

during the proposed acoustical calibration study. Table 3 in the LDEO 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 μ Pa (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 μ Pa (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 in³, and at other times will use a 20-gun array with 6–20 active guns and total volume 1350–8600 in³.

Individual airguns will range in size from 80 to 850 in³. 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 μ Pa (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 μ Pa (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