



MARINE MAMMAL COMMISSION

24 June 2013

Mr. P. Michael Payne, Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910-3225

Dear Mr. Payne:

The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the application submitted by the Scripps Institution of Oceanography seeking authorization under section 101(a)(5)(D) of the Marine Mammal Protection Act to take small numbers of marine mammals by harassment. The taking would be incidental to a marine geophysical survey to be conducted in the western tropical Pacific Ocean from September through October 2013. The Commission also has reviewed the National Marine Fisheries Service's 5 June 2013 notice announcing receipt of the application and proposing to issue the authorization, subject to certain conditions (78 Fed. Reg. 33811).

RECOMMENDATIONS

The Marine Mammal Commission recommends that the National Marine Fisheries Service—

- require Scripps, through the cooperation of the Lamont-Doherty Earth Observatory and the National Science Foundation, to determine whether the range of sound speeds (minimums to maximums) at each of the 10 survey sites would increase the associated radii by 20 percent or more and if so, require Scripps to re-estimate the proposed exclusion and buffer zones and associated takes of marine mammals accordingly;
- require the Lamont-Doherty Earth Observatory and the National Science Foundation to test the accuracy of the Observatory's model by comparing it to hydrophone data collected during previous surveys from environments other than the Gulf of Mexico prior to the submittal of applications to the Service for geophysical surveys to be conducted in 2014—if the Observatory and Foundation either do not have enough data to compare the Observatory's model to other environments or do not assess the accuracy of the model, re-estimate the proposed exclusion and buffer zones and associated takes of marine mammals using site-specific parameters (including sound speed profiles, bathymetry, and bottom characteristics) for all future applications that use the Observatory's model;
- (1) require Scripps to revise its take estimates to include Level B harassment takes associated with the use of the sub-bottom profiler and multibeam echosounder when the airgun array is not firing and (2) follow a consistent approach of requiring the assessment of Level B

- harassment takes for those types of sound sources (e.g., sub-bottom profilers, echosounders, side-scan sonar, and fish-finding sonar) by all applicants, who propose to use such sources;
- require Scripps to estimate the numbers of marine mammals taken when the sub-bottom profiler and multibeam echosounder are used in the absence of the airgun array based on the 120-dB re 1 μ Pa threshold rather than the 160-dB re 1 μ Pa threshold;
 - consult with experts in the field of sound propagation and marine mammal hearing to revise the acoustic criteria and thresholds as necessary to specify threshold levels that would be more appropriate for a wider range of sound sources, including sub-bottom profilers and echosounders;
 - require Scripps to use the (1) original density estimates from Dolar et al. (2006) rather than the estimates that have been adjusted by an arbitrary correction factor of 0.5; (2) density estimate for Fraser's dolphins from the Sulu Sea in 1994 and 1995 rather than just 1995; and (3) adjust density estimates for all species using some measure of uncertainty (e.g., two standard deviations) and re-estimate the numbers of takes accordingly;
 - formulate policy or guidance regarding a consistent approach for how applicants should incorporate uncertainty in density estimates;
 - consult with the funding agency (i.e., the National Science Foundation) and individual applicants (e.g., Scripps and Lamont-Doherty Earth Observatory) to develop, validate, and implement a monitoring program that provides a scientifically sound, reasonably accurate assessment of the types of marine mammal takes and the actual numbers of marine mammals taken—the assessment should account for applicable $g(0)$ and $f(0)$ values; and
 - work with the National Science Foundation to analyze monitoring data to assess the effectiveness of ramp-up procedures as a mitigation measure for geophysical surveys.

RATIONALE

The National Science Foundation is funding Scripps to conduct a geophysical survey at 10 sites in the western tropical Pacific Ocean in the area 4° S to 8° N latitude and 126.5 to 144.5° E longitude. Those sites are in international waters and the exclusive economic zones of the Federated States of Micronesia, the Independent State of Papua New Guinea, the Republic of Indonesia, and the Republic of the Philippines. The purpose of the proposed survey is to better assess the hydrologic cycle in the Western Pacific Warm Pool and to test hypotheses related to the Plio-Pleistocene evolution of that Pool. The survey would be conducted in waters 450 to 3,000 m in depth with approximately 1,033 km of tracklines. It would use the R/V *Roger Revelle* to tow a two-airgun array (nominal source level of 229.8 dB re 1 μ Pa at 1 m (peak-to-peak) with a maximum discharge volume of 90 in³) at 3 m depth. The *Revelle* also would tow one hydrophone streamer, 600 m in length, during the survey. In addition, Scripps would operate a 3.5-kHz sub-bottom profiler and a 12-kHz multibeam echosounder continuously throughout the survey. Finally, Scripps would collect piston cores, gravity cores, and multicores at each of the 10 sites.

The Service preliminarily has determined that, at most, the proposed activities would result in a temporary modification in the behavior of small numbers of up to 26 species of marine mammals and that any impact on the affected species would be negligible. The Service does not anticipate any take of marine mammals by death or serious injury. It also believes that the potential for temporary or permanent hearing impairment will be at the least practicable level because of the

proposed mitigation and monitoring measures. Those measures include monitoring exclusion and buffer zones and using shut-down and ramp-up procedures.

Staff members from the National Science Foundation, National Marine Fisheries Service, U.S. Geological Survey, Marine Mammal Commission, and Lamont-Doherty Earth Observatory recently met to discuss some of the Commission's ongoing concerns regarding the potential effects of geophysical surveys. Although a number of concerns were discussed and several resolved, the following paragraphs highlight areas that, in the Commission's view, warrant further attention.

Uncertainty in modeling exclusion and buffer zones

The Commission continues to have concerns regarding the model that is used to estimate sound propagation and the estimated numbers of takes for Foundation-funded geophysical research. These concerns date back to 2010 (please refer to its 12 March and 19 April 2013 letters for detailed rationale). Briefly, Lamont-Doherty Earth Observatory conducts acoustic modeling for Foundation-funded geophysical research, including research conducted by Scripps. For at least six years, the Observatory has estimated exclusion and buffer zones (based on Level A and B harassment, respectively) using a simple ray trace-based modeling approach that assumes a constant sound speed with no bottom interactions (Diebold et al. 2010). That model does not incorporate environmental characteristics of the specific study area including sound speed profiles and refraction within the water column, bathymetry/water depth, sediment properties/bottom loss, or absorption coefficients. However, the Observatory believes that its model generally is conservative when compared to in-situ sound propagation measurements of the R/V *Maurice Ewing's* arrays (i.e., 6-, 10-, 12-, and 20-airgun arrays) and the R/V *Marcus G. Langseth's* 36-airgun array from the Gulf of Mexico (Tolstoy et al., 2004; Tolstoy et al. 2009; Diebold et al. 2010). Diebold et al. (2010) demonstrated that the Observatory's model underestimates the near-field sound levels in waters of intermediate depth (600–1,100 m) and the far-field sound levels in waters of deep depth (1,600–1,700 m). They attributed the underestimation at intermediate depths to a change in the sound speed profiles—an input that the Observatory's model does not take into account. In fact, Diebold et al. (2010) noted the limited applicability of the Observatory's model when sound propagation is dependent on water temperature, water depth, bathymetry, and bottom-loss parameters, all of which may be factors of concern for a survey in water depths as shallow as 450 m. They further indicated that modeling could be improved by including realistic sound speed profiles within the water column. In addition, Tolstoy et al. (2009) acknowledged that sound propagation depends on water depth, bathymetry, and tow depth of the array and that sound propagation varies with environmental conditions and should be measured at multiple locations. Therefore, the Commission has concerns regarding the continued use of the Observatory's model.

Those concerns are based primarily on the need to test and verify the use of the Observatory's model under the environmental conditions to be encountered with each survey. For that reason, the Commission has recommended that the Service or the relevant entity estimate exclusion and buffer zones using either empirical measurements from the particular survey site or a model that takes into account the conditions in the proposed survey area. The model should incorporate operational parameters (e.g., tow depth, source level, number/spacing of active airguns) and site-specific environmental parameters (e.g., sound speed profiles, refraction in the water column, bathymetry/water depth, sediment properties/bottom loss, and wind speed). In the recent

meeting of the various agencies and entities involved, the Observatory indicated that it possibly could compare its model to hydrophone data collected during previous surveys that would represent environmental conditions other than those in the Gulf of Mexico (i.e., deep and intermediate waters in cold water environments that may have surface ducting conditions, shallow water environments, etc.). It also indicated that the sound speed parameter could be changed within its model. The Observatory has historically used and currently uses 1521.6 m/s as the assumed sound speed. That sound speed may be considered an underestimate in some areas where the surveys are conducted, but not necessarily in other areas. Accordingly, until such time that the Observatory's model can be tested and verified, the Commission recommended in its 19 April letter regarding a geophysical survey off Spain that the Service require the Observatory to use the greatest sound speed from the survey area, if sound at any depth travels faster than 1521.6 m/s. The Service did not implement that recommendation.

The Service indicated that it was satisfied that the information supplied by the Observatory within its application comprised the best available information on the likely effects of the activities on marine mammals (78 Fed. Reg. 34069). It is unclear how the Service justified its conclusion that "best available information" was used, when site-specific parameters from the survey area were not incorporated into the model. Effectively, the Observatory assumed that the conditions within the Gulf of Mexico apply worldwide—a supposition that is not supported by science. In addition, the *Federal Register* notice indicated that the 1521.6 m/s sound speed is not an unreasonably low value to be used as an average input. It would be important to have clarity on the meaning of "unreasonably low" and the use of an "average input." The Commission has argued that when uncertainty exists, in this instance in the applicability of the Observatory's model to environments other than the Gulf of Mexico, a precautionary approach should be taken. That approach should not include either a "low" estimate or an "average" input. It should use the maximum sound speed value, since in this instance the Observatory's model can only incorporate an input of a single sound speed.

Further, the issuance notice stated that the Observatory's goal is to have a model that is broadly applicable, without the typical data limitations and significant parameter assumptions that often limit the utility of site-specific models. The Observatory's assumption regarding the model's broad applicability currently is unsubstantiated and will continue to be of concern until such time that its applicability to areas other than the Gulf of Mexico has been verified. Moreover, if modeling underwater sound propagation could be as simple as using a ray-trace model that does not incorporate site-specific parameters, then other applicants would use such models. In the Commission's experience this does not appear to be the case.

Finally, the *Federal Register* notice stipulated that using a maximum sound speed, which likely would occur at the surface, would be less reflective of the entire water column and a poorer value to use in the model. However, in the specific case of sound speed profiles near the proposed area off Spain, sound speeds greater than 1521.6 m/s likely would occur within the top 500 m and below a few thousand meters. The area near the surface presumably would be within the area that the Observatory has indicated the Level A harassment isopleths are the widest, thus affecting the distance to which sound propagates. Therefore, maximum sound speed would in fact be a better value for use in the Observatory's model.

The Commission still believes that use of a maximum sound speed would be a precautionary approach until such time that the Observatory determines the accuracy of its model in environments other than the Gulf of Mexico. But because the Observatory has not implemented the Commission's previous recommendation on this matter, the Commission offers another proposed approach. The Observatory should determine how the associated threshold radii (both for exclusion and buffer zones) change with the range of sound speeds expected to occur at the proposed survey sites. That is, it should calculate the ranges to the various thresholds at representative minimum, average, and maximum sound speeds consistent with the 10 survey sites. A change in 5 percent of those radii may not have a significant effect. However, a 20 percent increase in those radii may increase not only the numbers of animals estimated to be taken but also the distances to which the observers would need to be monitoring. The Commission understands that for the proposed survey the smaller two-airgun array would be used and a 20 percent change may not seem significant. For example, the exclusion and buffer zones for the Observatory's survey off of Spain would have increased from 1.1 km to 1.3 km and 6.9 km to 8.3 km, respectively, with subsequent increases in the numbers of takes for all species.

For all of these reasons, the Marine Mammal Commission recommends that the National Marine Fisheries Service require Scripps, through the cooperation of the Lamont-Doherty Earth Observatory and the National Science Foundation, to determine whether the range of sound speeds (minimums to maximums) at each of the 10 survey sites would increase the associated radii by 20 percent or more and if so, require Scripps to re-estimate the proposed exclusion and buffer zones and associated takes of marine mammals accordingly. Sound speed profiles can be obtained from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model database—the database that the National Science Foundation used to develop its programmatic environmental impact statement for geophysical surveys worldwide. The Commission also recommends that the Service require the Lamont-Doherty Earth Observatory and the National Science Foundation to test the accuracy of the Observatory's model by comparing it to hydrophone data collected during previous surveys from environments other than the Gulf of Mexico prior to the submittal of applications to the Service for geophysical surveys to be conducted in 2014. If the Observatory and Foundation either do not have enough data to compare the Observatory's model to other environments or do not assess the accuracy of the model, the Commission recommends that the Service re-estimate the proposed exclusion and buffer zones and associated takes of marine mammals using site-specific parameters (including sound speed profiles, bathymetry, and bottom characteristics) for all future applications that use the Observatory's model.

Takes associated with the sub-bottom profiler and multibeam echosounder

Scripps estimated the numbers of Level B harassment takes associated with the two-airgun array. However, it did not estimate the numbers of takes associated with the use of the sub-bottom profiler or multibeam echosounder, which would be used continuously during the survey including when the airgun array would not be firing (approximately six days). The Service did not require Scripps to estimate the numbers of takes associated with the use of those sources in the absence of the array firing. The Commission disagrees with that stance.

On several occasions, the Service has determined that the sound sources proposed for use during the survey are within the hearing range of marine mammals and have the potential to cause

Level B harassment. For example, the Service recently issued an incidental harassment authorization to Cape Wind Associates for the use of a single-beam depth sounder, multibeam depth sounder, side scan sonar, magnetometer, shallow-penetration sub-bottom profiler, and medium-penetration sub-bottom profiler to conduct site assessment surveys for renewable energy development off Nantucket Island (78 Fed. Reg. 19217). Those sources generally are the same being proposed for use by Scripps during its geophysical survey. In addition, the Service is considering rulemaking to authorize Level B harassment takes for the use of only high-frequency sound sources (single-beam and multibeam echosounders and side-scan sonar) to conduct hydrographic surveys (78 Fed. Reg. 1205) and for hydrographic, oceanographic, and meteorologic sampling associated with fisheries research activities (78 Fed. Reg. 25703). The Commission believes not only that the estimated takes by Level B harassment should include the potential for taking by all proposed sound sources but also that the Service should follow a consistent approach by requiring all applicants to include taking by those types of sources. Therefore, the Marine Mammal Commission recommends that the National Marine Fisheries Service (1) require Scripps to revise its take estimates to include Level B harassment takes associated with the use of the sub-bottom profiler and multibeam echosounder when the airgun array is not firing and (2) follow a consistent approach of requiring the assessment of Level B harassment takes for those types of sound sources (e.g., sub-bottom profilers, echosounders, side-scan sonar, and fish-finding sonar) by all applicants, who propose to use such sources.

In addition, the Service has categorized sound sources as either impulsive or continuous when determining acoustic criteria and thresholds for Level B harassment (70 Fed. Reg. 1871). However, the Service's guidance currently does not address the appropriate acoustic threshold for non-impulsive intermittent sound sources. As discussed in previous letters to the Service regarding shallow penetration sub-bottom profilers, echosounders, and sonars, those sources have temporal and spectral characteristics which suggest that a lower Level B harassment threshold of 120 dB re 1 μ Pa would be more precautionary. The Commission's 20 May 2013 letter regarding proposed rulemaking to authorize the Southwest Fisheries Science Center's fisheries research activities (see enclosure) outlined various reasons for using that lower threshold. Until such time that the Service includes non-impulsive, intermittent sounds in its revised acoustic criteria and thresholds, the Marine Mammal Commission recommends that the National Marine Fisheries Service require Scripps to estimate the numbers of marine mammals taken when the sub-bottom profiler and multibeam echosounder are used in the absence of the airgun array based on the 120-dB re 1 μ Pa threshold rather than the 160-dB re 1 μ Pa threshold. The Marine Mammal Commission further recommends that the Service consult with experts in the field of sound propagation and marine mammal hearing to revise the acoustic criteria and thresholds as necessary to specify threshold levels that would be more appropriate for a wider range of sound sources, including shallow penetration sub-bottom profilers, echosounders, and side-scan sonar.

Density estimates

Scripps estimated the numbers of takes expected to result from the proposed surveys using the sizes of the buffer zones and associated ensonified areas, coupled with estimates of marine mammal densities. To be precautionary, it then increased the sizes of the ensonified areas by 25 percent. Scripps based its density estimates on marine mammal surveys conducted in the Philippines from May to June 1994 (Dolar et al. 2006), in Guam and the southern Commonwealth of the

Northern Mariana Islands from January to April 2007 (Fulling et al. 2011), and in the outer exclusive economic zone of the Hawaiian Islands from August to November 2002 (Barlow 2006). Because those marine mammal surveys were not conducted in the same locations or during the same months as the proposed geophysical survey, there are inherent uncertainties associated with those estimates.

Some density estimates did incorporate adjustments for trackline detection probabilities ($g(0)$; the probability of sighting an animal that is present along the trackline) and sighting probability density functions ($f(0)$; diminishing sightability with increasing lateral distance from the trackline). However, the Service and Scripps indicated that Dolar et al. (2006) and Fulling et al. (2011) did not correct their estimates for $g(0)$, which resulted in underestimated densities. In addition, Fulling et al. (2011) acknowledged that their estimates were probably of low precision and were underestimated because sighting conditions during the survey were poor and 66 percent of the survey occurred in Beaufort sea states of 4 to 7.

Further, the Service and Scripps applied a correction factor of 0.5 to the density estimates of Dolar et al. (2006). This was based on the supposition that those densities were from surveys that included coastal waters and approximately half of the total ensonified area for the proposed survey is in deep waters. The Commission is unsure of the basis of that supposition because the species surveyed by Dolar et al. (2006) were found in water depths up to 4,500 m. Specifically, the majority of the sightings for spinner dolphins, pantropical spotted dolphins, Fraser's dolphins, short-finned pilot whales, and dwarf sperm whales occurred beyond the 500-m isobaths. For bottlenose dolphins, melon-headed whales, and Risso's dolphins, the majority of the sightings occurred near or along the 500-m isobaths and in deep waters. Because the proposed survey would occur in water depths from 450 to 3,000 m, the Commission does not support the proposed application of a 0.5 correction factor for the Dolar et al. (2006) data. Finally, the Service and Scripps used a density of 430 animals/1,000 km² for Fraser's dolphins, which originated from data from the Sulu Sea in 1995 (Dolar et al. 2006). For the other species, the Service and Scripps appear to have used data from the Sulu Sea in both 1994 and 1995. Use of the Fraser's dolphin data from 1995 not only is inconsistent with the Service's and Scripps' approach for those other species, but it also is the lowest density based on the least number of sightings of either of the years or the two years combined. (430 animals/1,000 km² in 1995 vs. 730 animals/1,000 km² in 1994 and 580 animals/1,000 km² for 1994 and 1995 combined).

The Commission understands that density data are not available for all areas in which activities occur. However, it repeatedly has recommended that when the density estimates have inherent uncertainties, the Service should require the applicant to provide, and the Service should use, the best available density estimate plus some measure of uncertainty (i.e., two standard deviations). The Service has yet to follow this recommendation or require applicants to do so. In this case, most density estimates have an associated coefficient of variation (i.e., the standard deviation divided by the mean) and uncertainty can be incorporated into the density estimates easily. Further, it is unclear why the Service continues to allow some applicants, including those that are Foundation-funded, to use mean densities when scientific studies (and in some instances the very studies from which the data originate) indicate that the mean densities are underestimated or that there are known geographical or temporal differences. The Service followed Commission recommendations for some of its other incidental harassment authorizations (78 Fed. Reg. 28412; 76 Fed. Reg. 18187). While the Foundation may be waiting for guidance from the Service regarding this

issue, the Service can, in the interim, require applicants to adjust those density estimates based on the Commission's recommendations and associated rationale. Thus, the Marine Mammal Commission recommends that the National Marine Fisheries Service require Scripps to (1) use the original density estimates from Dolar et al. (2006) rather than the estimates that have been adjusted by an arbitrary correction factor of 0.5; (2) use the density estimate for Fraser's dolphins from the Sulu Sea in 1994 and 1995 rather than just 1995; and (3) adjust density estimates for all species using some measure of uncertainty (e.g., two standard deviations¹) and re-estimate the numbers of takes accordingly. Further, the Commission recommends that the Service formulate policy or guidance regarding a consistent approach for how applicants should incorporate uncertainty in density estimates.

Monitoring measures

In previous letters, the Commission has indicated that monitoring and reporting requirements should provide a reasonably accurate assessment of the types of taking and the numbers of animals taken by the proposed activity. Those assessments also should account for animals at the surface but not detected and for animals present but underwater and not available for sighting, which are accounted for by $g(0)$ and $f(0)$ values. Those adjustments are essential for making accurate estimates of the numbers of marine mammals taken during surveys. To be useful, the corrections should be based on the ability of the protected species observers to detect marine mammals rather than a hypothetical optimum derived from scientific studies (e.g., from the Service's shipboard surveys). Therefore, the Marine Mammal Commission recommends that the National Marine Fisheries Service consult with the funding agency (i.e., the National Science Foundation) and individual applicants (e.g., Scripps and Lamont-Doherty Earth Observatory) to develop, validate, and implement a monitoring program that provides a scientifically sound, reasonably accurate assessment of the types of marine mammal takes and the actual numbers of marine mammals taken—the assessment should account for applicable $g(0)$ and $f(0)$ values.

Effectiveness of ramp-up procedures

Although the effectiveness of ramp-up procedures has yet to be verified empirically, the Service would continue to require the Observatory to monitor, document, and report marine mammal observations during all ramp-up procedures. Such data will provide a stronger scientific basis for determining the effectiveness of, and deciding when to implement, this particular mitigation measure. The National Science Foundation has indicated that monitoring data from past surveys are being compiled into a single database. The Commission supports that effort. After the data are compiled and quality control measures have been completed, the Marine Mammal Commission recommends that the National Marine Fisheries Service work with the National Science Foundation to analyze those data to assess the effectiveness of ramp-up procedures as a mitigation measure for geophysical surveys. The Commission continues to believe that the Service should continue to require data collection and analysis to assess the effectiveness of ramp-up procedures, given that they are considered a substantial component of mitigation measures.

¹ Most density estimates used for the proposed survey have an associated coefficient of variation, which can be used to determine the standard deviation (i.e., coefficient of variation=standard deviation divided by the mean).

Mr. P. Michael Payne
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The Commission would appreciate an opportunity to discuss in a meeting with the Service several of the general issues raised in this letter and for incidental harassment authorizations as a whole. Thanks for the opportunity to provide comments on Scripps' application. Please contact me if you have questions regarding the Commission's comments and recommendations.

Sincerely,



Rebecca J. Lent, Ph.D.
Executive Director

Cc: Holly Smith, National Science Foundation
Helene Carton, Lamont-Doherty Earth Observatory

Enclosure

References

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MARINE MAMMAL COMMISSION

20 May 2013

Mr. P. Michael Payne, Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910-3225

Dear Mr. Payne:

The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the application submitted by the Southwest Fisheries Science Center (Center) seeking authorization under section 101(a)(5)(A) of the Marine Mammal Protection Act to take small numbers of marine mammals by harassment. The taking would be incidental to fisheries research activities during a five-year period. The Commission also has reviewed the Center's draft environmental assessment and the National Marine Fisheries Service's 2 May 2013 notice (78 Fed. Reg. 25703) announcing receipt of the application and proposing to issue regulations, subject to certain conditions.

RECOMMENDATIONS

The Marine Mammal Commission recommends that, prior to publishing the proposed rule and finalizing the programmatic environmental assessment, the National Marine Fisheries Service—

- require the Center to re-estimate the numbers of marine mammals taken based on the 120-dB re 1 μ Pa threshold rather than the 160-dB re 1 μ Pa threshold for non-impulsive intermittent sound sources; and
- consult with experts in the field of sound propagation and marine mammal hearing to revise the acoustic criteria and thresholds as necessary to specify threshold levels that would be more appropriate for a wider range of sound sources, including echosounders and fish-finding sonar.

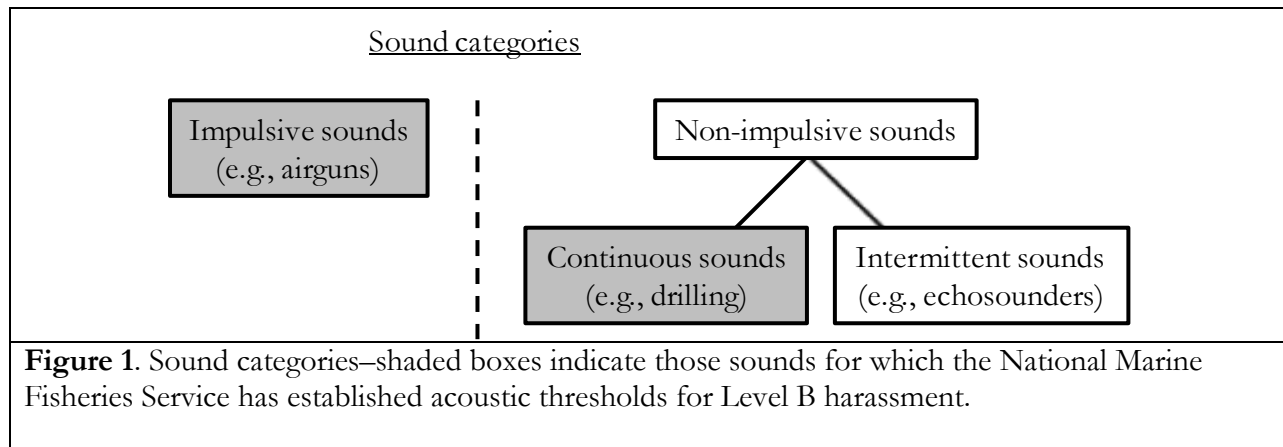
RATIONALE

The Center plans to conduct fisheries research surveys along the U.S. West Coast, throughout the eastern tropical Pacific Ocean, and in the Scotia Sea off Antarctica during a five-year period. The objectives are to (1) evaluate the status of exploited fishery resources and the marine environment and (2) provide scientific information regarding fisheries management to the Pacific Fishery Management Council and numerous other domestic and international fisheries management organizations. Researchers would conduct approximately 14 surveys during the five-year period. The surveys could occur on Service-owned and -operated vessels, charter vessels, or commercial fishing vessels during daytime and nighttime hours.

The Center requested to take by Level A harassment or mortality individuals from up to 17 species or stocks of marine mammals incidental to gear interactions. The takes would occur through marine mammal interactions with fisheries survey gear. To conduct the surveys, the Center would use pelagic trawl gear, pelagic longlines, bottom-contacted trawl gear, and other types of gear (i.e., bongo nets, manta nets, fish egg samplers) but, based on historical data, marine mammals are likely to interact only with pelagic trawl and longline gear. In addition, the Center would conduct concurrent hydrographic, oceanographic, and meteorologic sampling. Researchers could use multi-frequency, narrow-beam scientific echosounders, multi-beam echosounders, acoustic Doppler current profilers, narrow-beam sonar (i.e., fish-finding sonar), and multi-beam sonar that operate at frequencies from 18 to 333 kHz at source levels of 205 to 224 dB re 1 μ Pa at 1 m. The Center has requested to take by Level B harassment individuals from up to 51 species or stocks of marine mammals incidental to use of the acoustic sources.

Threshold for the non-impulsive intermittent sources

The Service has categorized sound sources as either impulsive or continuous to establish acoustic criteria and thresholds for Level B harassment (70 Fed. Reg. 1871; see Figure 1). Impulsive sounds are those with a rapid rise time, high peak pressure, and rapid decay. They are brief (<1 second) and may be repetitive (e.g., an airgun) or singular (e.g., an explosion). Non-impulsive sounds do not have those characteristics and they can be divided into those that are either temporally continuous or intermittent. Continuous sounds are those for which the sound pressure level is elevated consistently above the ambient level during the operation of the sound source—they are not interrupted by a silent period. Examples include sounds from drilling and vessel engines or dynamic positioning systems.



Relying on the results of Malme et al. (1983, 1984), the Service established a 160-dB re 1 μ Pa threshold to estimate the area (or zone) in which animals could be harassed by impulsive sounds and a 120-dB re 1 μ Pa threshold to estimate the area (or zone) in which animals could be harassed by continuous sounds. However, the Service has yet to establish or apply a consistent threshold for non-impulsive, intermittent sounds, such as those produced by echosounders and fish-finding sonars proposed for use by the Center. Those sources generally emit a steady ping, ping, ping that do not exhibit the rapid rise, high peak pressure, and rapid decay used to define impulsive sounds,

but they also are not continuous. Based on their characteristics, echosounders and sonars fall into a category of sounds for which the Service has yet to establish a threshold.

Although the Service has proposed to use the 160-dB re 1 μ Pa threshold for the sound sources that the Center would use, it has not applied the 160-dB re 1 μ Pa threshold consistently to all non-impulsive, intermittent sources. In a 2011 notice (76 Fed. Reg. 43639) the Service determined that for non-impulsive sound sources, whether continuous or intermittent, Level B harassment is presumed to begin at received levels of 120 dB re 1 μ Pa. Recently, the Service reiterated that position when it indicated that Level B harassment is considered to have occurred when marine mammals are exposed to sounds at or above 120 dB re 1 μ Pa for non-pulsed (i.e., non-impulsive) sounds (78 Fed. Reg. 22096). Consistent with that more precautionary determination, the Commission has recommended in numerous letters that the Service require applicants to recalculate Level B harassment zones for non-impulsive, intermittent sounds based on the 120-dB re 1 μ Pa threshold for non-impulsive sounds, rather than the 160-dB re 1 μ Pa threshold used by the Service for impulsive sounds. The Service has disagreed with that recommendation.

Noting the inconsistency, the Commission inquired about the appropriate threshold to be applied to non-impulsive, intermittent sources. The Service explained its reasoning for applying the 160-dB re 1 μ Pa threshold to that type of sound source as follows.

When comparing non-impulsive, intermittent sounds at distances relevant for behavioral harassment to our current criteria for impulsive and continuous sounds (and the data upon which they are based), the temporal characteristics associated with these types of sound sources are more similar to impulsive sounds (which are also intermittent) than to continuous sounds.

This may be true for some sounds, but other sounds may vary from the well-separated blasts of an airgun to the more rapid staccato of an echosounder to sounds timed so closely together that the interval between them is not discernible to the animal—that is, they are effectively continuous. How marine mammals respond to the relatively rapid sounds associated with echosounders is not clear. In the face of this uncertainty, the Service has chosen the least protective threshold.

In its rationale for applying the 160-dB re 1 μ Pa threshold to non-impulsive, intermittent sources, the Service also noted the following.

Furthermore, impulsive sounds lose many of the characteristics that make them potentially injurious (e.g., rise time and high peak pressure) at distances further from the source (i.e., beyond injury zone) making them even more similar to non-impulsive, intermittent sources. Thus, the 160 dB_{rms} threshold is more appropriate than the 120 dB_{rms} threshold for non-impulsive, intermittent sounds.

Although the acoustic discreteness of all sounds deteriorates with propagation, the intervals between intermittent sounds also tend to disappear with the sounds becoming more continuous in nature. Here, too, the Service has interpreted those changes in sound in the far field in the least precautionary way, seemingly ignoring contrary arguments and the associated uncertainty.

The Service has acknowledged that impulsive and non-impulsive, intermittent sound sources also may vary in other characteristics (i.e., spectral characteristics). That distinction is particularly relevant in this instance, because sound from echosounders is emitted in 0.06- to 5-msec pulses every 0.25 to 2 seconds and primarily at frequencies from 18 to 200 kHz. Those source characteristics differ considerably from an impulsive source that emits a broadband sound with a rapid rise time and decay in the lower frequency range (i.e., the medium penetration sub-bottom profiler, with energy levels of 1 kJ from 100 to 1,000 Hz).

The Commission recognizes that the Service has a limited basis for setting acoustic thresholds. However, in the face of uncertainty regarding the importance of various sound characteristics and their impacts on marine mammal behavior, the Commission believes that the Service should be taking a more precautionary approach. Such an approach is necessary for two reasons. First, it is more protective and provides greater assurance that the impacts of the sound will, indeed, be negligible. Second, a more precautionary approach generally provides a stronger incentive for parties (e.g., agencies, industry) to support the research needed to address the uncertainty.

Moreover, the Service has indicated in numerous *Federal Register* notices for incidental taking authorizations that some species of marine mammals have reacted to non-impulsive sources—especially those that are similar in source characteristics to those proposed for use by the Center.

Southall et al. (2007) concluded that the existing data indicate that harbor porpoises are likely sensitive to a wide range of anthropogenic sounds at low received levels (around 90 to 120 dB), at least for initial exposures. All recorded exposures above 140 dB induced profound and sustained avoidance behavior in wild harbor porpoises (Southall et al. 2007).

The Service also indicated that in some cases animals in the wild exhibited significant responses to received levels between 90 and 120 dB re 1 μ Pa from non-impulsive sources, while in other cases those responses were not observed at received levels from 120 to 150 dB re 1 μ Pa. The Commission agrees that certain received levels may elicit a response from some individuals and not others. However, all received levels mentioned by the Service are less than the 160-dB re 1 μ Pa threshold. In addition, numerous researchers have observed various species of marine mammals, including those that would be harassed by the Center, responding to sources (e.g., acoustic deterrent devices, acoustic harassment devices, pingers) with characteristics similar to those to be used by the Center and at received levels below 160 dB re 1 μ Pa (Watkins and Schevill 1975, Olesiuk et al. 1995, Kastelein et al. 1997, Kastelein et al. 2000, Culik et al. 2001, Johnston 2002, Morton and Symonds 2002, Kastelein et al. 2005, Kastelein et al. 2006a and 2006b, Carretta et al. 2008).

Therefore, until such time that the Service includes non-impulsive, intermittent sounds in its revised acoustic criteria and thresholds, the Marine Mammal Commission recommends that the National Marine Fisheries Service require the Center to re-estimate the numbers of marine mammals taken based on the 120-dB re 1 μ Pa threshold rather than the 160-dB re 1 μ Pa threshold. The Marine Mammal Commission further recommends that the Service consult with experts in the field of sound propagation and marine mammal hearing to revise the acoustic criteria and thresholds as necessary to specify threshold levels that would be more appropriate for a wider range of sound sources, including echosounders and fish-finding sonar.

Please contact me if you have questions about the Commission's recommendations or rationale.

Sincerely,



Timothy J. Ragen, Ph.D.
Executive Director

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