

Along with the airgun operations, two additional acoustical data acquisition systems will be operated during most or all of the cruise. The ocean floor will be mapped with an Atlas Hydrosweep DS-2 multi-beam 15.5-kHz bathymetric sonar, and a 3.5-kHz sub-bottom profiler will also be operated along with the multi-beam sonar. These mid-frequency sound sources are commonly operated from the *Maurice Ewing* simultaneous with the airgun array.

The Atlas Hydrosweep is mounted in the hull of the *R/V Maurice Ewing*, and it operates in three modes, depending on the water depth. The first mode is when water depth is <400 (1312.3 ft). The source output is 210 dB re 1 μ Pa-m rms and a single 1-millisecond pulse or "ping" per second is transmitted, with a beamwidth of 2.67 degrees fore-aft and 90 degrees in beamwidth. The beamwidth is measured to the 3 dB point, as is usually quoted for sonars. The other two modes are deep-water modes: The Omni mode is identical to the shallow-water mode except that the source output is 220 dB rms. The Omni mode is normally used only during start up. The Rotational Directional Transmission (RDT) mode is normally used during deep-water operation and has a 237 dB rms source output. In the RDT mode, each "ping" consists of five successive transmissions, each ensonifying a beam that extends 2.67 degrees fore-aft and approximately 30 degrees in the cross-track direction. The five successive transmissions (segments) sweep from port to starboard with minor overlap, spanning an overall cross-track angular extent of about 140 degrees, with tiny (<1 millisecond) gaps between the pulses for successive 30-degree segments. The total duration of the "ping", including all 5 successive segments, varies with water depth but is 1 millisecond in water depths <500 m (1640.4 ft) and 10 millisecond in the deepest water.

The sub-bottom profiler is normally operated to provide information about the sedimentary features and bottom topography that is simultaneously being mapped by the Hydrosweep. The energy

from the sub-bottom profiler is directed downward by a 3.5-kHz transducer mounted in the hull of the *Maurice Ewing*. The output varies with water depth from 50 watts in shallow water to 800 watts in deep water. Sounds from the sub-bottom profiler are very short pulses, occurring for 1, 2 or 4 msec once every second. Pulse interval is 1 second but a common mode of operation is to broadcast five pulses at 1-s intervals followed by a 5-s pause. 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 30° and is directed downward.

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 μ Pa-m). The 160 and 180 dB re 1 μ 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.

The sub-bottom profiler on the *Maurice Ewing* has a maximum source level of 204 dB re 1 μ Pa-m. Thus the received level would be expected to decrease to 160 and 180 dB at about 160 m (525 ft) and 16 m (52 ft) below the transducer, respectively (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). Additional information on the airgun arrays, Atlas Hydrosweep, and sub-bottom profiler specifications is contained in the application, which is available upon request (see ADDRESSES).

Description of Habitat and Marine Mammals Affected by the Activity

A detailed description of the Norwegian Sea and its associated

marine mammals can be found in a number of documents referenced in the LDEO application and is not repeated here. Approximately 24 species of cetaceans and seven species of pinnipeds may be found within the area of the Storegga slide. These species are the sperm whale (*Physeter macrocephalus*), Cuvier's beaked whale (*Ziphius cavirostris*), northern bottlenose whale (*Hyperoodon ampullatus*), Sowerby's beaked whale (*Mesoplodon bidens*), Blainville's beaked whale (*Mesoplodon densirostris*), beluga whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*), bottlenose dolphin (*Tursiops truncatus*), striped dolphin (*Stenella coeruleoalba*), short-beaked common dolphin (*Delphinus delphis*), white-beaked dolphin (*Lagenorhynchus albirostris*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), Risso's dolphin (*Grampus griseus*), false killer whale (*Pseudorca crassidens*), killer whale (*Orcinus orca*), long-finned pilot whale (*Globicephala melas*), harbor porpoise (*Phocoena phocoena*), North Atlantic right whale (*Eubalaena glacialis*), bowhead whale (*Balaena mysticetus*), humpback whale (*Megaptera novaeangliae*), minke whale (*Balaenoptera acutorostrata*), sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus*), blue whale (*Balaenoptera musculus*), walrus (*Odobenus rosmarus*), bearded seal (*Erignathus barbatus*), hooded seal (*Cystophora cristata*), harbor seal (*Phoca vitulina*), ringed seal (*Pusa hispida*), grey seal (*Halichoerus grypus*), and the harp seal (*Pagophilus groenlandicus*). Additional information on most of these species is contained in Caretta *et al.* (2001, 2002) which is available at: http://www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/sars.html.

Potential Effects on Marine Mammals

With 2-GI gun and 6-gun arrays, the distances at which seismic pulses are expected to diminish to received levels of 190, 180, 170 dB and 160 dB re 1 μ Pa, on an rms basis, are as follows:

Airgun Array	RMS Radii (m/ft)			
	190 dB	180 dB	170 dB	160 dB
2 GI guns	15/49	50/164	155/509	520/1706
6 airguns	50/164	220/722	700/2297	2700/8859

An earlier notice of a (LDEO) application and proposed IHA was published in the **Federal Register** on

April 14, 2003 (68 FR 17909). That notice described, in detail, the characteristics of the *Ewing's* acoustic

sources and, in general, the anticipated effects on marine mammals including masking, disturbance, and potential