

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 μ Pa-m source level). The 160 and 180 dB re 1 μ Pa (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 μ Pa-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 μ Pa (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 μ Pa (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