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Holly A. Kuga,

Acting Deputy Assistant Secretary for Import Administration.

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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[I.D. 031703A]

Small Takes of Marine Mammals Incidental to Specified Activities; Marine Seismic Testing in the Northern Gulf of Mexico

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

ACTION: Notice of receipt of application and proposed authorization for a small take exemption; request for comments.

SUMMARY: NMFS has received an application from the Lamont-Doherty Earth Observatory (LDEO) for an Incidental Harassment Authorization (IHA) to take small numbers of marine mammals, by harassment, incidental to conducting calibration measurements of its seismic array in the northern Gulf of Mexico (GOM). Under the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue a small take authorization to LDEO to incidentally take, by harassment, small numbers of several species of cetaceans for a short period of time within the next 12 months.

DATES: Comments and information must be received no later than My 12, 2003.

ADDRESSES: Comments on the application should be addressed to the 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. A copy of the application, and/or the Environmental Assessment (EA), which contain the list of references used in this document, may be obtained by writing to this address or by telephoning the contact listed here. Comments cannot be accepted if submitted via e-mail or the Internet.

FOR FURTHER INFORMATION CONTACT: Kenneth R. Hollingshead, Office of Protected Resources, NMFS, (301) 713–2055, ext 128.

SUPPLEMENTARY INFORMATION:

Background

Sections 101(a)(5)(A) and (D) of the MMPA ((16 U.S.C. 1361 *et seq.*) directs 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.''

Subsection 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 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; 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.

(B) The term ''Level A harassment'' means harassment described in subparagraph (A)(i).

(C) The term ''Level B harassment'' means harassment described in subparagraph (A)(ii).

Subsection 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 small numbers 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 February 24, 2003, NMFS received an application from LDEO for the taking, by harassment, of several species of marine mammals incidental to conducting calibration measurements of its seismic array in the northern GOM. The LDEO plans to measure sound levels from each of the airgun arrays that will be used during their seismic survey programs during future studies. These measurements will be made in shallow, shelf slope, and deep waters in the GOM during late May and/or June 2003, but may be rescheduled. The purpose of these measurements is to verify estimates of sound fields around the airgun arrays that have been made using LDEO acoustical models. Verification of the output from these models is needed to confirm the distances from the airguns (safety radii) within which mitigation may be necessary to avoid exposing marine mammals to airgun sounds at received levels exceeding established limits, e.g. the 180 and 190 dB re 1 μPa (rms) limits set for cetaceans and pinnipeds, respectively. The measurements will also verify the distances at which the sounds diminish below other lower levels that may be assumed to characterize the zone where disturbance is possible or likely.

The data to be collected during this project can be used to develop a better understanding of the impact of man-made acoustic sources on marine mammals. There is a paucity of calibrated data on levels of man-made sounds in relation to the differing responses of marine mammals to these sources. The planned project will obtain the first calibrated measurements of the *R/V Maurice Ewing*'s (Ewing) acoustic sources across a broad range of frequencies from 1 Hz to 25 kHz, and for various configurations of the Ewing's airgun array. Calibration experiments will be conducted in the shallow, shelf slope, and deep water of the GOM to quantify the differences in sound attenuation in relation to water depth. Once calibration measurements have been made, they will be used to model the full propagation field of the Ewing in varying geographical settings. This modeling will provide data needed to help minimize any potential risk to marine mammals during future seismic surveys.

Description of Activity

The proposed seismic sound measurements will involve one vessel, the *Ewing*. It will deploy and retrieve a spar buoy that will record received airgun sounds, and it will tow the airgun arrays whose sounds will be measured at various distances from the buoy. The *Ewing* will deploy two different airgun arrays in each of the three water depths where measurement will be made. One array will be a 20–

gun array and the other will be a 20–gun array (with varying numbers of those 20 guns active at any one time). While towing each of the arrays and firing the guns at 20–sec intervals, the *Ewing* will approach the spar buoy from 10 km (5.4 nm) away, pass the spar buoy about 100 m (54 nm) to the side of it, and continue until it is 10 km (5.4 nm) past the spar buoy. Sounds will be recorded at the spar buoy and telemetered to the *Ewing*. The Ewing will be self-contained, and the crew of the vessel will live aboard

During the GOM cruise, water depths in the study area will range from <100 to >2000 m (<330 >6500 ft). Airgun operations will be conducted along a total of about 132 km (71.3 nm) of trackline. This includes 66 km (35.6 nm) of trackline for each of the 2–Generator-Injector (GI) guns and the 20–gun array. About one third of the survey effort will be in water <100 m (328.1 ft), one third will be in water 100–2,000 m (328.1–6,561.7 ft), and one third will be in water >2,000 m (>6,561.7 ft). These linear figures represent the planned surveys. There may be additional operations associated with equipment testing and repeat coverage of any calibration run where initial data quality is sub-standard. To allow for these possible additional operations, the estimates of marine mammals that may be taken includes an allowance for an additional 44 km (23.7 nm) of airgun operations or 110 km (59.4 nm) for each of the 2–GI and 20–gun configurations (220 km (118.8 nm) of total trackline).

About one-half of the airgun operations in each water depth category will be conducted with the 2–gun array and the other half will be with varying proportions of the 20–airgun array. During operations with the larger array, the number of airguns active will vary from 6 to 20. The five configurations to be tested (2, 6, 10, 12 and 20 airguns) will include all of the airgun configurations that are anticipated to be used during LDEO's subsequent 2003 cruises.

The procedures to be used during the airgun calibration surveys will be similar to those used during previous seismic surveys by LDEO, e.g., in the equatorial Pacific Ocean (Carbotte *et al.*, 1998, 2000). The proposed program will use conventional seismic methodology with a towed airgun array as the energy source and a LDEO spar buoy as the receiver system. At one of the locations, a moored US Navy/University of New Orleans EARS (Environmental Acoustic Recording System) buoy will also record received sound levels as an independent calibration of the data that are received by the LDEO spar buoy.

The energy for the airgun array is compressed air supplied by compressors on board the source vessel. The specific configuration of the airgun array will be varied to represent all of the different arrays that will be used during 2003 and the most common arrays that will be used in future years. In addition, a multi-beam bathymetric sonar will be operated from the source vessel for part of the calibration survey. A lower-energy sub-bottom profiler will also be operated for part of this cruise. Detailed specifications on the acoustic instrumentation planned for this calibration study can be found in LDEO's application.

Description of Habitat and Marine Mammals Affected by the Activity

A total of 28 cetacean species and one species of sirenian (West Indian manatee) are known to occur in the GOM. These species are the sperm whale (*Physeter macrocephalus*), pygmy sperm whale (*Kogia breviceps*), dwarf sperm whale (*Kogia sima*), Cuvier's beaked whale (*Ziphius cavirostris*), Sowerby's beaked whale (*Mesoplodon bidens*), Gervais' beaked whale (*Mesoplodon europaeus*), Blainville's beaked whale (*Mesoplodon densirostris*), rough-toothed dolphin (*Steno bredanensis*), bottlenose dolphin (*Tursiops truncatus*), pantropical spotted dolphin (*Stenella attenuata*), Atlantic spotted dolphin (*Stenella frontalis*), spinner dolphin (*Stenella longirostris*), Clymene dolphin (*Stenella clymene*), striped dolphin (*Stenella coeruleoalba*), Fraser's dolphin (*Lagenodelphis hosei*), Risso's dolphin (*Grampus griseus*), melon-headed whale (*Peponocephala electra*), pygmy killer whale (*Feresa attenuata*), false killer whale (*Pseudorca crassidens*), killer whale (*Orcinus orca*), short-finned pilot whale (*Globicephala macrorhynchus*), North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), minke whale (*Balaenoptera acutorostrata*), Bryde's whale (*Balaenoptera edeni*), sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus*), and the blue whale (*Balaenoptera musculus*). Another 3 species (long-beaked common dolphin (*Delphinus capensis*), short-beaked common dolphin (*Delphinus delphis*), and long-finned pilot whale (*Globicephala melas*)) could potentially occur in the GOM.

In the northern GOM, cetaceans are concentrated along the continental slope near cyclonic eddy and confluence areas of cyclonic-anticyclonic eddy pairs, due to nutrient-rich water which is thought to increase zooplankton stocks and thus prey abundance in those areas (Davis *et al.*, 2002). The narrow continental shelf south of the Mississippi River delta appears to be an important habitat for some cetacean species (Baumgartner *et al.*, 2001; Davis *et al.*, 2002). Low salinity, nutrient-rich waters may occur over the continental slope near the mouth of the Mississippi River or be entrained within the confluence areas and transported beyond the continental slope, creating a deep-water environment with increased productivity (Davis *et al.*, 2002). The rate of primary productivity and the standing stocks of chlorophyll and plankton are higher in this area as compared with other regions in the oceanic Gulf (Dagg *et al.*, 1988; Ortner *et al.*, 1989; Muller-Karger *et al.*, 1991). This increased productivity may explain the presence of a breeding population of endangered sperm whales within 100 km (54 nm) of the Mississippi River delta (Davis *et al.*, 2002). The southwestern Florida continental shelf may be another region of high productivity, and an important habitat for several cetacean species (Baumgartner *et al.*, 2001).

Several species of cetaceans are also widespread outside the previously described areas, on the continental shelf and/or along the shelf break. These include bottlenose dolphins, Atlantic spotted dolphins, and Bryde's whales (Davis *et al.*, 2002). Thus, cetaceans in the GOM seem to be partitioned by their habitat preferences, which are likely based on prey distribution (Baumgartner *et al.*, 2001).

Detailed descriptions of the marine mammal species are provided in the LDEO application and EA (both documents are available upon request (see **ADDRESSES**)). Please refer to those documents for additional information. Additional information on these species can also be found in Waring *et al.* (2001, 2002). These latter reports are available at the following location: *http://www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/sars.html*

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 (as are vehicle launches), 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). 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.

Characteristics of Airgun Pulses

Airguns were first developed by the offshore seismic industry as a replacement to the use of explosives to obtain necessary acoustic signals (Richardson *et al.*, 1995). 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 sizes, arrangement and firing times of the individual airguns in an array are designed and synchronized to suppress the pressure oscillations subsequent to the first cycle. 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.

The peak-to-peak (P-P) source levels of the 2–20–gun arrays to be studied in the planned project range from 236 to 262 dB re 1 μPascal at 1 m. These are the nominal source levels applicable to downward propagation. The effective source level for horizontal propagation is lower than the nominal source level, at least for the 6- to 20–gun arrays.

Several factors may reduce the effects of sounds on marine mammals. First, 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. Second, 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. Finally 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 P-P levels, in bar-meters or dB re 1 μPa-m. The peak (= zero-to-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 P-P value (Greene, 1997; McCauley *et al.*, 1998, 2000a). A fourth measure that is sometimes used is the energy level, in dB re 1 μPa^2. Because the pulses are <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. In the past, NMFS has commonly referenced 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. (However, sound travel in the bottom may travel faster than that in the water and, thus, may arrive earlier than the direct arrival despite traveling a greater distance.) 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. For example, for one airgun array operating in the Beaufort Sea, pulse duration was about 300 ms at a distance of 8 km (4.3 nm), 500 ms at 20 km (10.8 nm), and 850 ms at 73 km (39.4 nm) (Greene and Richardson, 1988).

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 marine 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, even during operations in nearshore waters (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 mPa). 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.

The distances at which seismic pulses from the Ewing's airguns are expected to diminish to various received levels of 190, 180, 170 dB and 160 dB re 1 mPa, on an rms basis) are as follows:

Airgun Array	RMS Radii (m/ft)			
	190 dB	180 dB	170 dB	160 dB
2 GI airguns*	15/49	50/164	155/508	520/1706
6 airguns**	50/164	220/722	700/2296	2700/8858
10 airguns**	250/820	830/2723	2330/7644	6500/21325
12 airguns**	300/984	880/2887	2680/8793	7250/23786
20 airguns**	400/1312	950/3117	3420/11220	9000/29527

* Airgun depth 6 m (20 ft)
**airgun depth 7.5 m (24.6 ft)

The primary objective of LDEO's planned study is to verify or improve these estimated distances. Additional details concerning the expected levels at various distances and angles relative to each of these airgun arrays can be found in the LDEO application.

Effects of Seismic Surveys on Marine Mammals

The LDEO application provides the following information on what is known about the effects on marine mammals of the types of seismic operations planned by LDEO. 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 LDEO application.

Masking

Masking effects on marine mammal calls and other natural sounds are expected to be limited. Seismic sounds are short pulses occurring for less than 1 sec every 20 or 60–90 sec in this project. Sounds from the multi-beam 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 multi-beam sonar as received at any one location would actually be only 1/5th or at most 2/5th 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 (e.g., 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). 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 plus the fact that sounds important to them 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; 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 and preadaptation to tolerate some masking by natural sounds (Richardson *et al.*, 1995), would all reduce the importance of masking.

Disturbance by Seismic Surveys

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous dramatic changes in activities, and displacement. Disturbance is the primary concern for this project. 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 be significant to the individual let alone the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be significant. 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 were 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 disturbed to some biologically important degree by a seismic program are based on behavioral observations during studies of several species (humpback, gray and bowhead whales; ringed seals). However, information is lacking for many other species. These potential impacts are discussed further in the LDEO application.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. 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 temporary threshold shift (TTS). The level associated with the onset of TTS is considered to be a level below which there is no danger of damage and current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds exceeding 180 and 190 dB re 1 micro Pa (rms), respectively.

Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun array (and multi-beam 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 might (in theory) occur 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.

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. The magnitude of TTS depends on the level and duration of noise exposure, among other considerations (Richardson *et al.*, 1995). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. Only a few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals.

The predicted 180– and 190–dB distances for the airgun arrays operated by LDEO during this activity were summarized previously in this document. These sound levels are not considered to be the levels at or above which TTS would occur. Rather, they are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS, one cannot be certain that there will be no injurious effects, auditory or otherwise, to marine mammals. It has 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. 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, ramping up airgun arrays, which has become standard operational protocol for many seismic operators, including LDEO, should allow cetaceans to move away from the seismic source and to avoid being exposed to the full acoustic output of the airgun array.

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, and 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 do not cause permanent auditory damage in terrestrial mammals, and presumably do not do so in marine 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). In terrestrial mammals, the received sound level from a single sound exposure must be far above the TTS threshold for any risk of permanent hearing damage (Kryter, 1994; Richardson *et al.*, 1995). 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.

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 μPa (P-P) in odontocetes, then the PTS threshold might be about 240 dB re 1 μPa (P-P). 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). 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 and pinnipeds are not found in the GOM. Therefore, although it is unlikely that the planned seismic surveys could cause PTS in any marine mammals, caution is warranted given the limited knowledge about noise-induced hearing damage in marine mammals, particularly baleen whales.

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, and there is no evidence that they can cause serious injury, death, or stranding. However, the association of mass strandings of beaked whales with naval exercises and, in a recent case, an LDEO seismic survey has 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 Channel 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.

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 recent (September, 2002) stranding of two Cuvier's beaked whales in the Gulf of California (Mexico) when a seismic survey by the National Science Foundation (NSF)/LDEO vessel 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 this 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, as discussed later in this document, 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

As mentioned previously, possible types of non-auditory physiological effects or injuries that might occur in marine mammals exposed to strong underwater sound might, in theory, include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage. There is no proof 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 of the type planned by LDEO, where the tracklines are generally not as closely spaced as in many 3–dimensional industry surveys, or the brief acoustic measurement program planned for the northern GOM.

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. Diving marine mammals are not subject to the bends or air embolism because, unlike a human SCUBA diver, they only breath air at sea level pressure and have protective adaptations against getting the bends. There may 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).

A recent workshop (Gentry (ed.), 2002) was held 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 auditory impairment or other physical effects in marine mammals. Available data suggest that such effects, if they occur at all, would be limited to situations where the marine mammal is located at a short distance 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) will be operated from the source vessel at some time during the calibration study. Sounds from the multi-beam sonar are very short pulses, occurring for 1–10 msec once every 1 to 15 sec, depending on water depth. Most of the energy in the sound pulses emitted by this multi-beam sonar is at high frequencies, centered at 15.5 kHz. The beam is narrow (2.67°) in fore-aft extent, and wide (140°) in the cross-track extent. Each ping consists of five successive transmissions (segments) at different cross-track angles. Any given mammal at depth near the trackline would be in the main beam for only one or two of the five segments, i.e. for 1/5th or at most 2/5th of the 1–10 msec.

Navy sonars that have been linked to avoidance reactions and stranding of cetaceans (1) generally are more powerful than the Atlas Hydrosweep, (2) have a longer pulse duration, and (3) are directed close to horizontally (vs. downward for the Hydrosweep). The area of possible influence of the Hydrosweep is much smaller (a narrow band below the source vessel). Marine mammals that encounter the Hydrosweep 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.

Masking by Mid-Frequency Sonar Signals

There is little chance that marine mammal communications will be masked appreciably by the multi-beam sonar signals given the low duty cycle of the sonar 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 do not overlap with the predominant frequencies in the calls, which would avoid significant masking.

Behavioral Responses Resulting from Mid-Frequency Sonar Signals

Marine mammal behavioral reactions to military and other sonars appear to vary by species and circumstance. Sperm whales reacted to military sonar, apparently from a submarine, by dispersing from social aggregations, moving away from the sound source, remaining relatively silent and becoming difficult to approach (Watkins *et al.*, 1985). Other early and generally limited observations were summarized in Richardson *et al.* (1995). More recently, Rendell and Gordon (1999) recorded vocal behavior of pilot whales during periods of active naval sonar transmission. The sonar signal was made up of several components each lasting 0.17 sec and sweeping up from 4 to 5 kHz. The pilot whales were significantly more vocal while the pulse trios were being emitted than during the intervening quiet periods, but did not leave the area even after several hours of exposure to the sonar.

Reactions of beaked whales near the Bahamas to mid-frequency naval sonars were summarized earlier. Following extended exposure to pulses from a variety of ships, some individuals beached themselves, and others may have abandoned the area (Balcomb and Claridge, 2001; NOAA and USN, 2001). Pulse durations from these sonars were much longer than those of the LDEO multi-beam sonar, and a given mammal would probably receive many pulses. All of these observations are of limited relevance to the present situation because exposures to multi-beam pulses are expected to be brief as the vessel passes by, and the individual pulses will be very short.

Captive bottlenose dolphins and a beluga 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 LDEO (Ridgway *et al.*, 1997; Schlundt *et al.*, 2000), and to shorter broadband pulsed signals (Finneran *et al.*, 2000, 2002). Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure or to avoid the location of the exposure site during subsequent tests (Schlundt *et al.*, 2000; Finneran *et al.*, 2002). Dolphins exposed to 1–sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa rms and belugas did so at received levels of 180 to 196 dB and above. Received levels necessary to elicit such reactions to shorter pulses were higher (Finneran *et al.*, 2000, 2002). Test animals sometimes vocalized after exposure to pulsed, mid-frequency sound from a watergun (Finneran *et al.*, 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway *et al.*, 1997; Schlundt *et al.*, 2000). The relevance of these data to free-ranging odontocetes is uncertain. In the wild, cetaceans sometimes avoid sound sources well before they are exposed to the levels listed above, and reactions in the wild may be more subtle than those described by Ridgway *et al.* (1997) and Schlundt *et al.*(2000).

In summary, cetacean behavioral reactions to military and other sonars appear to vary by species and circumstance. While there may be a link between naval sonar use and changes in cetacean vocalization rates and movements, it is unclear what impact these behavioral changes (which are likely to be short-term) might have on the animals. Therefore, as mentioned previously, because simple momentary behavioral reactions that are within normal behavioral patterns for that species are not considered to be a taking, the very brief exposure of cetaceans to signals from the Hydrosweep is unlikely to result in a ‘‘take’’ by harassment.

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 on Marine Mammals). It is worth noting that the multi-beam sonar proposed for use by LDEO is quite different than sonars used for navy operations. Pulse duration of the multi-beam sonar 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 beamwidth. (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.

Possible Effects of the Sub-bottom Profiler Signals

A sub-bottom profiler will be operated from the source vessel at some times during the planned study. Sounds from the sub-bottom profiler are very short pulses, occurring for 1, 2 or 4 msec once every second. Most of the energy in the sound pulses emitted by this multi-beam sonar is at mid frequencies, centered at 3.5 kHz. The beamwidth is approximately 300 and is directed downward.

Sound levels have not been measured for the sub-bottom profiler used by the *Ewing*, but Burgess and Lawson (2000) measured the sounds propagating more or less horizontally from a similar unit with similar source output (205 dB re 1 μPa-m source level). The 160 and 180 dB re 1 μPa (rms) radii, in the horizontal direction, were estimated to be near 20 m (65.6 ft) and 8 m (26.2 ft) from the source, as measured in 13 m (42.6 ft) water depth. The corresponding distances for an animal in the beam below the transducer would be greater, on the order of 180 m (590.5 ft) and 18 m (59 ft) (assuming spherical spreading).

The sub-bottom profiler on the *Ewing* has a maximum source level of 204 dB re 1 μPa-m. Thus the received level should be expected to decrease to 160 and 180 dB about 160 and 16 m (525 and 52.5 ft) below the transducer, respectively (again assuming spherical spreading). Corresponding distances in the horizontal plane would be lower, given the directionality of this source (30° beamwidth) and the measurements of Burgess and Lawson (2000).

Masking by Sub-bottom Profiler Signals

There is little chance that marine mammal communications will be masked appreciably by the sub-bottom profiler signals given its relatively low power output, the low duty cycle 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 do not overlap with the predominant frequencies in the calls, which would avoid significant masking.

Behavioral Responses by Sub-bottom Profiler Signals

Marine mammal behavioral reactions to pulsed sound sources are discussed above and responses to the sub-bottom profiler are likely to be similar to those of other pulsed sources at the same received levels. However, the pulsed signals from the sub-bottom profiler are much weaker than those from the airgun array and the multi-beam, so behavioral responses are not expected unless marine mammals were very close to the source, e.g. with about 160 m (525 ft) below the vessel, or a lesser distance to the side. Thus, the very brief exposure of cetaceans to small numbers of signals from the sub-bottom profiler would not result in Level B harassment.

Hearing Impairment and Other Physical Effects

Source levels of the sub-bottom profiler are much lower than airguns and the multi-beam. Sound levels from a sub-bottom profiler similar to the one on the *Ewing* were estimated to decrease to 180 dB re 1 μPa (rms) at 8 m (26.2 ft) horizontally from the source (Burgess and Lawson, 2000), and about 18 m (59 ft) downward from the source. Thus few, if any, marine mammals are likely to approach close enough to the sub-bottom profiler to be exposed to pulse levels that might cause hearing impairment or other physical injuries.

Furthermore, 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 before the mammals would be close enough to be affected by the less intense sounds from the sub-bottom profiler. In the event that mammals 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.

Estimates of Take by Harassment

As described previously in this document and in the LDEO application, animals subjected to sound levels greater than 160 dB may alter their behavior or distribution, and, therefore, might be considered to be taken by harassment. However, the 160–dB criterion, used by NMFS as an indicator of where Level B harassment may result from impulse sounds, is based on studies of baleen whales. Odontocete hearing at low frequencies is relatively insensitive, and the dolphins generally appear to be more tolerant of strong sounds than are most baleen whales. For that reason, it has been suggested that for purposes of estimating incidental harassment of odontocetes, a 170–dB criterion might be appropriate.

All anticipated takes would be Level B harassment takes involving temporary changes in behavior. The mitigation measures to be applied by LDEO will minimize the possibility of injurious takes during the planned acoustic calibration project in the northern GOM. The estimate of the number of marine mammals that might be taken by harassment is based on a consideration of the number of marine mammals that might be disturbed by operations with the specific airgun arrays planned for each of the calibration runs past the spar buoy. LDEO's initial estimates of the numbers that might be disturbed assume that, on average, cetaceans exposed to airgun sounds with received levels ≤160 dB re 1 μPa (rms) might be sufficiently disturbed to be ''taken by harassment.'' The best estimate also includes an allowance for four extra source-vessel transits past the spar buoy in order to obtain the required calibration data and, therefore, is an overestimate if the calibrations measurements require only six transits. The best estimates take account of data on marine mammal abundance from previous surveys in that area.

The anticipated radii of influence of the multi-beam sonar and the sub-bottom profiler are much less than that for the airgun array (see previous discussion). It is assumed that any marine mammal close enough to be affected by the multi-beam sonar or the sub-bottom profiler would already be affected by the airguns. Therefore, no additional takings by harassment would occur for animals that might be affected by the multi-beam sonar or the sub-bottom profiler.

Estimates of Take by Harassment for the GOM

Extensive aircraft- and ship-based surveys have been conducted for marine mammals in the GOM, including the area where the calibration study will be conducted (Davis *et al.*, 2000, 2002; Wursig *et al.*, 2000; Baumgartner *et al.*, 2001). However, oceanographic and other conditions strongly influence the distribution and numbers of marine mammals present in an area (Davis *et al.*, 2002). Thus, for some species the densities derived from recent surveys may not be representative of the densities that will be encountered during the proposed acoustical calibration study. Table 3 in the LGEO application gives the densities for each species or species group of marine mammals in LDEO's proposed study area based on the 1996/97 GulfCet II surveys (Davis *et al.*, 2000). The densities from the GulfCet studies had been corrected by the original authors for detectability bias but not for availability bias. Therefore, in Table 3, LDEO has adjusted the originally reported densities and population estimates to account for availability bias. Based on those densities, the numbers of each species that might be taken by harassment and the requested level of take by harassment are shown in that table.

Dolphins account for 94 percent of the ''best estimate'' (i.e., 486 of 520 animals). There is no general agreement regarding any alternative ''take'' criterion for dolphins exposed to airgun pulses. However, if only those dolphins exposed to ≥170 dB re 1 μPa (rms) were affected sufficiently to be considered ''taken by harassment'', then the best estimate for dolphins would be 183 rather than 486. This is based on the predicted 170 dB radii around the 2 GI gun and 20–airgun arrays (155 m (508 ft) and 3,420 m (11, 220 ft), respectively). This number of 183 animals is considered by LDEO to be a more realistic ''best estimate'' of the number of dolphins that may be disturbed (i.e., Level B harassment). This number is about 0.1 percent of the estimated GOM population of dolphins (approx. 165,715). Therefore, the total number of dolphins likely to react behaviorally is considerably lower than the estimated 486 animals.

Of the 520 marine mammals that might be exposed to airgun sounds with received levels >160 dB re 1 μPa (rms), an estimated two would be sperm whales. Two sperm whales represent 0.4 percent of the estimated GOM population of about 530 sperm whales.

Mitigation

The directional nature of the alternative airgun arrays to be used in this project (especially the larger arrays) is an important mitigating factor. This directionality will result in reduced sound levels at any given horizontal distance than would be expected at that distance if the source were omnidirectional with the stated nominal source level.

For the proposed airgun calibration work in the GOM in 2003, LDEO at times will use 2 GI-guns with total volume 210 in^3, and at other times will use a 20–gun array with 6–20 active guns and total volume 1350–8600 in^3. Individual airguns will range in size from 80 to 850 in^3. The airguns comprising these arrays will be spread out horizontally, so that the energy from the array will be directed mostly downward.

The sound pressure fields have been modeled in relation to distance and direction from each of the five array configurations and are shown in Figs. 7–11 in LDEO's application. The radii around the arrays where the received level would be 180 dB re 1 μPa (rms), the shutdown criterion applicable to cetaceans, were estimated as 50 m (164 ft), 220 m (722 ft), 830 m (2,723 ft), 880 m (2,887 ft) and 950 m (3,117 ft) for the 2-, 6-, 10-, 12-, and 20–gun arrays, respectively.

Vessel-based observers will watch for marine mammals in the vicinity of the arrays. Until such time as the sound pressure fields estimated by the model have been confirmed by measurements of actual sound pressure levels, LDEO proposes to use 1.5 times the 180 dB isopleth. One of the main purposes of the measurements that will be made during the GOM project is to verify or refine these safety radii. The current plan is to measure sounds produced by the 6-, 10-, 12- and 20–gun arrays during the same transit past the spar buoy, operating these four combinations of airguns in a repeating sequence. The safety radius for the 20–gun array (x1.5) will be used whenever the sequence including (at times) 20 active guns is in progress. Sounds from the 2 GI guns will be measured during separate transits past the spar buoy. During the GOM cruise, the proposed safety radii for cetaceans are 75 m (246 ft) and 1,425 m (4,675 ft), respectively, for the 2 GI-guns and 20–gun array. LDEO proposes to shut down the airguns if marine mammals are detected within the proposed safety radii.

Also, LDEO proposes to use a ramp-up (soft-start) procedure when commencing operations. Ramp-up will begin with the smallest gun in the array that is being used (80 in3 for all subsets of the 20–gun array). Guns will be added in a sequence such that the source level of the array will increase at a rate no greater than 6 dB per 5–minutes.

Marine Mammal Mitigation Monitoring

Vessel-based observers will monitor marine mammals near the source vessel starting 30 minutes before all airgun operations. Airguns will be operated only during daylight; they will not be operated or started up during nighttime. Airgun operations will be suspended when marine mammals are observed within, or about to enter, designated safety zones where there is a possibility of significant effects on hearing or other physical effects. Vessel-based observers will watch for marine mammals near the seismic vessel during daylight periods with shooting, and for at least 30 minutes prior to the planned start of airgun operations.

Two observers will monitor marine mammals near the *Ewing* during all airgun operations in the GOM. The *Ewing* is a suitable platform for marine mammal observations. The observer's eye level will be approximately 11 m (36 ft) above sea level when stationed on the bridge, allowing for good visibility within a 21° arc for each observer. In addition to visual observations, a towed hydrophone array will be used to detect and locate marine mammals. This will increase the likelihood of detecting and identifying any marine mammals that are present during airgun operations. The proposed monitoring plan is summarized later in this document.

Proposed Safety Radii

Received sound levels have been modeled for the 2-, 6-, 10-, 12-, and 20–airgun arrays and are depicted in Figures 7–11 of the LDEO application. Based on the modeling, estimates of the 190-, 180-, 170-, and 160–dB re 1 μPa (rms) distances (safety radii) for these arrays are shown in Table 1 in the application and previously in this document. Acoustic measurements in shallow (<100 m/328 ft), mid-depths (100–2000 m/328–6,562 ft), but probably about 1000 m (3,281 ft)), and deep (>2000 m) water will be taken during the proposed cruise, in order to check the modeled received sound levels during operation of these airgun arrays in a wide variety of water depths. Because the safety radii will not be confirmed before the cruise, conservative safety radii will be used during the proposed GOM surveys. Conservative radii will be established at 1.5 times the distances calculated for the 2 GI-guns and the 20 airgun array. Thus, during the GOM cruise the proposed conservative safety radii for cetaceans are 75 m (246 ft) and 1,425 m (4,675 ft) for the 2 GI guns and 20–gun arrays, respectively.

Airgun operations will be suspended immediately when cetaceans are detected within or about to enter the appropriate 180–dB (rms) radius. This 180 dB criterion is consistent with guidelines listed for cetaceans by NMFS (2000) and other guidance by NMFS.

Mitigation During Operations

The following mitigation measures, as well as marine mammal monitoring, will be adopted during the GOM acoustic verification program, provided that doing so will not compromise operational safety requirements:

Course alteration

If a marine mammal is detected outside the safety radius and, based on its position and the relative motion, is likely to enter the safety radius, alternative ship tracks will be plotted against anticipated mammal locations. If practical, the vessel's course and/or speed will be changed in a manner that avoids approaching within the safety radius while also minimizing 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 radius. If the mammal appears likely to enter the safey radius, further mitigative actions will be taken (i.e., either further course alterations or shutdown of the airguns).

Shutdown procedures

Vessel-based observers using visual aids and acoutical arrays will monitor marine mammals near the seismic vessel for 30 minutes prior to start up and during all airgun operations. No airguns will be operated during periods of darkness. Airgun operations will be suspended immediately when marine mammals are observed or otherwise detected within, or about to enter, designated safety zones where there is a possibility of physical effects, including effects on hearing (based on the 180 dB criterion specified by NMFS). The shutdown procedure should be accomplished within several seconds (or a ''one shot'' period) of the determination that a marine mammal is within or about to enter the safety zone. Airgun operations will not resume until the marine mammal is outside the safety radius. Once the safety zone is clear of marine mammals, the observers will advise that seismic surveys can re-commence. The ''ramp-up'' procedure will then be followed.

Ramp-up procedure

A ''ramp-up'' procedure will be followed when the airgun arrays begin operating after a specified-duration period without airgun operations. Under normal operational conditions (vessel speed 4–5 knots), a ramp-up would be required after a ''no shooting'' period lasting 2 minutes or longer. At 4 knots, the source vessel would travel 247 m (810 ft) during a 2–minute period. If the towing speed is reduced to 3 knots or less, as sometimes required when maneuvering in shallow water, it is proposed that a ramp-up would be required after a ''no shooting'' period lasting 3 minutes or longer. At towing speeds not exceeding 3 knots, the source vessel would travel no more than 277 m (909 ft) in 3 minutes. These guidelines would require modification if the normal shot interval were more than 2 or 3 min, respectively, but that is not expected to occur during the GOM project.

Ramp-up will begin with the smallest gun in the array that is being used (80 in3). Guns will be added in a sequence such that the source level of the array will increase in steps not exceeding 6 dB per 5–minute period over a total duration of approximately 18–20 min (10–12 gun arrays).

Avoidance of Cetacean Concentrations

The *Ewing* will be involved in separately-permitted studies of sperm whales during the late May and June period when the proposed acoustical measurements will be obtained. Thus the scientists in charge of this program will have first-hand knowledge of the locations of concentrations of sperm whales and other cetaceans. The proposed acoustical measurements therefore will be able to avoid operating near known concentrations of marine mammals.

Monitoring and Reporting

Vessel-based Visual Monitoring

As mentioned under Mitigation, two observers dedicated to marine mammal observations will be stationed aboard LDEO's seismic survey vessel during the acoustical measurement program in the GOM. It is proposed that two marine mammal observers aboard the seismic vessel will search for and observe marine mammals whenever airgun operations are in progress. Airgun operations will be restricted to periods with good visibility during daylight hours. Two observers will be on duty for at least 30 minutes prior to the start of airgun operations and during ramp-up procedures. The observers will watch for marine mammals from the highest practical vantage point on the vessel, which is the bridge. The observer(s) will systematically scan the area around the vessel with 7X50 Fujinon reticle binoculars or with the naked eye. ''Bigeye'' (25 X 150) binoculars will be available during this cruise to assist with species identification of marine mammals that are sighted. Laser rangefinding binoculars (Bushnell Lytespeed 800 laser rangefinder with 4X optics or equivalent) will be available to assist with distance estimation. If a marine mammal is detected well outside the safety radius, the vessel may be maneuvered to avoid having the mammal come within the safety radius. When mammals are detected within or about to enter the designated safety radii, the airguns will be shut down immediately. The observer(s) will continue to maintain watch to determine when the animal is outside the safety radius. Airgun operations will not resume until the animal is outside the safety radius.

The vessel-based monitoring will provide data required to estimate the numbers of marine mammals exposed to various received sound levels, to document any apparent disturbance reactions, and thus to estimate the numbers of mammals potentially taken by harassment. It will also provide the information needed in order to shut down the airguns at times when mammals are present in or near the safety zone. When a mammal sighting is made, the following information about the sighting will be recorded: (1) Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to seismic vessel (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace; (2) Time, location, heading, speed, activity of the vessel (shooting or not), sea state, visibility, cloud cover, and sun glare (The data listed under (2) will also be recorded at the start and end of each observation watch and during a watch, whenever there is a change in one or more of the variables.) All mammal observations and airgun shutdowns will be recorded in a standardized format.

At least two experienced marine mammal observers (with at least one previous year of marine mammal observation experience) will be on duty aboard the seismic vessel.

Prior to the start of the project, the primary observers will participate in a 1–day meeting and training or refresher course on the specific marine mammal monitoring procedures required for this project.

Two observers will be on duty in shifts of duration no longer than 4 hours. Use of two simultaneous observers will increase the proportion of the marine mammals present near the source vessel that are detected. Bridge personnel additional to the dedicated marine mammal observers will also assist in detecting marine mammals and implementing mitigation requirements, and before the start of the seismic survey will be given instruction in how to do so. The results from the vessel-based observations will provide (1) the basis for real-time mitigation (airgun shutdown); (2) information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS; (3) data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted; (4) information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity; and (5) data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity.

Vessel-based Passive Acoustic Monitoring

A towed hydrophone array will be deployed during the airgun measurements in the GOM. The acoustical array will be monitored during airgun operations to detect, locate and identify marine mammals near the Ewing, insofar as this is possible via passive acoustic methods. The acoustical array will provide additional ability to detect, locate and identify marine mammals over and above that provided by visual observations. The acoustical data will be integrated, in real time, with the visual observations to ensure that marine mammals do not enter the 180–dB safety radius.

Acoustical Measurements of Airgun Sounds

The acoustic measurement program is designed to document the received levels of the airgun sounds, relative to distance, during operation of each standard configuration of airgun array deployed from the *Ewing*. In particular, these data will be used to verify or refine present estimates of the safety radii. Those radii are used to determine when the airguns need to be shut down to prevent exposure of cetaceans to received levels ≥180 dB. Sound measurements will be made and reported as discussed previously in this document. LDEO will use the standard methods that have been used and reported during other recent studies of seismic and marine mammals (Greene *et al.*, 1997; McCauley *et al.*, 1998, 2000a,b).

Reporting

A report will be submitted to NMFS within 90 days after the end of the acoustic measurement program in the GOM. The report will describe the operations that were conducted, the marine mammals that were detected near the operations, and at least some of the results of the acoustical measurements to verify the safety radii. (Data from the LDEO spar buoy are expected to be available quickly, but it is uncertain how quickly the EARS data will be available given the nature of the EARS buoys.) The report will be submitted to NMFS, providing full documentation of methods, results, and interpretation pertaining to all monitoring tasks with the possible exception of the backup EARS data. The 90–day report will summarize the dates and locations of seismic operations, sound measurement data, 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.

Endangered Species Act (ESA)

Under section 7 of the ESA, NMFS has begun consultation on the proposed issuance of an IHA under section 101(a)(5)(D) of the MMPA for this activity. Consultation will be concluded prior to the issuance of an IHA.

National Environmental Policy Act (NEPA)

The NSF has prepared an EA for the GOM calibration study. 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 short-term impact of conducting a short-term calibration study of the seismic airgun array onboard the Ewing in the northern GOM in 2003, will result, at worst, in a temporary modification in behavior by certain species of marine mammals. While behavioral modifications may be made by these species as a result of seismic survey activities, this behavioral change is expected to result in no more than a negligible impact on the affected species.

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, no take by injury and/or death is anticipated, and the potential for temporary or permanent hearing impairment is low and will be avoided through the incorporation of the mitigation measures mentioned in this document.

Proposed Authorization

NMFS proposes to issue an IHA to LDEO for conducting a calibration study of the seismic airgun arrays onboard the Ewing in the northern GOM 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 only 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 stocks for subsistence uses.

Information Solicited

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

Dated: April 7, 2003.

Laurie K. Allen,

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

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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[I.D. 040403A]

Advisory Committee to the U.S. Section to the International Commission for the Conservation of Atlantic Tunas (ICCAT); Spring Species Working Group Workshop

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

ACTION: Notice of public meeting.

SUMMARY: The Advisory Committee to the U.S. Section to ICCAT announces its spring meeting with its Species Working Group Technical Advisors, April 30–May 1, 2003.

DATES: The open sessions of the Committee meeting will be held on April 30, 2003, from 9:30 a.m. to 12:30 p.m., and on May 1, 2003, from 10:30 a.m. to 1:30 p.m. Closed sessions will be held on April 30, 2003, from 1:45 p.m. to approximately 6 p.m., and on May 1, 2003, from 8:30 a.m. to 10:30 a.m.

ADDRESSES: The meeting will be held at the Hilton Hotel Silver Spring, 8727 Colesville Road, Silver Spring, MD 20910.

FOR FURTHER INFORMATION CONTACT: Kim Blankenbeker at (301) 713–2276.