

3345. These are based on the predicted 170-dB radius around the 20-airgun arrays (2600 m or 8530 ft for the 8575 in<sup>3</sup> array and 2900 m or 9514 ft for the approximately 11,000 in<sup>3</sup> array), and are considered to be more realistic estimates of the number of these species that may be disturbed. Therefore, the total number of animals likely to be harassed is considerably lower than the 10,910 animals that LDEO has estimated in Table 3 (LDEO Bermuda 2003).

#### *Conclusions-Effects on Cetaceans*

The proposed airgun array configurations are larger than those used in many seismic projects; however, shot intervals are longer than during many surveys and so marine mammals will be exposed to fewer seismic pulses than during many other similar seismic surveys. The pulse interval for the 8575 in<sup>3</sup> gun array is 20 seconds and is 240 seconds for the 11,000 in<sup>3</sup> array.

Strong avoidance reactions by several species of mysticetes to seismic vessels have been observed at ranges up to 6 to 8 km (3.2 to 4.3 n.mi.) and occasionally as far as 20–30 km (10.8–16.2 n.mi.) from the source vessel. Some bowhead whales avoided waters within 30 km (16.2 n.mi.) 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. 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 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. LDEO's best estimate is that 501 fin whales, or 1.1 percent of the estimated North Atlantic fin whale population (IWC 2003) will be exposed to sound levels  $\geq 160$  dB re 1  $\mu$ Pa (rms) and potentially affected during the proposed cruise near Bermuda. In light of all these factors, these potential takings by Level

B harassment are expected to have no more than a negligible impact on the affected species or stock.

Larger numbers of odontocetes may be affected by the proposed activities, but the population sizes of the main species also are larger and the numbers potentially affected are small relative to the population sizes. 38 sperm whales or 0.3 percent of the estimated North Atlantic sperm whale population would receive seismic sounds  $\geq 160$  dB. Similarly, only 78 beaked whales from the 5 beaked whale species may be affected by the proposed activities. This is 2.4 percent of the estimated total of all 5 species of beaked whales (3196) that occur along the northeast coast of the U.S. Because the CETAP (1982) surveys were conducted from an airplane, few beaked whales were seen, or at least identified, and densities of beaked whales were estimated to be zero during the autumn surveys. However, LDEO believes there are probably small numbers of beaked whales in the proposed survey area throughout the year, so LDEO used the mean density for the entire year to estimate the densities of beaked whales that might be present during autumn. Most of the proposed seismic survey area is outside of the area for which this 3196 estimate was made, and only a very small part of beaked whale habitat in the North Atlantic was included in the estimate. Thus the actual estimate is more than likely much larger than 3196, and the percentage of animals that might receive seismic sounds  $\geq 160$  dB during the proposed cruise is believed to be less than 1 percent of the 3196 estimated North Atlantic population of the 5 species of beaked whales.

The best estimate of the total number of common dolphins, pilot whales, bottlenose dolphins, Risso's dolphins and striped dolphins that might be exposed to  $\geq 160$  dB re 1  $\mu$ Pa (rms) in the proposed survey area near Bermuda are 3941, 3345, 1871, 858 and 277, respectively. Of these, about 1191, 1011, 565, 259 and 84, respectively might be exposed to  $\geq 170$  dB. These figures are  $<0.1$  to  $<1.1$  percent of the North Atlantic population estimates of these species. However, the actual population sizes are much larger than the estimates so the percentage of the various populations that might be affected are considerably lower than the  $<0.1$  to  $<1.1$  percent mentioned above. The values based on the  $\geq 170$  dB criterion are believed to be a more accurate estimate of the number potentially affected.

Mitigation measures such as controlled speed, look-outs, non-pursuit, ramp-ups, and power- and shut-down procedures when within defined

ranges (See Mitigation) should further reduce short-term reactions to disturbance, and minimize any effects on hearing sensitivity.

#### *Conclusions-effects on Pinnipeds*

Very few if any pinnipeds are expected to be encountered during the proposed seismic survey near Bermuda. However, a few stray hooded and grey seals could be encountered. The best estimate of the numbers of each of the more common (but unlikely) species that might be taken by Level B harassment is no more than two and is most likely zero. It is estimated that a maximum of 10 pinnipeds (five for each species) may be affected by the proposed seismic surveys. None of the pinniped species is considered endangered or vulnerable.

No pinnipeds regularly occur in the proposed survey area and thus none are expected to be encountered. If pinnipeds are encountered, the proposed seismic activities would have, at most, a short-term effect on their behavior and no long-term impacts on individual seals or their 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. Taking these factors into account, impacts are expected to be no more than negligible.

#### **Mitigation**

For the proposed seismic operations in the Bermuda Rise area in 2003, LDEO will use a 20-airgun array. The airguns comprising these arrays will be spread out horizontally, so that the energy from the arrays will be directed mostly downward.

The sound pressure fields have been modeled by LDEO in relation to distance and direction from the standard and augmented 20-gun array as shown in Figures 5 and 6, respectively (LDEO Bermuda 2003). Since the sound pressure fields around both configurations of the 20-gun array are similar, the marine mammal safety radii for the augmented 20-gun array will be used for the duration of the cruise. The radius around the augmented 20-gun array where the received level would be 180 dB re 1  $\mu$ Pa (rms) (the level for onset of Level A harassment applicable to cetaceans) is estimated as 925 m (3035 ft). The radius around the augmented 20-gun array where the received level would be 190 dB re 1  $\mu$ Pa (rms), (the level for onset of Level A harassment applicable to