Below are answers to questions posed by the California Coastal Commission in a letter, dated 18 March 1999, to the National Marine Fisheries Service.

1) The operations will be both day and night (and presumably in various weather-conditions). How will marine mammals be observed and avoided during these low-visibility times? Will there only be visual monitoring or is acoustic monitoring included as well?

We propose to rely on visual monitoring. As we mentioned in our IHA request to NMFS, this survey will be the third one the USGS has conducted under the guidance and authority of marine-mammal biologists. We have gained considerable experience in operating an airgun in ways that do not harm the environment.

At night biologists will use light-amplification scopes, and the low power of the airgun is important in this regard because the mitigation zones will be close to the ship. We asked John Calambokidis for his opinion regarding mitigation at night: "Night observations of marine mammals are able to detect only animals in the immediate vicinity, say within 20-30m, of the ship. Even with the use of night vision equipment, sighting rates of marine mammals are dramatically reduced at night. Night observations are primarily valuable in detecting bow-riding dolphins or marine mammals in the immediate vicinity of the ship and air guns. During last year's airgun survey off southern California, the airguns were shut off at night as a result of sightings of marine mammals near the ship, indicating these observations were somewhat effective." We believe there are cogent arguments in favor of continuous airgun operation. If we turn the airgun on and off repeatedly because of dark, fog or high sea state, then whenever the airgun is off, marine mammals would move back into the survey area and could be unintentionally harassed each time we resume operations. In contrast, continuous use of the airgun reveals our location and direction of travel to mammals so they can avoid the survey ship. During the SHIPS survey in Puget Sound, mammals observed from the ship were moving away from the active airguns, so given the choice, marine mammals apparently will stay away. Off Southern California the airguns will be fired every 12 s, and during this interval the ship will have moved 25 m, so the ship will not approach mammals unannounced. If airgun use is restricted to periods of good visibility our operations would be greatly prolonged, thereby increasing the possibility that some mammals would be unintentionally harassed. This survey will require only two weeks to complete, and it will be spread out geographically from Los Angeles south to San Diego, so no one area will be greatly impacted by our activities.

As a final point in favor of continuous operations, the USGS has a fixed budget for this cruise, and the contract for the ship has a set period of performance. The USGS, therefore, cannot conduct this survey as if it had an indefinite time span. In our view, the best course is to complete the experiment as expeditiously as possible.

2) If the operation includes shallow water, why is 25 log R an appropriate dispersion model? Also, one of the two sources, the "Huntec" system, emits sound at or near the

seabottom - how will marine mammals be observed area the bottom (if at all), and again, is the 25 log R the appropriate dispersion model for this source?

In the permit request to NMFS, the USGS used a 25log(R) decay in sound pressure level (SPL) because acoustic modeling and measurements in the field show that sound decays quickly in water that overlies a sloping seabottom. In a medium with no acoustic interfaces, sound spreads spherically and SPL reduces at 20log(R). A sloping bottom, however, causes sound to exit the water layer and beam into the underlying sediment, enhancing the transmission loss toward a beach (e.g. Jensen and Tindle, 1987; Deane and Buckingham, 1993; Glegg, et al., 1993; Richardson et al., 1994; Jensen, et al., 1994). In fact, a zone of high transmission loss, an "acoustic shadow zone," lies just offshore from a beach. This argues against the common misunderstanding that underwater sound intensifies up-slope toward a beach. The enhanced transmission loss, relative to 20log(R), that occurs over a sloping bottom has been verified by field measurements from scattered locations. The U.S. Geological Survey, in conjunction with the SHIPS seismic survey in Puget Sound (Fisher et al., 1999), measured sound decay with distance from a 108 L airgun array (Bain, 1999; a copy of this draft report has been sent to the CCC). A least-squares, straight line fit to data from ranges less than 10 km indicates that airgun sound decays at 29log(R). Off the Big Sur coast of central California, the SPL of a single, 1.6 L airgun decreased at 25log(R) (Malme et al., 1986). Airgun SPL measured off northern Germany, where the water is shallow (2-10 m; J. Nedwell, Subacoustech, Ltd., written commun., 1999), indicates a sharp, 33log(R) decay toward the beach. Greeneridge Sciences, Inc. measured the transmission loss of airgun sound at Platform Harmony in the Santa Barbara Channel (Greeneridge Sciences, Inc., 1998). Estimated loss in this report is high, the coefficient of the logarithm is 48 to 60; however we propose a least-squares, straight line fit to all data, which yields a transmission loss of 27log(R). Measurements of ATOC sounds versus distance, in nearshore water that is 10 m to 80 m deep, indicate a high transmission loss of about 43log(R)

(http://atoc.ucsd.edu/HIquicklookrpt.html).

Hence on the basis of abundant, numerical acoustic modeling and some field measurements we believe that 25log(R) is a conservative estimate of sound transmission loss for airgun sounds over a sloping seabottom, like that offshore from Southern California. In particular sound that propagates into shallow water near and within the 3-mile limit should decay sharply toward shore.

The Huntec instrument is deployed at varying depths beneath the sea surface to avoid noise from large ships and ocean waves, but no attempt is made to maintain this instrument at a close distance to the sea floor. For safety reasons, the Huntec vehicle remains at least 50 m above the seafloor, except in water that is shallower than 100 m, where the Huntec will be at about a 10-m depth. The maximum deployment depth is 150 m. The maximum SPL of the Huntec is about 1/4 of the G-I gun's maximum SPL, and mitigation zones were calculated to account for the G-I gun. These zones, therefore, are even more conservative for Huntec.

3) Just out of curiosity, why is a 35 cu. In. air gun louder than a 40 cu. in. air gun-is that because it contains 2 chambers?

The 3000-psi air pressure used with the generator-injector gun, instead of the 2000-psi pressure used with most airguns, likely accounts for the greater source strength of the G-I gun.

4) At what point will we know who will be doing the actual monitoring?

Employees of John Calambokidis at Cascadia Research in Olympia, WA, will most likely oversee the mitigation.

5) When does NMFS expect to complete its review of USGS' application?

NMFS expects to complete the review in early to middle May (Ken Hollingshead, oral commun.; April 8, 1999)

6) What is the currently-anticipated commencement date for the survey?

We propose to conduct the seismic-reflection survey for two weeks sometime during June and July. Contract negotiations for the research boat are not yet complete.

7) Concerning night-time visual monitoring, what is the illumination distance for the handheld commercial light magnification scope - is it enough to cover the marine mammal avoidance area?

The proposed night-vision equipment will not have the capability to illuminate the ocean with infra-red radiation but instead will amplify available light.

8) The federal register notice notes that marine mammal monitoring occurred during past USGS surveys of March 1998 in Puget Sound and August 1998 in southern California. We would appreciate being provided a copy containing or summarizing the results of such monitoring., including but not limited to marine mammals observed, marine mammal reactions, and avoidance actions taken.

Copies of two reports about the SHIPS survey have been included in a package sent to California Coastal Commission.

References

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