

Shutdown Procedures

Vessel-based observers using visual aids and acoustical arrays will monitor marine mammals near the seismic vessel for 30 minutes prior to start up and during all airgun operations. No airguns will be operated during periods of darkness. Airgun operations will be suspended immediately when marine mammals are observed or otherwise detected within, or about to enter, designated safety zones where there is a possibility of physical effects, including effects on hearing (based on the 180 dB criterion specified by NMFS). The shutdown procedure should be accomplished within several seconds (or a "one shot" period) of the determination that a marine mammal is within or about to enter the safety zone. Airgun operations will not resume until the marine mammal is outside the safety radius. Once the safety zone is clear of marine mammals, the observers will advise that seismic surveys can recommence. The "ramp-up" procedure will then be followed.

Ramp-up Procedure

A "ramp-up" procedure will be followed when the airgun arrays begin operating after a specified-duration period without airgun operations. Under normal operational conditions (vessel speed 4–5 knots), a ramp-up would be required after a "no shooting" period lasting 2 minutes or longer. At 4 knots, the source vessel would travel 247 m (810 ft) during a 2-minute period. If the towing speed is reduced to 3 knots or less, as sometimes required when maneuvering in shallow water, it is proposed that a ramp-up would be required after a "no shooting" period lasting 3 minutes or longer. At towing speeds not exceeding 3 knots, the source vessel would travel no more than 277 m (909 ft) in 3 minutes. These guidelines would require modification if the normal shot interval were more than 2 or 3 min, respectively, but that is not expected to occur during the GOM project.

Ramp-up will begin with the smallest gun in the array that is being used (80 in³). Guns will be added in a sequence such that the source level of the array will increase in steps not exceeding 6 dB per 5-minute period over a total duration of approximately 18–20 min (10–12 gun arrays).

Monitoring and Reporting

Vessel-based Visual Monitoring

As mentioned under Mitigation, two observers dedicated to marine mammal observations will be stationed aboard LDEO's seismic survey vessel during the

acoustical measurement program in the GOM. They will search for and observe marine mammals whenever airgun operations are in progress. Airgun operations will be restricted to periods with good visibility during daylight hours. Two observers will be on duty for at least 30 minutes prior to the start of airgun operations and during ramp-up procedures. The observers will watch for marine mammals from the highest practical vantage point on the vessel, which is the bridge. The observer(s) will systematically scan the area around the vessel with 7X50 Fujinon reticle binoculars or with the naked eye. "Bigeye" (25X150) binoculars will be available during this cruise to assist with species identification of marine mammals that are sighted. Laser rangefinding binoculars (Bushnell Litespeed 800 laser rangefinder with 4X optics or equivalent) will be available to assist with distance estimation. If a marine mammal is detected well outside the safety radius, the vessel may be maneuvered to avoid having the mammal come within the safety radius. When mammals are detected within or about to enter the designated safety radii, the airguns will be shut down immediately. The observer(s) will continue to maintain watch to determine when the animal is outside the safety radius. Airgun operations will not resume until the animal is outside the safety radius.

The vessel-based monitoring will provide data required to estimate the numbers of marine mammals exposed to various received sound levels, to document any apparent disturbance reactions, and thus to estimate the numbers of mammals potentially taken by harassment. It will also provide the information needed to shut down the airguns at times when mammals are present in or near the safety zone. When a mammal sighting is made, the following information about the sighting will be recorded: (1) Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to seismic vessel (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace; (2) Time, location, heading, speed, activity of the vessel (shooting or not), sea state, visibility, cloud cover, and sun glare (The data listed under (2) will also be recorded at the start and end of each observation watch and during a watch, whenever there is a change in one or more of the variables.) All mammal observations

and airgun shutdowns will be recorded in a standardized format.

At least two experienced marine mammal observers (with at least one previous year of marine mammal observation experience) will be on duty aboard the seismic vessel.

Prior to the start of the project, the primary observers will participate in a 1-day meeting and training or refresher course on the specific marine mammal monitoring procedures required for this project.

Two observers will be on duty in shifts of duration no longer than 4 hours. Use of two simultaneous observers will increase the proportion of the marine mammals present near the source vessel that are detected. Bridge personnel additional to the dedicated marine mammal observers will also assist in detecting marine mammals and implementing mitigation requirements, and before the start of the seismic survey will be given instruction in how to do so. The results from the vessel-based observations will provide (1) the basis for real-time mitigation (airgun shutdown); (2) information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS; (3) data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted; (4) information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity; and (5) data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity.

Vessel-based Passive Acoustic Monitoring

A towed hydrophone array will be deployed during the airgun measurements in the GOM. The acoustical array will be monitored during airgun operations to detect, locate and identify marine mammals near the *Ewing*, insofar as this is possible via passive acoustic methods. The acoustical array will provide additional ability to detect, locate and identify marine mammals over and above that provided by visual observations. The acoustical data will be integrated, in real time, with the visual observations to ensure that marine mammals do not enter the 180-dB safety radius. LDEO will use the standard methods that have been used and reported during other recent studies of seismic and marine mammals (Greene *et al.*, 1997; McCauley *et al.*, 1998, 2000a,b).