2 May 2016

Ms. Jolie Harrison, Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910-3225

Dear Ms. Harrison:

The Marine Mammal Commission (the Commission), in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the application submitted by Lamont-Doherty Earth Observatory (LDEO), in collaboration with the National Science Foundation (NSF), seeking authorization under section 101(a)(5)(D) of the Marine Mammal Protection Act (the MMPA) to take small numbers of marine mammals by harassment. The taking would be incidental to three marine geophysical surveys to be conducted in the southeastern Pacific Ocean between June 2016 and June 2017. The Commission also has reviewed the National Marine Fisheries Service's (NMFS) 19 April 2016 notice announcing receipt of the application and proposing to issue the authorization, subject to certain conditions (81 Fed. Reg. 23118).

Background

LDEO proposes to conduct three 2D geophysical surveys off Chile in its territorial waters[1] and exclusive economic zone (EEZ). The purpose is to study the (1) structure of the upper and lower plates that slipped during the 2014 Pisagua/Iquique earthquake sequence and of the plates to the south where a seismic gap remains unruptured for the northern survey, (2) extent and location of seafloor displacement and related subsurface fault movement relative to the 2015 Illapel earthquake for the central survey, and (3) deep plate boundary thrust fault that can produce some of the world's largest earthquakes and tsunamis for the southern survey. The surveys would be conducted in waters estimated to be 50 to 7,600 m in depth along approximately 9,633 km of tracklines. LDEO would use the R/V *Marcus G. Langseth* to operate a 36-airgun array at a tow depth of 9–12 m. The *Langseth* also would (1) tow a hydrophone streamer (8–15 km in length), (2) use up to 68 ocean-bottom seismometers, and/or (3) deploy an unmanned submersible vehicle (i.e., wave glider) to collect data during the surveys. In addition, LDEO would operate a 10.5- to 13-kHz multibeam echosounder and a 3.5-kHz sub-bottom profiler continuously during the surveys. The surveys are expected to last for a total of 75 days[2].

[1] NMFS does not authorize the taking of marine mammals within the territorial waters (in this case within 12 nmi) of a foreign country but does consider such taking when determining whether the activity would have a negligible impact on the affected species or stocks.
[2] Which includes a 25 percent contingency for equipment failures, resurveying of lines, and other operational needs.

NMFS preliminarily has determined that, at most, the proposed activities would result in the incidental taking of small numbers of up to 44 species of marine mammals by Level B harassment and 26 species of marine mammals by Level A harassment[3] and that any impact on the affected species would be negligible. NMFS 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 measures. Those measures include (1) refraining from operating the multibeam echosounder and sub-bottom profiler in transit to and from the survey area, (2) monitoring the exclusion and buffer zones (based on Level A and B harassment, respectively), (3) implementing speed and course alterations if those alterations do not compromise operational safety, and (4) using power-down, shut-down, and ramp-up procedures. In addition, LDEO would power down the array, if possible, when concentrations of large whales (six or more individuals that do not appear to be traveling and are feeding, socializing, etc.) are observed within the Level B harassment zone. Further, LDEO would report any injured or dead marine mammal to the Office of Protected Resources using NMFS's phased approach. The Commission believes that stranded marine mammals also should be reported to the local stranding network, as is standard practice for other incidental take authorizations, and thus recommends that NMFS require LDEO to report any injured or dead marine mammal to the Government of Chile's Servicio Nacional de Pesca y Acuicultura[4] in addition to the Office of Protected Resources.

Uncertainty in modeling exclusion and buffer zones

The Commission has raised concerns about the method used to estimate exclusion and buffer zones (based on Level A and B harassment, respectively) and the numbers of takes incidental to NSF-funded geophysical research for nearly six years. Recently, other stakeholders[5] have expressed similar concerns regarding the appropriateness of those methods (80 Fed. Reg. 67713). LDEO performs acoustic modeling[6] for geophysical research funded by NSF[7] to estimate exclusion and buffer zones using a simple ray trace–based modeling approach that assumes spherical spreading, a constant sound speed, and no bottom interactions for surveys in deep water (Diebold et al. 2010). As noted in numerous Commission letters, multiple LDEO-affiliated studies[8] have emphasized the importance of incorporating site-specific environmental and operational parameters into estimating exclusion and buffer zones. Most recently, a group of technical experts[9] confirmed that site-specific modeling should be conducted for each seismic survey because each individual acoustic footprint differs based on the source array (including total operational volume,

[3] The Commission understands that NMFS proposed to authorize taking by Level A harassment to account for situations in which marine mammals may enter the Level A harassment zone before the airguns can be either powered or shut down, namely because standard mitigation measures included in incidental take authorizations rely primarily on visual monitoring and implementation may not occur until an animal is observed within the specified zone.
[4] SERNAPESCA. The Commission has provided NMFS with the relevant contact information.
[5] Natural Resources Defense Council and Whale and Dolphin Conservation.
[6] LDEO applies a correction factor to the deep-water radii for surveys in intermediate water and scales empirically-derived measurements from the calibration study in the Gulf of Mexico for surveys in shallow water.
[7] Including NSF's Division of Polar Programs and Antarctic Support Contract (ASC) and projects funded by the U.S. Geological Survey (USGS).
[8] Tolstoy et al. (2004), Tolstoy et al. (2009), Diebold et al. (2010), and most recently, Crone et al. (2014).
[9] Including experts from government, academia, the oil and gas industry, and multiple consulting companies (JASCO Applied Science, Seiche Limited, Styles Group, etc.) tasked with reviewing and providing information relevant to New Zealand Seismic Code of Conduct for Minimizing Acoustic Disturbance to Marine Mammals from Seismic Survey Operations.

configuration, operating pressure/source level, tow depth, etc.) and the bathymetry, substrate, and sound speed profile (which varies by season) associated with the survey area (Department of Conservation (DOC) in prep).

To estimate the proposed exclusion and buffer zones for the surveys in the southeastern Pacific Ocean, LDEO used its model for the 36-airgun array in deep water and the mitigation airgun in general. The use of LDEO's simple model has yet to be substantiated relative to conditions beyond the Gulf of Mexico, including waters off Chile. The Chilean waters, as indicated by both NMFS and LDEO, have a narrow continental shelf with complex bathymetry, upwelling conditions, and high productivity—which are conducive to creating surface duct conditions. LDEO's simple model also is not appropriate for modeling (1) acoustic frequencies greater than 100 Hz due to the isovelocity sound speed assumption, (2) propagation in water depths less than 2 km due to interaction with the ocean floor, which would increase received levels significantly at large ranges from the source, and (3) rough sea states due to eliminating any interference pattern between the direct and surface-reflected (ghost) path, which is assumed by the LDEO model. In addition, LDEO applied a correction factor of 1.5 to the deep-water radii for surveys in intermediate water and scaled, based on tow depth, empirically-derived measurements from the calibration study in the Gulf of Mexico for surveys in shallow water. NMFS did state in the *Federal Register* notice that LDEO used a process to confirm the conservative nature of its radii for a shallow-water seismic survey, which was based on the empirical measurements LDEO routinely uses from the Gulf of Mexico survey likely overestimating the size of the empirically-derived exclusion and buffer zones from Crone et al. (2014)[10]. NMFS indicated it had reviewed that preliminary information when considering how those data reflect on the accuracy of LDEO's current modeling approach and concluded that modeling of the distances likely results in predicted distances that are conservative. The Commission questions the reliance on shallow-water data since the proposed surveys would occur in intermediate and deep water, in addition to shallow water. Further, the shallow-water 'model' continues to rely on scaled empirical measurements from the Gulf of Mexico as a proxy for other shallow-water survey areas—a method no other action proponent that conducts seismic surveys employs, whether in the United States or abroad.

With regard to shallower water environments, LDEO has used numerous models[11] to fit empirical data collected with hydrophone streamers off Washington and New Jersey. In those cases, extrapolation also was necessary for the various thresholds due to the radii being either beyond the range of the hydrophone streamer or closer to the ship than what the streamer could collect. These recent examples highlight the inherent site-specific and near- and far-field differences related to deriving both exclusion and buffer zones. Although LDEO's model and other methodologies do not incorporate environmental characteristics of the specific southeastern Pacific survey areas[12], the most widely accepted modeling approaches that currently are used, and historically have been used,

[10] Crone et al. (2014) used hydrophone data from waters off Washington State to compare empirically derived to predicted exclusion and buffer zones for LDEO's 36-airgun array towed at 9 m with a total volume of 6,600 in^3. Data were used only for water depths of up to 200 m.

[11] A non-parametric smoothing cubic spline model, spherical spreading model with an attenuation term, and high-degree polynomial model were used in Crone et al. (2014) for waters off Washington and a simple logarithmic spreading loss model (the spreading loss factor/fitting parameters were not specified) was used in Crone (2015) for waters off New Jersey.

[12] Including sound speed profiles and refraction within the water column, bathymetry/water depth, sediment properties/bottom loss, wind speed, and absorption coefficients.

by other action proponents conducting seismic surveys do incorporate those characteristics. Specific types[13] of propagation models[14] are used routinely to model sound propagation associated with seismic surveys. Those models account for source frequency, water depth, and range dependence, none of which are accounted for in a simple spherical spreading model or the other methods used by LDEO. Specifically, DOC (in prep) indicated that the modeler or acoustician should have sufficient understanding of the physics of underwater acoustic propagation to ensure the results being produced by any model are accurate and make sense in physical terms. The Commission is not convinced that is true for LDEO's model and the various extrapolations and scaling factors used. Further, other action proponents generally collect empirical sound source and sound propagation measurements to verify their modeled outputs—this is becoming routine both in the United States and abroad[15].

Despite the Commission's repeated comments on this issue, LDEO continues to base its 'modeling' approaches on significantly outdated and seemingly inaccurate methods and NMFS continues to make the determination that they represent the best available science. The Commission again underscores that LDEO, NSF, and related entities (ASC, USGS, Scripps Institution of Oceanography (Scripps)) should be held to the same standard as other action proponents (i.e., Bureau of Ocean Energy Management, the oil and gas industry, U.S. Navy, U.S. Air Force). In addition, many propagation models (including those mentioned previously) are publicly available[16] via the Ocean Acoustics Library[17], which is supported by the U.S. Office of Naval Research. Given that LDEO normally employs an acoustician, investigating and ultimately implementing such models should not be an insurmountable task.

The Commission believes LDEO's use of a simplistic model, various extrapolations, and correction and scaling factors does not represent best available science and therefore strongly recommends that NMFS (1) require LDEO to re-estimate the proposed exclusion and buffer zones and associated takes of marine mammals using site-specific environmental (including sound speed profiles, bathymetry, and sediment characteristics[18] at a minimum) and operational (including number/type/spacing of airguns, tow depth, source level/operating pressure, operational volume) parameters for the proposed incidental harassment authorization and (2) impose the same requirements for all future incidental harassment authorizations submitted by LDEO, NSF, ASC, USGS, Scripps, or any other relevant entity.

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[13] Including normal mode (e.g., KRAKEN), wavenumber integration (e.g., OASES), and parabolic equation (e.g., RAM, PDPE). BELLHOP also is useful for propagation modeling of sound above 100 Hz with range dependent environmental specifications (e.g., bathymetry).
[14] See Etter (1996) for the original review of such models or Etter (2013), which is the fourth edition of that book.
[15] In some other countries, collection of those data is required rather than voluntary.
[16] As are environmental parameters.
[17] Either as documented source code or as ready-to-use executables for various computer platforms at http://oalib.hlsresearch.com.
[18] Those data can be obtained from the National Geophysical Data Center, Leveticus, and the U.S. Navy Oceanographic and Atmospheric Master Library's databases including Generalized Digital Environmental Model, Digital Bathymetric Database Variable-Resolution, Surface Marine Gridded Climatology.

Uncertainty in density estimates

LDEO acknowledged uncertainty regarding the representativeness of the density data and the assumptions used to calculate the numbers of takes. Specifically, LDEO indicated that uncertainty in the density data was based on oceanographic conditions, including occasional El Niño and La Niña events, which influence the year-to-year distribution and numbers of marine mammals present in the equatorial tropical and southeastern Pacific Ocean. However, neither LDEO nor NMFS addressed the main types of uncertainty inherent in the density data. Those include (1) geographical differences (i.e., the majority of the densities originated from the equatorial tropical Pacific and the California Current system), (2) temporal differences (i.e., some data were collected in the mid-1980's and the data were collected in summer and fall, although the proposed activities could occur at anytime during the year), and (3) accuracy of the data (i.e., densities for some Northern Hemisphere species were used as proxies for similar Southern Hemisphere species). The same data and methods were used for a 2012 NSF-funded geophysical survey off Chile, for which the Commission also questioned their applicability. At that time, NMFS indicated it had confidence in the assumptions and calculations used to estimate densities for the survey areas off Chile (77 Fed. Reg. 27191) and did not make any adjustments to account for the inherent uncertainty.

The Commission has recommended numerous times in the last four years that NMFS adjust density estimates using some measure of uncertainty when available density data originate from different geographical areas, temporal scales, and seasons and that it formulate policy or guidance regarding a consistent approach for how applicants should incorporate uncertainty in density estimates. In 2013 NMFS indicated that it was evaluating available density information and working on guidance that would outline a consistent approach for addressing uncertainty in specific situations where certain types of data are or are not available (78 Fed. Reg. 57354). The Commission is unaware of any such guidance being developed since that time but continues to believe that it is necessary, especially for an action proponent such as LDEO that primarily operates in areas outside the U.S. EEZ where site- and species-species density estimates tend to be scant. Thus, the Commission recommends that NMFS (1) adjust density estimates using some measure of uncertainty when available density data originate from different geographical areas, temporal scales, and seasons and (2) provide an update on the development of its guidance for addressing such uncertainty.

Monitoring measures

The Commission has indicated for many years that the monitoring and reporting requirements adopted under section 101(a)(5) of the MMPA need to be sufficient to provide a reasonably accurate assessment of the manner of taking and the numbers of animals taken incidental to the specified activity. The Commission continues to believe those assessments should account for all animals in the various survey areas, including those animals directly on the trackline that are not detected and how well animals are detected based on the distance from the observer, which are accounted for by g(0) and f(0) values[19]. In response to the Commission's 8 December 2015 letter on LDEO's survey off Brazil, NMFS indicated it agreed with the Commission's

[19] These values vary based on, among other things, platform characteristics, observer skill, environmental conditions, and sightability and detectability of the species.

recommendation to improve the post-survey reporting requirements for NSF and LDEO by accounting for takes using applicable g(0) and f(0) values (81 Fed. Reg. 2177). NMFS met with Commission staff in December 2015 to discuss ways to develop and validate a monitoring program that would provide a scientifically sound and reasonably accurate assessment of the types of marine mammal takes and the actual numbers of marine mammals taken, accounting for applicable g(0) and f(0) values.

At that time NMFS indicated it would work with NSF to develop ways to improve its post-survey take estimates and included a requirement that NSF do so, in collaboration with NMFS and the Commission, in the incidental harassment authorization for LDEO's survey off Brazil (81 Fed. Reg. 2177). The Commission is unsure if any progress has been made toward fulfilling that requirement but would welcome the opportunity to participate in such a collaborative approach. Therefore, the Commission again recommends that NMFS consult with LDEO and other relevant entities (e.g., NSF, ASC, USGS, Scripps) to develop, validate, and implement a monitoring program that provides a scientifically sound, reasonably accurate assessment of the types of marine mammal takes and reliable estimates of the numbers of marine mammals taken by incorporating appropriate estimates of g(0) and f(0) values, based in part on monitoring data collected during geophysical surveys.

Lastly, the Commission understands that LDEO's passive acoustic monitoring (PAM) system[20] is used to supplement visual detection of marine mammals, primarily odontocetes that could occur within the mitigation zone[21]. NMFS would require that only one dedicated PAM observer be on board, with the other protected species observers relieving the PAM observer, as necessary. The Commission is unsure whether this provides sufficient coverage when the survey operations are occurring throughout a 24-hour period. In this regard, the Commission notes that the Acoustical Society of America has convened a panel of experts to develop various PAM standards. While those standards likely won't be finalized for another 18 months, NMFS should anticipate the need to incorporate them into mitigation and monitoring requirements of incidental take authorizations at that time.

The Commission looks forward to collaborating with NMFS on the various issues raised in this and past letters. Please contact me if you have questions concerning the Commission's recommendations.

Sincerely,

Rebecca J. Lent

Rebecca J. Lent, Ph.D.
Executive Director

[20] Which is towed at a depth of less than 20 m and within 250 m of the seismic vessel, making detection of baleen whales difficult.
[21] Or within a few kilometers of the vessel.

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