the safety zone, further mitigative actions will be taken (i.e., either further course alterations or shut down of the airguns). In the closely constrained waters of Lynn Canal, Muir Inlet, and Frederick Sound, it is unlikely that significant alterations to the vessel's speed or course could be made. In these circumstances, shut-down procedures would be implemented rather than speed or course changes.

Shut-down Procedures

If a marine mammal is detected outside the safety zone but is likely to enter the safety zone, and if the vessel's speed and/or course cannot be changed to avoid having the mammal enter the safety zone, the airguns will be shut down before the mammal is within the safety zone. Likewise, if a mammal is already within the safety zone when first detected, the airguns will be shut down immediately. The airguns will be shut down if a North Pacific right whale is sighted from the vessel, even if it is located outside the safety zone.

Following a shut down, airgun activity will not resume until the marine mammal has cleared the safety zone. The animal will be considered to have cleared the safety zone if it (1) is visually observed to have left the safety zone, or (2) has not been seen within the zone for 15 min in the case of small odontocetes and pinnipeds, or (3) has not been seen within the zone for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales.

If the complete safety zone has not been visible for at least 30 min prior to the start of operations in either daylight or nighttime, airgun operations will not commence. However, if the airgun array has been operational before nightfall, it can remain operational throughout the night, even though the entire safety radius may not be visible. If the entire safety zone is visible at night, using vessel lights and NVDs (as may be the case in deep and intermediate waters), then start up of the airguns may occur at night.

Ramp-up

When airgun operations commence after a certain period without airgun operations, the number of guns firing will be increased gradually, or ''ramped up'' (also described as a ''soft start''). Usually, operations begin with the smallest gun in the array and guns are added in sequence such that the source level of the array will increase in steps not exceeding 6 dB per 5–min period. However, during this survey, with only 2 GI-guns, ramp-up will be implemented by turning on one airgun, followed 5 minutes later by the second airgun. Throughout the ramp-up procedure, the safety zone will be maintained.

Comments on past IHAs raised the issue of prohibiting nighttime operations as a practical mitigation measure. However, this is not practicable due to cost considerations. The daily cost to the federal government to operate vessels such as Ewing is approximately $33,000 to $35,000/day (Ljunngren, pers. comm. May 28, 2003). If the vessels were prohibited from operating during nighttime, it is possible that each trip would require an additional three to five days, or up to $175,000 more, depending on average daylight at the time of work.

If a seismic survey vessel is limited to daylight seismic operations, efficiency would be much reduced. Without commenting specifically on how that would affect the present project, for seismic operators in general, a daylight-only requirement would be expected to result in one or more of the following outcomes: cancellation of potentially valuable seismic surveys; reduction in the total number of seismic cruises annually due to longer cruise durations; a need for additional vessels to conduct the seismic operations; or work conducted by non-U.S. operators or non-U.S. vessels when in waters not subject to U.S. law.

Taking into consideration the additional costs of prohibiting nighttime operations and the likely impact of the activity (including all mitigation and monitoring), NMFS has preliminarily determined that the proposed mitigation and monitoring ensures that the activity will have the least practicable impact on the affected species or stocks. Marine mammals will have sufficient notice of a vessel approaching with operating seismic airguns, thereby giving them an opportunity to avoid the approaching array; if ramp-up is required, two marine mammal observers will be required to monitor the safety radii using shipboard lighting or NVDs for at least 30 minutes before ramp-up begins and verify that no marine mammals are in or approaching the safety radii; ramp-up may not begin unless the entire safety radii are visible. Therefore it is likely that the 2 GI-airgun array will not be ramped-up from a shut-down at night when in waters shallower than 100 m (328 ft).

Marine Mammal Monitoring

L-DEO must have at least three visual observers on board the *Ewing*, and at least two must be an experienced marine mammal observer that NMFS has approved in advance of the start of the GOA cruise. These observers will be on duty in shifts of no longer than 4 hours.

The visual observers will monitor marine mammals and sea turtles near the seismic source vessel during all daytime airgun operations, during any nighttime start-ups of the airguns and at night, whenever daytime monitoring resulted in one or more shut-down situations due to marine mammal presence. During daylight, vessel-based observers will watch for marine mammals and sea turtles near the seismic vessel during periods with shooting (including ramp-ups), and for 30 minutes prior to the planned start of airgun operations after a shut-down.

Use of multiple observers will increase the likelihood that marine mammals near the source vessel are detected. L-DEO bridge personnel will also assist in detecting marine mammals and implementing mitigation requirements whenever possible (they will be given instruction on how to do so), especially during ongoing operations at night when the designated observers are on stand-by and not required to be on watch at all times.

The observer(s) will watch for marine mammals from the highest practical vantage point on the vessel, which is either the bridge or the flying bridge. On the bridge of the *Ewing*, the observer's eye level will be 11 m (36 ft) above sea level, allowing for good visibility within a 210° arc. If observers are stationed on the flying bridge, the eye level will be 14.4 m (47.2 ft) above sea level. The observer(s) will systematically scan the area around the vessel with Big Eyes binoculars, reticle binoculars (e.g., 7 X 50 Fujinon) and with the naked eye during the daytime. Laser range-ding binoculars (Leica L.F. 1200 laser rangefinder or equivalent) will be available to assist with distance estimation. The observers will be used to determine when a marine mammal or sea turtle is in or near the safety radii so that the required mitigation measures, such as course alteration and power-down or shut-down, can be implemented. If the airguns are shut down, observers will maintain watch to determine when the animal is outside the safety radius.

Observers will not be on duty during ongoing seismic operations at night; bridge personnel will watch for marine mammals during this time and will call for the airguns to be shut-down if marine mammals are observed in or about to enter the safety radii. However, a biological observer must be on standby at night and available to assist the bridge watch if marine mammals are detected. If the airguns are ramped-up at night, two marine mammal observers will monitor for marine mammals for 30 minutes prior to ramp-up and during the ramp-up using either deck lighting or night vision equipment that will be available (ITT F500 Series Generation 3 binocular image intensifier or equivalent).

Passive Acoustic Monitoring (PAM)

Although PAM has been used in previous seismic surveys, L-DEO does not propose to use the PAM system during this research cruise. First, the 180–dB zones are significantly smaller than those found for the larger L-DEO arrays making the PAM unnecessary for locating marine mammals. Secondly, the effectiveness of the PAM in shallow water is not high and third, because of the coring operations, additional berthing is unavailable for the PAM operators.

Reporting

L-DEO will submit a report to NMFS within 90 days after the end of the cruise, which is currently predicted to occur during August, 2004. The report will describe the operations that were conducted and the marine mammals that were detected. The report must provide full documentation of methods, results, and interpretation pertaining to all monitoring tasks. The report will summarize the dates and locations of seismic operations, marine mammal sightings (dates, times, locations, activities, associated seismic survey activities), and estimates of the amount and nature of potential take of marine mammals by harassment or in other ways.

ESA

Under section 7 of the ESA, the National Science Foundation (NSF), the agency funding L-DEO, has begun consultation on the proposed seismic survey. NMFS will also consult on the issuance of an IHA under section 101(a)(5)(D) of the MMPA for this activity. Consultation will be concluded prior to a determination on the issuance of an IHA.

National Environmental Policy Act (NEPA)

The NSF has prepared an EA for the GOA oceanographic surveys. NMFS is reviewing this EA and will either adopt it or prepare its own NEPA document before making a determination on the issuance of an IHA. A copy of the NSF EA for this activity is available upon request (see **ADDRESSES**).

Preliminary Conclusions

NMFS has preliminarily determined that the impact of conducting the seismic survey in the GOA in the northeastern Pacific Ocean will result, at worst, in a temporary modification in behavior by certain species of marine mammals. This activity is expected to result in no more than a negligible impact on the affected species or stocks.

For reasons stated previously in this document, this preliminary determination is supported by (1) the likelihood that, given sufficient notice through slow ship speed and ramp-up, marine mammals are expected to move away from a noise source that it ds annoying prior to its becoming potentially injurious; (2) recent research that indicates that TTS is unlikely (at least in delphinids) until levels closer to 200–205 dB re 1 microPa are reached rather than 180 dB re 1 microPa; (3) the fact that 200–205 dB isopleths would be within 100 m (328 ft) of the vessel even in shallow water; and (4) the likelihood that marine mammal detection ability by trained observers is close to 100 percent during daytime and remains high at night to that distance from the seismic vessel. As a result, no take by injury and/or death is anticipated, and the potential for temporary or permanent hearing impairment is very low and will be avoided through the incorporation of the mitigation measures mentioned in this document.

While the number of potential incidental harassment takes will depend on the distribution and abundance of marine mammals in the vicinity of the survey activity, the number of potential harassment takings is estimated to be small. In addition, the proposed seismic program is not expected to interfere with any subsistence hunts, since seismic operations will not take place in subsistence whaling and sealing areas and will not affect marine mammals used for subsistence purposes.

Proposed Authorization

NMFS proposes to issue an IHA to L-DEO for conducting a oceanographic seismic survey in the GOA, northeastern Pacific Ocean, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. NMFS has preliminarily determined that the proposed activity would result in the harassment of small numbers of marine mammals; would have no more than a negligible impact on the affected marine mammal stocks; and would not have an unmitigable adverse impact on the availability of species or stocks for subsistence uses.

Information Solicited

NMFS requests interested persons to submit comments and information concerning this request (see **ADDRESSES**).

Dated: June 17, 2004.

Laurie K. Allen,

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

[FR Doc. 04–14242 Filed 6–22–04; 8:45 am]

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