3 August 2017

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 the University of Hawaii (UH), in collaboration with the Japan Agency for Marine-Earth Science and Technology[1], 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 a marine geophysical survey to be conducted in the central Pacific Ocean in September 2017. The Commission also has reviewed the National Marine Fisheries Service's (NMFS) 24 June 2017 notice announcing receipt of the application and proposing to issue the authorization, subject to certain conditions (82 Fed. Reg. 34352).

Background

UH proposes to conduct a geophysical survey off Hawaii within the U.S. exclusive economic zone and in international waters. The purpose is to image the oceanic crust, mantle, and boundary between the crust and mantle (i.e., Mohorovičić discontinuity) and to better inform and further refine planning efforts for the proposed "Project Mohole" under consideration by the International Ocean Discovery Program. The survey would be conducted along approximately 1,083 km of tracklines in waters estimated to be 4,000 to 5,000 m in depth. UH would use the R/V *Kairei* to operate a 32-airgun array at a tow depth of 10 m. The *Kairei* also would (1) tow a 6-km hydrophone streamer, (2) use two OBSs, and (3) use a 12-kHz multibeam echosounder during the survey. The survey is expected to last for a total of 6.9 days[2].

NMFS preliminarily has determined that, at most, the proposed activities would result in the incidental taking of small numbers of up to 24 species of marine mammals by Level A and/or B harassment 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 has preliminarily determined that the proposed mitigation measures provide the means effecting the least practicable

[1] The National Science Foundation (NSF) is funding the retrieval of the ocean-bottom seismometers (OBSs).
[2] 5.5 days plus a 25-percent contingency for turns, airgun testing, and repeat coverage of any areas where initial data quality is substandard.

impact on the affected species or stocks. Those measures include (1) refraining from operating the multibeam echosounder in transit to and from the survey area[3], (2) using two protected species observers to monitor the Level A and B[3] harassment zones for 30 minutes before, during, and for 30 minutes after[3] the survey, (3) using passive acoustic monitoring to supplement visual observations, (4) implementing speed and course alterations, and (5) using power-down, shut-down[4], and ramp-up procedures. In addition, UH would shut down the airguns immediately if a North Pacific right whale is sighted[3], regardless of the distance from the *Kairei*. Ramp-up procedures would not be initiated until the right whale has not been seen at any distance for 30 minutes. Further, UH would power down the array when a large whale[5] with a calf or an aggregation of large whales (six or more individuals that do not appear to be traveling and are feeding, socializing, etc.) is observed at any distance. UH would report any injured or dead marine mammal to NMFS's Office of Protected Resources and the Pacific Islands Regional Stranding Coordinator[3] using its phased approach.

Uncertainty in modeling Level A and B harassment zones

UH used Lamont-Doherty Earth Observatory's (LDEO) model to estimate the extent of the Level A and B harassment zones and the numbers of marine mammal takes. The Commission has raised concerns regarding LDEO's model for more than seven years. In more recent years, other stakeholders[6] have expressed similar concerns regarding the appropriateness of those methods (80 Fed. Reg. 67713). LDEO uses the Nucleus source model and a simple ray trace–based modeling approach[7] 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 Level A and B harassment zones.

In addition, the Commission has provided extensive comments regarding the inappropriateness of LDEO's model, which should be reviewed in conjunction with this letter (see the Commission's most recent 2 May 2016 letter) and are not reiterated herein. The Commission continues to believe LDEO's model does not represent best available science and again recommends that NMFS require UH, in collaboration with LDEO, to re-estimate the proposed Level A and B harassment zones and associated takes of marine mammals using both operational (including number/type/spacing of airguns, tow depth, source level/operating pressure, operational volume) and site-specific environmental (including sound speed profiles, bathymetry, and sediment characteristics[9] at a minimum) parameters for the proposed incidental harassment authorization. Specifically, the Commission reiterates that LDEO should be using the ray-tracing model

[3] NMFS informed the Commission that it incorrectly omitted from the *Federal Register* notice these standard measures, which would be included in the final authorization.
[4] Power or shut downs would not be required for small delphinids (*Steno* spp., *Tursiops* spp., *Stenella* spp., and *Lagenodelphis* spp.) that are traveling and voluntarily approaching the source vessel to interact with the vessel and/or airgun array.
[5] A sperm whale or mysticete.
[6] Natural Resources Defense Council and Whale and Dolphin Conservation.
[7] Essentially a MATLAB algorithm.
[8] Tolstoy et al. (2004), Tolstoy et al. (2009), Diebold et al. (2010), and Crone et al. (2014).
[9] Those data can be obtained from the National Geophysical Data Center, Leviticus, 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.

BELLHOP—which is a free, standard propagation code that readily incorporates all environmental inputs listed herein rather than the limited, in-house MATLAB code currently in use. The Commission underscores the need for NMFS to hold LDEO, NSF, and other-affiliated entities[10] 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).

The Commission also has the following comments regarding other aspects of LDEO's method. With NMFS's finalization of its updated acoustic thresholds for permanent threshold shift (PTS; i.e., Level A harassment) in summer 2016, many action proponents have had to adjust the manner in which they estimate the extent of the Level A harassment zones. Specifically, LDEO claims that its model cannot incorporate more than a single shot and thus cannot readily estimate ranges to the cumulative sound exposure level (SEL_{cum}) thresholds. Thus, LDEO used NMFS's user spreadsheet to estimate the Level A harassment zones for the various functional hearing groups.

To do so, LDEO computed 'modified' frequency-weighted, farfield source levels and noted that those are more appropriate than the 'actual' farfield source levels because an 'actual' farfield source level "does not take into account the large array effect near the source and is calculated as a point source." The modified farfield source levels are essentially back-calculated source levels[11] based on the relevant frequency-weighted threshold—the resulting source levels were similar for some functional hearing groups but varied by approximately 3 to 18 dB for other functional hearing groups[12]. Those differences were attributed to source levels being located close the airgun array, where the assumption that the array can be modeled as a single spatial point is weakest[13]. LDEO did incorporate the spectral aspects of the 32-airgun array to better refine the frequency-specific weighting function adjustments for the SEL_{cum} thresholds rather than using NMFS's simple weighting factor adjustment (i.e., 1 kHz for seismic). The Commission supports that approach. However, the Commission is unaware of any other seismic operators using such a circuitous approach to estimate harassment zones. Generally, source levels are inputs to models rather than products of those models, and the sound field from spatially-distributed sources (e.g., airgun arrays) is modeled as sums of point sources, under the assumption that individual airgun pressures don't substantially influence each other. Such an approach is straightforward, easy to implement, and accounts for both the 'near-field' and 'far-field' effects.

However, a much more significant concern is that LDEO is using a high-pass filter for the unweighted SPL_{peak} thresholds, which are intended to provide a measure of potential *mechanical* damage and are unrelated to *auditory* capability. The filters that LDEO used were based on the lowest frequency of the generalized hearing range for the various functional hearing groups (Table 1 in NMFS 2016). The impact of using filtered airgun signals to estimate the range to the SPL_{peak} thresholds has dramatic consequences. For example, the extent of the Level A harassment zone for high-frequency cetaceans was reduced from 516 to 14.5 m.

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[10] Including the U.S. Geological Survey (USGS) and Scripps Institution of Oceanography (Scripps).
[11] Assuming spherical propagation loss.
[12] Specifically, otariids (OW) for SEL_{cum} thresholds and OW and mid-frequency cetaceans for peak sound pressure level (SPL_{peak}) thresholds (Tables 2 and 4 in the application).
[13] Where the effects of the array are the greatest and coherent summation does not occur.

The Commission understands that LDEO has interpreted NMFS (2016) to imply that the SPL_{peak} should be calculated using a band-limited source spectrum, based on the generalized hearing range of each functional hearing group. NMFS did state that—

> "peak sound pressure is defined by ANSI as incorporating frequency weighting, which is not the intent for this Technical Guidance. Hence, the subscript 'flat' is being included to indicate peak sound pressure should be flat weighted or unweighted *within the generalized hearing range*." [Italics added for emphasis]

The Commission believes that the italicized phrase was not intended to be restrictive and that NMFS expected action proponents to use the full bandwidth of sources when implementing the SPL_{peak} threshold. Use of the full bandwidth is appropriate given that the thresholds themselves were based on responses of the animals to the full frequency spectrum of the airgun pulses, not a filtered bandwidth (see Figure 2 in Finneran et al. 2002 and Figure 6 of Lucke et al. 2009). The Commission agrees that the guidance in NMFS (2016) is contradictory. A generalized hearing range is inherently frequency-based and could include frequency roll-offs (as with the current weighting functions and M-weighting) or hard cut-offs. Thus, LDEO assumed a hard cut-off such that SPL_{peak} was considered zero beyond the generalized hearing range of the various species.

This is the first time that NMFS has proposed to use high-pass filters to estimate ranges to the SPL_{peak} thresholds. That approach has not been implemented[14] by the Navy in its Phase III draft environmental impact statement for Atlantic Fleet Training and Testing activities, by the Bureau of Ocean Energy Management in its draft programmatic environmental impact statement for geological or geophysical (G&G) activities in the Gulf of Mexico, or by NMFS for any of the four incidental harassment authorizations for G&G activities in the Atlantic Ocean[15]. The Commission is very concerned that NMFS moved forward with an approach that is inconsistent with the methods used for other seismic activities and with methods used by the entities that developed the thresholds. If the Commission had been aware of the possible use of high-pass filters, it would have commented on it in its 11 July 2017 letter regarding NMFS's updated acoustic thresholds. Given that the use of high-pass filters can yield dramatically reduced Level A harassment zones for seismic surveys and other broadband or low-frequency sources, the Commission strongly recommends that NMFS (1) refrain from allowing any action proponent to use high-pass filters when estimating the ranges to the various SPL_{peak} thresholds until such time that it has fully considered implications of their use both internally at NMFS and externally with other federal partners, (2) amend NMFS (2016) to clarify what type of filtering, if any, is intended by the phrase 'within the generalized hearing range,' and (3) require UH to re-estimate the Level A harassment zones and numbers of marine mammal takes accordingly.

Rounding of take estimates

The method used to estimate the numbers of takes during the proposed activities, which summed fractions of takes for each species across project days, does not account for and negates the intent of NMFS's 24-hour reset policy. As the Commission has indicated in previous letters

[14] They also were not used in Southall et al. (2007).
[15] Some of which are currently available for public comment or available for public comment a few weeks ago.

regarding this matter[16], the issue at hand involves policy rather than mathematical accuracy. The Commission notes that, although NMFS developed criteria associated with rounding that it had planned to share with the Commission a few months ago, it has yet to do so. Therefore, the Commission recommends that NMFS share the rounding criteria with the Commission such that this matter can be resolved in the near future.

Mitigation measures

NMFS proposed to include numerous mitigation measures consistent with its recently proposed incidental harassment authorizations for G&G activities[17] in the Atlantic Ocean (82 Fed. Reg. 26244). The Commission is encouraged that NMFS is striving for some consistency regarding mitigation measures for the same type of activities (i.e., geophysical or seismic surveys) but questions why NMFS did not include some other related measures. Specifically, NMFS did not propose to prohibit the use of power downs or the mitigation airgun. NMFS recently stated that, in a mitigation and monitoring workshop for seismic surveys, industry representatives indicated that power downs may ultimately increase sound input to the marine environment due to the need to re-shoot the trackline to prevent gaps in data acquisition (unpublished workshop report, 2012; 82 Fed. 26255). For that reason and because a power down may not actually be useful, NMFS proposed to require operators to implement a full shutdown rather than allowing a power down (82 Fed. 26255). Similarly, NMFS stated that there was no information to suggest that the mitigation airgun is an effective protective strategy, while it was certain that use of that technique would involve input of extraneous sound energy into the marine environment, including when use of the mitigation airgun is limited to some maximum time period (82 Fed. 26255). For those reasons, NMFS concluded that use of the mitigation airgun was not appropriate and did not propose to allow its use. The Commission agrees with NMFS on both of those restrictions. Given that neither the efficacy of the measures has changed nor the energy that would be emitted would be substantially reduced, the Commission recommends that NMFS use a consistent approach for requiring all geophysical and seismic survey operators to abide by the same general mitigation measures, including prohibiting UH from using power downs and the mitigation airgun during its geophysical survey.

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[18]. In response to the Commission's 8 December 2015 letter on a LDEO survey off Brazil, NMFS indicated that it agreed with the Commission's recommendation to improve the post-survey reporting requirements by accounting for takes using applicable g(0) and f(0) values (81 Fed. Reg. 2177). NMFS met with Commission staff in December

[16] See the Commission's 29 November 2016 letter detailing this issue.
[17] Using similar-sized airgun arrays.
[18] These values vary based on, among other things, platform characteristics, observer skill, environmental conditions, and sightability and detectability of the species.

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, using applicable g(0) and f(0) values to account for availability and perception biases. Further, NMFS requested that the Commission help formulate such an approach, which the Commission provided to NMFS in summer 2016 (see the Addendum).

Although the Commission is uncertain whether any progress has been made toward NSF-funded or other-affiliated entities implementing the proposed approach, the Commission recommended that NMFS use a similar approach for incidental harassment authorizations associated with G&G activities in the Atlantic Ocean[19]. Therefore, the Commission recommends that NMFS require UH to use the Commission's method as described in the Addendum to better estimate the numbers of marine mammals taken by Level A and B harassment for the incidental harassment authorization. NSF-funded or other-affiliated entities[20] and all seismic operators should use the Commission's method as well.

The Commission looks forward to working 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

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[19] See the Commission's 6 July 2017 letter.
[20] Including LDEO, Scripps, USGS, etc.

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ADDENDUM

The Commission's recommended method for estimating the number of cetaceans in the vicinity of geophysical surveys based on the number of groups detected

For each geophysical survey, observers collect the number of sightings observed, group size, distance and angle to sighting, distance travelled on survey effort, Beaufort sea state (BSS), wind speed, swell height, etc. A simple method to estimate the total number of cetaceans potentially taken by Level B harassment[21] can therefore be used. This method incorporates $f(0)$ and BSS-specific $g(0)$ values from Barlow (2015) that were derived using Distance sampling methods (Buckland et al. 2001, 2004) and sightings data from each geophysical survey. The number of animals detected by an observer on a ship is an underestimate of the true number of animals in the vicinity of the ship because the observer inevitably misses some groups. If we know that we have detected n objects, and the probability of detecting each object is p, a standard way to estimate the total number of objects is n/p. We know n for each species from the data collected on each survey, so the problem is to find p for each species. Normally p is estimated from the data collected on each survey as part of a line-transect analysis. The probability p for each species depends principally on the distance of the animals from the observer, but may also depend on other factors such as group size and sea state.

In the absence of a line-transect analysis, the Commission suggests taking estimates of p from other studies which use ships of similar size and searching methods. In the parlance of line-transect analysis, p is a product of the probability of detecting a group of animals directly on the trackline ($g(0)$) and the probability of detecting a group of animals within the half-strip width on each side of the trackline (μ/w, where w is the transect truncation distance beyond which data are not recorded and μ is the effective strip half-width). The effective strip half-width also may be expressed as $\mu = 1/f(0)$, where $f(0)$ is the estimated probability density function of observed perpendicular distances y evaluated at $y = 0$.

Based on the Commission's understanding of the ships and areas for the geophysical surveys, $g(0)$ and $f(0)$ from Barlow (2015) should be appropriate. The species discussed in the references may be different from those observed during the geophysical survey, but data from similar species can be used. Since $g(0)$ and $f(0)$ values for each species or genera depend on group size, BSS, swell height and other factors, those factors should be taken into account if possible.

The probability of detecting a group of cetaceans can therefore be expressed as

$$p = g(0)\frac{\mu}{w} = \frac{g(0)}{w\,f(0)} \ .$$

[21] Given the slow speed of the vessel during geophysical surveys and the perceived abilities of the observers, animals taken by Level A harassment generally should be reported as the actual number of animals observed during surveys. However, if the BSS-specific effective strip half-width is less than the extent of the estimated Level A harassment zones, the extrapolation method discussed herein should be used rather than reporting the uncorrected number of animals observed.

If there are n sightings of a species along a section of trackline, the estimated number of groups within a given BSS, within a perpendicular distance w on each side of the trackline, and within a given Level B harassment zone[22] is

$$N_{groups} = \frac{n}{p} = \frac{n w f(0)}{g(0)} = \frac{n w}{\mu g(0)} \ ,$$

and the estimated number of individual animals in that given BSS then is

$$N \ = \frac{n}{p} S = \frac{n w}{\mu g(0)} S \ ,$$

where S is the mean group size for the species.

The number of animals seen within each BSS should be summed for each Level B harassment zone. That total number then must be scaled by the distance to the Level B harassment threshold relative to the truncation distance to estimate the total number of animals potentially taken during a given survey.

Example calculation for common dolphins when sightings data are partitioned by group size and BSS

Suppose we have detected n = 3 groups within a BSS of 2, with a mean group size of S = 120, and n = 2 groups within a BSS of 3, with a mean group size of S = 130—both in a Level B harassment radii = 11 km. From Table 2 of Barlow (2015), μ = 3.54 km and w = 5.5 km and μ = 3.24 km and w = 5.5 km from Table 3, $g(0)$ = 0.940. The estimated total number of dolphins potentially taken during the survey is therefore

$$N = \frac{(3)(5.5)}{(3.54)(0.94)} 120 = 595$$
$$N = \frac{(2)(5.5)}{(3.24)(0.94)} 130 = 470$$
$$N = 595 + 470 = 1065 \ \frac{11}{5.5} = 2130$$

One has to be particularly careful when enumerating the number of sightings and mean group size for geophysical surveys. Given that the vessel is traveling so slowly, often a sighting of a large group of animals is observed at a distance and a smaller sub-pod can break off and close in on the vessel. Ideally, each vessel would have a tracker who monitors the position of the different sightings. If the operators are not able to afford a separate individual to track each sighting, the observers must be cognizant of tracking each sighting until it passes abeam. For example, if 65 Pacific white-sided dolphins are observed 2 km from the vessel and then a group of 7 Pacific white-

[22] Which differ depending on water depth and airgun array size.

sided dolphins are observed approaching the vessel[23] a short time later, this should be enumerated as a single sighting of 65 dolphins rather than 2 sightings of 65 and 7 dolphins each. Further, large whales can be documented via multiple sightings. If there are 4 sightings of a single humpback whale and its trajectory has taken it across the path of the vessel, that sighting should be documented as 1 sighting of 1 whale rather than 4 sightings of 1 whale.**

If sightings data partitioned into the various BSSs are not available, an even more simple and rapid method can be used by assuming single, overall values for the various parameters for each species or genera. Those values can be obtained from Barlow and Forney (2007).

The probability of detecting a group of cetaceans again is expressed as

$$p = g(0)\frac{\mu}{w} = \frac{g(0)}{w\,f(0)} \ .$$

If there are n sightings of a species along a section of trackline, the estimated number of groups within a perpendicular distance w on each side of the trackline and within a given Level B harassment zone is

$$N_{groups} = \frac{n}{p} = \frac{n\,w\,f(0)}{g(0)} = \frac{n\,w}{\mu\,g(0)} \ ,$$

and the estimated number of individual animals is

$$N \ = \frac{n}{p}S = \frac{n\,w}{\mu\,g(0)}S \ ,$$

where S is the mean group size for the species. That total number then must be scaled by the distance to the Level B harassment threshold relative to the truncation distance to estimate the total number of animals potentially taken during a given survey.

Example calculation for common dolphins when sightings data partitioned into the various BSSs are not available

Suppose we have detected n = 10 groups, with a mean group size of S = 120 within a Level B harassment radii = 8 km. From Table 1 of Barlow and Forney (2007), μ = 2.22 km and w = 4.0 km and from Table 3, $g(0)$ = 0.970. The estimated total number of dolphins potentially taken during the survey is therefore

$$N = \frac{(10)(4)}{(2.22)(0.97)}120\ \frac{8}{4} = 4458$$

[23] And, if that smaller sub-pod comes within the Level A harassment zone, it should be enumerated as such.

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