

appear to be more tolerant of strong low-frequency sounds than are most baleen whales. As a result, significantly fewer odontocetes than estimated here are likely to be harassed by the proposed action.

Pinnipeds are not expected to be encountered in the SE Caribbean Sea and so the "best estimate" of the number that might be affected is zero. Although unlikely, a more conservative estimate of a maximum of five pinnipeds (most likely hooded seals) might be affected by a portion of the proposed survey in the SE Caribbean Sea. For further information regarding the estimated takes, refer to the LDEO Caribbean 2003 application.

#### *Conclusions- Effects on Cetaceans*

Strong avoidance reactions by several species of mysticetes to seismic vessels have been observed at ranges up to 8 km (4.3 nm) and occasionally as far as 30 km (16.2 nm) from the source vessel. Some bowhead whales avoided waters within 30 km (16.2 nm) of the seismic operation. However, reactions at such long distances appear to be atypical of other species of mysticetes and, even for bowheads, may only apply during migration.

Odontocete reactions to seismic pulses, or at least those 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. 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 account of the mitigation measures that are planned, effects on cetaceans are generally expected to be limited to avoidance of the area around the seismic operation and short-term changes in behavior, falling within the MMPA definition of "Level B harassment." In the cases of mysticetes, these reactions are expected to involve small numbers of individual cetaceans. The "best estimate" is that 377 humpback whales or about 1.7 percent of the North and South Atlantic populations will be exposed to sound levels greater than or equal to 160 dB re 1  $\mu$ Pa (rms). Acevedo and Smultea (1995) provide evidence that the North and South Atlantic populations overlap in their wintering areas. Similarly, only 52 sperm whales or approximately 0.4 percent of the North Atlantic sperm whale population would receive seismic sounds greater than or equal to 160 dB

during the proposed survey in the SE Caribbean Sea.

The numbers of odontocetes that may be harassed by the proposed activities are small relative to the population sizes. A maximum of 2475, 2222, 1369, 867, and 564 common, bottlenose, Atlantic spotted, rough toothed, and pantropical spotted dolphins, respectively (the most abundant delphinids in the proposed survey area) are expected to be exposed to seismic sounds greater than or equal to 160 dB. This represents 1.9 to 4.4 percent of the North Atlantic populations of these species based on population estimates for these species. However, these dolphin species surveys have not been conducted for most of their range in the North Atlantic Ocean and adjacent waters. The true percentages of the populations that might be exposed to seismic sounds greater than or equal to 160 dB are much less than 1.9–4.4 percent. The population sizes and the 1.9 to 4.4 percent are based on a small fraction of their range and their actual population sizes are actually much larger. The true percentages of the populations that might be exposed to seismic sounds greater than 160 dB are therefore much less than 1.9 to 4.4 percent. In light of all of these factors, the potential takings by Level B harassment are expected to have no more than a negligible impact on the affected species or stocks.

Mitigation measures such as controlled speed, course alteration, look-outs, non-pursuit, ramp-ups, and power-downs when marine mammals are seen within defined ranges (See Mitigation) should further reduce short-term reactions to disturbance, and minimize any effects on hearing sensitivity.

#### *Conclusions- Effects on Pinnipeds*

Pinnipeds are not expected to be encountered during the proposed seismic survey in the SE Caribbean Sea. However, a more conservative estimate of a maximum of 5 pinnipeds may be affected by a portion of the proposed survey in the SE Caribbean Sea if they were encountered. If pinnipeds were encountered, the proposed seismic survey would have, at most, a short-term effect on their behavior and negligible impacts on the affected populations. Responses of pinnipeds to acoustic disturbance are variable, but usually quite limited. Effects are expected to be limited to short-term and localized behavioral changes falling within the MMPA definition of "Level B harassment."

#### **Mitigation**

Vessel-based observers will monitor marine mammals in the vicinity of the arrays. LDEO proposes to power-down the airguns if marine mammals are observed within the proposed safety radii, which will be verified prior to the southeast Caribbean cruise, using data from an acoustical measurement study in the Gulf of Mexico which took place May 27, 2003, through June 3, 2003. Also, LDEO proposes to use a ramp-up procedure when commencing operations using the 20-gun array. Ramp-up will begin with the smallest gun in the array (80 in<sup>3</sup>), and 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-minute period over a total duration of about 25 minutes. Refer to LDEO's application for more detailed information about the mitigation measures that are an integral part of the planned activity.

#### *Operational Mitigation*

The directional nature of the 20-airgun array to be used in this project is an important mitigating factor, resulting in lower 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. Because the actual seismic source is a distributed sound source (20 guns) rather than a single point source, the highest sound levels measurable at any location in the water will be less than the nominal source level.

The airguns comprising these arrays will be spread out horizontally, so that the energy from the arrays will be directed mostly downward. 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 nominal source level.

#### *Marine Mammal Monitoring*

Vessel-based observers will monitor marine mammals near the seismic source vessel during all daytime airgun operations and during any nighttime start-ups of the airguns. During daylight, vessel-based observers will watch for marine mammals near the seismic vessel during periods with shooting (including ramp-ups), and for 30 minutes prior to the planned start of airgun operations after an extended shut-down. Observers will not be on duty during ongoing seismic operations at night; bridge personnel will watch for marine mammals during this period and will call for the airguns to be powered-