

(*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*), humpback whale (*Megaptera novaeangliae*), minke whale (*Balaenoptera acutorostrata*), Bryde's whale (*Balaenoptera edeni*), sei whale (*Balaenoptera borealis*), fin whale

(*Balaenoptera physalus*), and blue whale (*Balaenoptera musculus*). Also, one species of pinniped could potentially be encountered during the proposed seismic surveys. This includes the hooded seal (*Cystophora cristata*). Additional information on most of these species is available at: [http://www.nmfs.noaa.gov/prot\\_res/PR2/Stock\\_Assessment\\_Program/sars.html](http://www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/sars.html).

### Potential Effects on Marine Mammals

The sound pressure fields for the 20-gun arrays has been modeled by LDEO, in relation to distance and direction from the airguns. Table 1 in the application (LDEO Caribbean 2003) shows the distances from the arrays where sound levels of  $\geq 190$ , 180, 170, and 160 dB re 1  $\mu$ Pa (rms) are predicted to be received:

| Airgun Array     | Predicted RMS Radii in meters/ft |          |           |             |
|------------------|----------------------------------|----------|-----------|-------------|
|                  | 190 dB                           | 180 dB   | 170 dB    | 160 dB      |
| 20 airguns ..... | 275/902                          | 900/2953 | 2600/8531 | 9000/29,529 |

The rms (root-mean-squared) pressure is an average over the pulse duration. The rms level of a seismic pulse is typically about 10 dB less than its peak level (Greene 1997; McCauley *et al.* 1998, 2000a). The safety radii will be verified prior to the Southeast Caribbean cruise, using data from an acoustical measurement study in deep water within the Gulf of Mexico, which took place from 27 May to 3 June 2003. The data will either confirm or be used to refine the safety radii to be used during this and future LDEO seismic studies.

Previous applications from LDEO have described similar actions. Past **Federal Register** notices for LDEO include July 28, 2003 (68 FR 44291), August 26, 2003 (68 FR 51240), September 12, 2003 (68 FR 53714), and September 17, 2003 (68 FR 54421). The **Federal Register** notice on April 14, 2003 (68 FR 17909) describes, in detail, the characteristics of the *Ewing's* acoustic sources and, in general, the anticipated effects on marine mammals including masking, disturbance, and potential hearing impairment and other physical effects. Possible effects of the sub-bottom profiler have been used in the projects described in the above notices. The LDEO Southeast Caribbean application also provides information on what is known about the effects on marine mammals of the types of seismic operations planned by LDEO.

### Possible Effects of the Mid-Frequency Sonar Signals

A multibeam bathymetric sonar (Atlas Hydrosweep DS-2, 15.5-kHz) will be operated from a source vessel at some times during the planned study. Sounds from the multibeam 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 multibeam sonar is at high frequencies, centered at 15.5

kHz. The beam is narrow ( $2.67^\circ$ ) in fore-aft extent, and wide ( $140^\circ$ ) in the cross-track angles. A marine mammal at depth near the trackline would be in the main beam for only one or two of the five segments. Further information on mid-frequency sonar can be found in the application or in a previous **Federal Register** notice 68 FR 17909 (April 14, 2003).

### Possible Effects of the Sub-bottom Profiler Signals

Sound levels have not been measured for the sub-bottom profiler used by the *Maurice 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  $\mu$ Pa-m). The 160 and 180 dB re 1  $\mu$ Pa (rms) radii, in the horizontal direction, were estimated to be near 20 m (66 ft) and 8 m (26 ft), respectively, from the source, as measured in 13 m (43 ft) water depth. The corresponding distances for an animal in the beam below the transducer would be greater, on the order of 180 m (591 ft) and 18 m (59 ft), assuming spherical spreading. Further information on the sub-bottom profiler can be found in the application as well as in a previous **Federal Register** notice (68 FR 44291, July 28, 2003).

### Estimates of Take by Harassment for the Southeast Caribbean Sea Cruise

All anticipated takes by harassment involve a temporary change in behavior. The mitigation measures to be applied will minimize the possibility of injurious takes. LDEO has calculated the "best estimates" for the numbers of animals that could be taken by level B harassment during the proposed seismic survey in the SE Caribbean Sea using data on marine mammal abundance from a previous survey region, as shown in the predicted RMS radii table.

These estimates are based on a consideration of the number of marine mammals that might be exposed to sound levels greater than 160 dB, which is currently used as the criterion for the onset of level B harassment, by operations with the 20-gun array planned to be used for the project. The anticipated radius of influence of the multibeam sonar is less than that for the airgun array. It is assumed that any marine mammals close enough to be affected by the multibeam sonar would already be affected by the airguns. Therefore, no additional allowance is included for animals that might be affected by the multibeam sonar.

Tables 4 and 5 in the application explain the corrected density estimates as well as the "best estimate" of the numbers of each species that would be exposed to seismic sounds greater than 160 dB.

According to the tables, the percentages of delphinidae that might be exposed to sound levels greater than 160 dB range from zero to 4.4 percent. Aside from the sperm whale, the physeterida and ziphiidae exposure percentages are zero. The percent of sperm whales that might be exposed is 0.4 percent. Except for the humpback and blue whales, the mysticetes and pinnipeds percent of exposure is zero. It is estimated that 1.7 percent of humpback whales and 1.0 percent of blue whales could be exposed to sound levels greater than 160 dB. The "best estimate" of the numbers of common, bottlenose, Atlantic spotted, and pantropical spotted dolphins that might be harassed (exposed to levels greater than 160 dB) are 1.9 percent, 4.4 percent, 2.6 percent, and 4.3 percent, respectively.

The 160 dB criterion is based on studies of baleen whales. Odontocete hearing at low frequencies is relatively insensitive and delphinids generally