23 October 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 Lamont-Doherty Earth Observatory (LDEO), in collaboration with the National Science Foundation (NSF)[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 three marine geophysical surveys to be conducted in waters off of New Zealand in 2017 and 2018. The Commission also has reviewed the National Marine Fisheries Service's (NMFS) 27 September 2017 notice announcing receipt of the application and proposing to issue the authorization, subject to certain conditions (82 Fed. Reg. 45116).

Background

LDEO proposes to conduct three geophysical surveys using the R/V *Marcus G. Langseth* (*Langseth*) off New Zealand within its territorial waters[2] and waters of its exclusive economic zone. Specifically—

- The North Island 2D survey would be conducted along 5,398 km of tracklines using a 36-airgun array[3] at a tow depth of 9 m for approximately 35 days. The purpose of the North Island 2D survey is to collect seismic data to create images of the plat boundary fault zone and to investigate other faults and folding of the upper New Zealand plate and the underlying Pacific plate. A single 12.5-km hydrophone streamer and both land-based and ocean-bottom seismometers would be used.
- The North Island 3D survey would be conducted along 3,025 km of tracklines using two alternating 18-airgun arrays[4] at a tow depth of 9 m for approximately 33 days. The purpose of the North Island 3D survey is to determine what conditions are associated with slow-slip

[1] NSF has provided funding to researchers from California State Polytechnic University, California Institute of Technology, Pennsylvania State University, University of Southern California, University of Southern Mississippi, University of Hawaii at Manoa, University of Texas, and University of Wisconsin Madison for the surveys.
[2] Which New Zealand recognizes as within 12 nmi.
[3] With a total discharge volume of 6,600 in^3.
[4] With a total discharge volume of 3,300 in^3.

behavior, how those conditions differ from subduction zones that generate great earthquakes, and what controls the development of slow-slip faults rather than earthquake-prone faults. Four 6-km hydrophone streamers would be used.

- The South Island 2D survey would be conducted along 4,876 km of tracklines using a 36-airgun array[2] at a tow depth of 9 m for approximately 22 days. The purpose of the South Island 2D survey is to test models for the formation of new subduction zones and to measure several fundamental aspects of that process. A single 8-km hydrophone streamer and ocean-bottom seismometers would be used.

The three surveys would occur in waters from 50–5,000 m in depth. The *Langseth* also would operate a 12-kHz multibeam echosounder, 3.5-kHz subbottom profiler, and acoustic Doppler current profiler (ADCP) continuously during the surveys.

NMFS preliminarily has determined that, at most, the proposed activities would result in the incidental taking of small numbers of up to 38 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 of effecting the least practicable impact on the affected species or stocks. Those measures include (1) refraining from operating the multibeam echosounder, subbottom profiler, and ADCP in transit to and from the survey area, (2) using two protected species observers to monitor the Level A and B harassment zones for 30 minutes before, during, and for 1 hour after the survey, (3) using passive acoustic monitoring to supplement visual observations, (4) implementing speed and course alterations, and (5) using power-down, shut-down[5], and ramp-up procedures. In addition, LDEO would shut down the array when (1) a large whale[6] with a calf or (2) a beaked whale, *Kogia* spp., South Island Hector's dolphin (Hector's dolphin), or Māui dolphin[7] is observed at any distance. Ramp-up procedures would not be initiated until the animal(s) has not been seen at any distance for 30 minutes for large whales, beaked whales, and *Kogia* spp. and 15 minutes for Hector's and Māui dolphins. LDEO would report any injured or dead marine mammal to NMFS's Office of Protected Resources and the New Zealand Department of Conservation using its phased approach.

Uncertainty in modeling Level A and B harassment zones

LDEO used its model[8] to estimate the extent of the Level A and B harassment zones for portions of the surveys that would occur in deep water[9]. For portions of the surveys occurring in intermediate waters[10], LDEO applied a simple 1.5 correction factor to the zones derived from its model for deep water. Similarly, LDEO applied a scaling factor[11] to empirically-derived measurements from the Gulf of Mexico for portions of the New Zealand surveys that would occur

[5] Power or shut downs would not be required for small delphinids (*Tursiops* spp., *Delphinus* spp., and *Lissodelphis* spp.) that are traveling and voluntarily approaching the source vessel to interact with the vessel and/or airgun array.
[6] A sperm whale or mysticete.
[7] The Commission understands that NMFS plans to clarify in the final authorization that shut-down procedures would be required for both subspecies, South Island Hector's dolphins and Māui dolphins, but only for the two North Island surveys.
[8] The model also was used to estimate the zones associated with the mitigation airgun in all water depths.
[9] Waters greater than 1,000 m in depth.
[10] Waters from 100–1,000 m in depth.
[11] To account for tow-depth differences of 6 m in the Gulf of Mexico and 9 m in New Zealand.

in shallow water[12]. The Commission has raised concerns regarding LDEO's model and various correction and scaling factors for more than seven years. In recent years, other stakeholders[13] have expressed similar concerns (80 Fed. Reg. 67713). LDEO uses the Nucleus source model and a simple ray trace–based modeling approach[14] 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[15] have emphasized the importance of incorporating site-specific environmental and operational parameters into the estimation of Level A and B harassment zones.

The Commission has provided extensive comments regarding the inappropriateness of LDEO's model and other estimation methods, which should be reviewed in conjunction with this letter (see the Commission's 2 May 2016 letter) and are not reiterated herein. The Commission continues to believe LDEO's model and other estimation methods do not represent best available science and again recommends that NMFS require 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[16] at a minimum) parameters for the proposed incidental harassment authorization. Specifically, the Commission reiterates that LDEO should be using the ray-tracing model 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 entities[17] 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).

With NMFS's finalization of its updated acoustic thresholds for permanent threshold shift (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[18] 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" [19]. The modified farfield source levels[20] are essentially back-calculated source levels[21] based on the relevant frequency-weighted threshold. The *Federal Register* notice further indicated

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[12] Waters less than 100 m in depth.
[13] Natural Resources Defense Council and Whale and Dolphin Conservation.
[14] Essentially a MATLAB algorithm.
[15] Tolstoy et al. (2004), Tolstoy et al. (2009), Diebold et al. (2010), and Crone et al. (2014).
[16] 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.
[17] Including the Scripps Institution of Oceanography (Scripps) and U.S. Geological Survey (USGS).
[18] Deemed a 'theoretical representation of the source level' or a 'theoretical far-field signature' in the application.
[19] Where the effects of the array are the greatest and coherent summation does not occur.

that the modified farfield source level was considered more appropriate than the actual farfield source level. LDEO's method did incorporate the spectral aspects of the airgun arrays 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 incorporation of spectral data but wonders why the spectral levels were effectively cut off at 3 kHz, since airguns emit energy above 3 kHz. In addition, the Commission is unaware of any other seismic operators using such an 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 do not substantially influence each other. Such an approach is straightforward, easy to implement, and accounts for both the 'near-field' and 'far-field' effects. The use of truncated spectra and modified farfield source levels further support the Commission's continued recommendation that NMFS require LDEO, and other NSF-affiliated entities, to revise its sound propagation modeling methodology.

Further, NMFS had proposed to use high-pass filters[22] to estimate ranges to the SPL_{peak} thresholds for the UH's recently proposed geophysical survey (82 Fed. Reg. 34370). But, NMFS did not take that approach for LDEO's geophysical surveys. Sound produced from the *Langseth* airgun array was considered flat and no high-pass filter of any type was used. The Commission fully supports NMFS's current stance on this issue[23] and believes that NMFS should 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.

Uncertainty in density estimates

For LDEO's three proposed surveys, NMFS used density data from northern fur seals and northern elephant seals as surrogates for New Zealand fur seals and southern elephant seals, respectively. It based those surrogate densities on at-sea density data collected nearly 30 years ago (Bonnell et al. 1992), which NMFS believes are the best available data (82 Fed. Reg. 45140). Curiously though, NMFS recently asserted that data derived using the methods in U.S. Navy (2010) with updated abundance estimates from the 2015 stock assessment reports were considered the best available data for those two species in the same areas (82 Fed. Reg. 39297). When the Commission commented on those density estimates in its 5 September 2017 letter, it also noted that Navy (2010) had been updated with Navy (2015)[24] and used by NMFS as best available data in other incidental take authorizations in recent years. It is illogical that three different references currently are being considered by NMFS to be best available science for northern fur seal and

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[20] Although LDEO did not present both the modified and actual source levels in its application, the University of Hawaii (UH) presented those data in its recent application. UH's source levels were similar for some functional hearing groups but the modified source levels varied from the actual source levels by approximately 3 to 18 dB for other functional hearing groups. 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 UH's application).
[21] Assuming spherical propagation loss.
[22] NMFS had implemented a high-pass filter for the unweighted SPL_{peak} thresholds based on the lowest frequency of the generalized hearing range for the various functional hearing groups (Table 1 in NMFS 2016).
[23] NMFS implemented the Commission's recommendation regarding this issue based on its 3 August 2017 letter on UH's geophysical survey.
[24] Including applicable areas and correction factors based on age/sex differentiation and haul-out behavior. It also yields greater densities than those from Bonnell et al. (1992).

northern elephant seal densities—only one density estimate for a given timeframe and area can be considered best available.

The Commission has noted concerns regarding the pinniped density data derived in Navy (2015; see its 5 September 2017 letter and 17 June 2015 letter detailing this issue). But, if NMFS believes those data represent the best available science for northern fur seals and northern elephant seals, then they should be used as surrogates for New Zealand fur seals and southern elephant seals[25], respectively. Therefore, the Commission recommends that NMFS update the northern fur seal[26] and northern elephant seal densities based on Navy (2015) and incorporate the Commission's 2015 recommendations regarding derivation those densities, paying particular attention to the updated abundance estimates in more recent stock assessment reports, areas over which the densities are estimated, and any relevant correction factors. Further, the Commission recommends that NMFS convene an internal working group to determine what data sources are considered best available for the various species and in the various areas and provide that information to applicants accordingly.

The Commission has noted numerous times, including for the 2015 geophysical survey in New Zealand waters (see the Commission's 1 April 2015 letter[27]), that NMFS should adjust the density estimates used to estimate the numbers of potential takes by incorporating some measure of uncertainty when available density data originate from other geographical areas[28], temporal scales[29], and species[30]. In this instance[31], LDEO used various extrapolations and adjustments[32] based on numerous assumptions in the absence of applicable density data off New Zealand. It would have been useful if NMFS had a policy or other guidance that would set forth a consistent approach for how applicants should incorporate uncertainty in density estimates—an issue that is particularly problematic and persistent for both geophysical surveys and military activities[33].

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[25] Based on informal comments from NMFS, it believes it is reasonable to rely on data that may be older than Navy (2015) data when the data are not meant to estimate density of the species off the west coast of the United States but instead are being used as a surrogate for another similar species in another location. The Commission disagrees.
[26] Based on densities from southeast Alaska (which is stipulated as Western Behm Canal in Navy 2015) that are reflective of northern fur seals occurring in greater numbers closer to their rookeries, similar to the project area off New Zealand. New Zealand fur seals do not conduct extensive migratory movements like northern fur seals (Harcourt et al. 2001, Page et al. 2006). Thus, their densities are greater closer to the rookeries.
[27] Also its 5 September 2017 letter regarding a geophysical survey off Washington and Oregon and its 2 May 2016 letter regarding a geophysical survey off Chile.
[28] In this case, the Southern Ocean and waters off Washington and Oregon.
[29] In this case, data that originated from the mid- to late 1970s (and were themselves extrapolated from other locations).
[30] In this case, northern fur seals and northern elephant seals as well as various surrogate cetacean species.
[31] A similar approach was taken for the 2015 survey in New Zealand.
[32] Including corrections for species that lacked density data based on relative abundances scaled to the estimated densities.
[33] Especially for pinnipeds when a simple abundance divided by area method is used.

NMFS did acknowledge uncertainty in the density data[34] and proposed to add an additional 25-percent[35] contingency, due to the density estimates potentially underestimating actual marine mammal densities in the survey areas (82 Fed. Reg. 45150). The Commission appreciates that NMFS is beginning to address this issue but is unsure whether the 25-percent contingency is sufficient. For the 2015 New Zealand survey, the number of authorized Level B harassment takes[36] for New Zealand fur seals (n=15) was exceeded during the survey requiring NMFS to amend the authorization to increase the numbers of takes to 615. Similarly, LDEO exceeded the number of authorized Level A harassment takes for dusky dolphins by a factor of three[37] during its 2016 survey off Chile. In both instances, a 25-percent contingency[38] would not have been sufficient.

All of the references from which the density data originated include coefficients of variation (CVs) or standard errors (SEs). Those measures of uncertainty are inherent in the data rather than arbitrarily set, including the 25-percent contingency. The Commission therefore recommends that NMFS adjust the density estimates using some measure of uncertainty (i.e., CV, SD, SE) rather than using the proposed 25-percent contingency. NMFS indicated in 2013 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). Given that there is still no resolution of this issue and it is relevant to a multitude of different activities, the Commission recommends that NMFS convene a working group of scientists (including those from NMFS's science centers and academia) to determine how best to incorporate uncertainty in density data that are extrapolated[39]. The Navy has funded the University of St. Andrews and other collaborators to investigate various aspects of density surface modeling through its DenMod working group. Unfortunately, the working group is *not* developing guidance for incorporating uncertainty in density data in regions where no data exist and data from neighboring regions are absent (thus, when developing density surface models is not possible) or when single point abundance data are used relative to an assumed area. In addition, products from the DenMod working group would not be available until December 2021 at the earliest, and this issue needs resolved before that time.

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[34] LDEO made a similar acknowledgment. It proposed to increase the numbers of takes to at least 1 percent of populations for each species that takes were expected and population sizes were available. That proposed increase was based on previous surveys in New Zealand encountering greater numbers of individuals than the estimated densities predicted for some species.

[35] That correction was added in addition to the standard 25-percent contingency (for additional seismic operations associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is subpar) that is included for all NSF-funded and -affiliated surveys. NMFS also made the Commission aware of errors in the take estimates in Table 11 of the *Federal Register* notice based on the additional 25-percent contingency. It plans to fix those errors for the final authorization. Further, NMFS incorporated the additional 25-percent contingency only for the numbers of takes estimated to occur *beyond* the territorial seas—the topic of the territorial seas is discussed in the following section. The Commission understands NMFS is fixing this error by incorporating the additional 25-percent contingency for takes of marine mammals in the territorial seas in the final authorization as well. NMFS has yet to provide the revised numbers of takes to the Commission.

[36] Only Level B harassment was authorized.

[37] 175 takes were authorized and 560 takes were reported in the final monitoring report.

[38] Which would have been 19 takes of New Zealand fur seals and 219 takes of dusky dolphins.

[39] Beyond those methods that can be used for extrapolating data from neighboring regions, as used in Mannocci et al. (2017).

Take estimates

NMFS made the Commission aware of errors in the take estimates specified in Table 11 of the *Federal Register* notice based on incorrect incorporation of its additional 25-percent contingency. Level A harassment takes would increase by approximately 20 percent for 13 of the 38 species, while Level B harassment takes would increase[40] by approximately 4 percent for 28 of the 38 species in Table 11. NMFS plans to fix those errors for the final authorization. NMFS also incorporated the additional 25-percent contingency only for the numbers of takes estimated to occur *beyond* the territorial seas—the topic of the territorial seas is discussed in the following section. The Commission understands NMFS is fixing that error by incorporating the additional 25-percent contingency for takes of marine mammals in the territorial seas in the final authorization as well. Although NMFS is fixing those errors, inclusion of accurate take estimates is necessary for both the Commission and public to comment appropriately on proposed incidental harassment authorizations.

In addition, 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 regarding this matter[41], the issue at hand involves policy rather than mathematical accuracy. The Commission notes that NMFS has yet to share the criteria associated with rounding that it developed. Therefore, the Commission again recommends that NMFS share the rounding criteria with the Commission.

The Commission made this same recommendation in its 3 August 2017 letter on UH's geophysical survey. However, in the issuance of that incidental harassment authorization, NMFS did not specifically address the Commission's recommendation regarding the request for NMFS to share its rounding criteria. NMFS had indicated it would provide this to the Commission several months earlier. Rather, NMFS indicated that it believed its approach was appropriate and not at odds with the 24-hour reset policy (82 Fed. Reg. 44567). The Commission requests that NMFS address the Commission's specific request for the rounding criteria such that this matter can be resolved in the near future.

On a related matter, NMFS generally increases the numbers of takes to average group size when the estimated numbers of takes are less than the group size. NMFS did not include such increases in any of the proposed numbers of Level A harassment takes for the proposed authorization. For example, the estimated numbers of takes are less than average group size[42] for at least eight species of mid-frequency cetaceans (MF; 3 takes of bottlenose dolphins compared to the average group size of 13) as specified in Table 11 of the *Federal Register* notice. The Commission understands that the largest range to Level A harassment is less than 14 m for MF (see Tables 7 and 9 in the *Federal Register* notice) and that the only reason Level A harassment takes are estimated for the various species is because NMFS is summing the fractions of takes across days, 90 days in this case.

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[40] The numbers of takes would decrease for three species as well.
[41] See the Commission's 29 November 2016 letter detailing this issue.
[42] As noted in the recently proposed authorization for the geophysical survey off Washington and Oregon (82 Fed. Reg. 39297–39298).

NMFS has informally indicated that it believes it is unrealistic to assume a group of bottlenose dolphins would be taken by Level A harassment at such close proximity to the vessel. It is unclear why that rationale would not apply to Level A harassment takes in general. That is, if the Level A harassment takes are not expected to occur based on the size of harassment zone, then it is illogical to propose them. However, if Level A harassment takes are possible, then the numbers authorized should be based on the social behavior of the animals rather than on a mathematical equation. The Commission recommends that NMFS determine whether there is potential for the various species to be taken by Level A harassment and if such potential exists, authorize the associated numbers of takes based on group size[43].

On a separate matter, LDEO does not need to obtain an authorization for any taking of marine mammals that occurs within the territorial sea of another country. Nevertheless, NMFS generally estimates the numbers of incidental takes that could occur in the entire activity area (territorial seas, exclusive economic zones, and high seas) as part of the analysis for its negligible impact determination under the MMPA (80 Fed. Reg. 67709). NMFS apparently estimated the total number of takes to inform its negligible impact determination for the proposed surveys (82 Fed. Reg. 15450) but did not include the total numbers of takes[44] in the *Federal Register* notice. That information has been included for other authorizations (e.g., 80 Fed. Reg. 67726–67727) and provides the necessary context for evaluating the impacts of the proposed surveys. As such, the Commission recommends that NMFS include a take table that delineates the total numbers of takes for the entire activity area (territorial seas, exclusive economic zones, and high seas) in the *Federal Register* notice for the final incidental harassment authorization and for all future proposed authorizations involving activities that span international waters and any country's territorial sea.

Species proposed to be taken

As stated previously, there is a dearth of available marine mammal data for waters off New Zealand. NMFS indicated that it discounted 16 marine mammal species with ranges that are known to potentially occur in the waters of the proposed survey areas—NMFS based that presumption on Baker et al. (2016) and their categorization of those species as 'vagrants'. NMFS took a similar approach for the 2015 New Zealand survey but proposed to discount 18 species, including Arnoux's beaked whales and Risso's dolphins. However, based on a recommendation from the Commission, NMFS included Arnoux's beaked whales, Risso's dolphins, and pygmy beaked whales in the final 2015 authorization (80 Fed. Reg. 29641). It is unclear why the same approach was not taken for the proposed authorization. Takes for Arnoux's beaked whales and Risso's dolphins were proposed but takes for pygmy beaked whales were not.

Pygmy beaked whales are present in the Department of Conservation's (DOC) sightings database for marine mammals present in New Zealand's waters and are included by other action proponents in their marine mammal impact assessments[45] for seismic activities off New Zealand. Similar to spade-toothed whales that were included in the proposed authorization, pygmy beaked

[43] For those species whose estimated numbers of takes are less than average group size.
[44] Although only 9 percent of the North Island 2D survey, 1 percent of the North Island 3D survey, and 6 percent of the South Island 2D survey would occur in territorial waters, the numbers of takes attributed to those waters equate to roughly 29 to 33 percent of the total takes once NMFS incorporates the additional 25-percent contingency.
[45] As required by DOC and its 2013 Code of Conduct for Minimizing Acoustic Disturbance to Marine Mammals from Seismic Survey Operations (2013 Code).

whales are poorly studied but have been observed dead-stranded both in South America and New Zealand[46] (Baker and van Helden 1999). And, although pygmy beaked whales are not well studied and their habitat ranges are poorly understood, lack of information should not preclude their inclusion in the proposed authorization, especially since they have been observed in New Zealand. Given that the *potential* to encounter pygmy whales exists and NMFS included them in the 2015 authorization for the same reason, takes should be authorized for the proposed surveys as well.

In addition, the estimated range of gingko-toothed beaked whales includes the waters off New Zealand[47]. However, NMFS did not include them in the proposed authorization, again citing Baker et al. (2016). Similar to pygmy beaked whales, a dead-stranded ginkgo-toothed beaked whale has been documented in New Zealand[48]. The Government of New Zealand does recognize both pygmy and ginkgo-toothed beaked whales as occurring rarely in New Zealand waters along with Andrews' beaked whales, southern bottlenose whales, Blainville's beaked whales, and Hector's beaked whale—all of which were included in the proposed authorization[49]. Moreover, dwarf sperm whales potentially occur in waters off New Zealand[50], as referenced by the Government of New Zealand in its 2013 Code and NMFS itself[51].

The Commission believes that all species that have the potential to be taken should have been included in the proposed authorization. Further, it would have been prudent for NMFS to consult the various Government of New Zealand resources[52], including the 2013 Code that lists all three species as species of concern, rather than relying solely on Baker et al. (2016) for determining which species of marine mammals could be taken by the proposed surveys. For all these reasons, the Commission recommends that NMFS include both pygmy and gingko-toothed beaked whales and dwarf sperm whales in its incidental harassment authorization for the 2017/8 survey.

Mitigation measures

NMFS proposed to include multiple mitigation measures consistent with its recently proposed incidental harassment authorizations for geological and geophysical activities (G&G)[53] in the Atlantic Ocean (82 Fed. Reg. 26244). The Commission is encouraged that NMFS is striving for consistency regarding mitigation measures for the same types of activities (e.g., geophysical or seismic surveys). However, some other measures were absent. The use of power downs and mitigation airgun have been limitless in previous authorizations. In its 3 August 2017 letter, the Commission recommended that NMFS prohibit their use entirely. NMFS would limit their use to a maximum of 30 minutes in the proposed authorization, as it had done for the final authorization for the UH geophysical survey. The Commission is encouraged that NMFS agrees with the Commission that limiting the use of power downs can be beneficial in reducing the overall sound

[46] http://www.iucnredlist.org/details/13251/0
[47] http://www.iucnredlist.org/details/13246/0
[48] https://collections.tepapa.govt.nz/object/780233
[49] https://www.teara.govt.nz/en/whales/page-7
[50] Primarily off the North Island.
[51] http://www.fisheries.noaa.gov/pr/species/mammals/whales/dwarf-sperm-whale.html and http://www.iucnredlist.org/details/11048/0
[52] And those of the International Union for Conservation of Nature and Natural Resources, a leading purveyor of conservation data, assessments, and analyses.
[53] Using similar-sized airgun arrays.

input to the marine environment but continues to support the prohibition of this measure given the efficacy of the measure has not been determined. NMFS did indicate that, as it develops best practices for geophysical surveys, it would consider the Commission's recommendation that power downs be eliminated as a mitigation measure (82 Fed. Reg. 44567). Further, the Government of New Zealand does not support the use of power downs based on its 2013 Code[54]. Given that the effectiveness of the measure has not been proven and the Government of New Zealand does not support the measure, the Commission recommends that NMFS prohibit LDEO from using power downs and the mitigation airgun during its geophysical surveys.

On a related point, the Commission understands that LDEO is under the impression that geophysical surveys conducted by foreign research vessels are exempt from the regulatory requirements of New Zealand's Exclusive Economic Zone and Continental Shelf Act and, through it, the mandatory provisions of the 2013 Code. The Commission has requested through NMFS that NSF provide information regarding LDEO's compliance with the Code, but further details have yet to be made available. Given that the surveys are scheduled to begin in a few days, it is somewhat concerning that information regarding LDEO's plans for compliance with the Code remain unknown. Other research entities (including those whose research programs are funded by foreign governments) have voluntarily adopted the provisions of the 2013 Code to protect marine mammals, including abiding by the various mitigation measures and developing marine mammal impact assessments[55]. Adherence to the code also would help protect Māui and Hector's dolphins, two species recently listed by NMFS under the Endangered Species Act (82 Fed. Reg. 43701). Inasmuch as the proposed activities would be occurring in waters under New Zealand jurisdiction, the Commission recommends that NMFS condition the incidental harassment authorization to require LDEO to abide by the regulatory requirements of the Exclusive Economic Zone and Continental Shelf Act and, through it, the mandatory provisions of the 2013 Code. The Commission believes that such a requirement would help ensure that the proposed activities have the least practicable adverse impact on marine mammals, as required by section 101(a)(5)(D)(ii)(I) of the MMPA.

In addition, NMFS would require LDEO to shut down the airgun array if a large whale with a calf is observed but would not require it to shut down the array for an aggregation of large whales (six or more individuals[56] that do not appear to be traveling and are feeding, socializing, etc.). That latter requirement has been a standard mitigation measure for geophysical surveys for many years and was a requirement in the two most recent authorizations for geophysical surveys (82 Fed. Reg. 39301 and 44577). The intent of the measure was to minimize impacts on mysticetes and sperm whales that are engaged in biologically-important behaviors (e.g., nursing, breeding, feeding, etc.), similar to the justification for shutting down the array when a large whale with a calf is observed. The Commission understands that the original premise of the measure was that mysticetes[57] are likely to be more sensitive to airgun pulses[58], which still remains a concern. Therefore, it is unclear

[54] Which includes other mitigation measures that may be more stringent than those proposed by NMFS.
[55] http://www.doc.govt.nz/our-work/seismic-surveys-code-of-conduct/marine-mammal-impact-assessments/
[56] The basis for that number is not clear. However, it would be best to base the number on the mean group size of the various species, which may be less than six (i.e., three whales).
[57] Presumably based on references at that time, such as McCauley et al. (2000), International Whaling Commission (IWC; 2005), Weller (2006a and 2006b), IWC (2007), Castellote et al. (2012), etc.
[58] Foraging behavior of sperm whales also has been shown to be affected by airgun pulses at low exposure levels and at ranges that exceed those predicted by 160 dB re 1 μPa (Miller et al. 2009).

why the measure was not included in the proposed authorization. The Commission recommends that NMFS require LDEO to shut down the airgun array when either (1) a large whale with a calf or (2) an aggregation of large whales is observed at any distance—the size of the aggregation should be based on group size rather than an arbitrary number.

Moreover, NMFS would require LDEO to shut down the airgun array if a beaked whale or *Kogia* spp. is observed. The Commission assumes that NMFS intended that shut-down procedure to be based solely on visual observations. However, NMFS had proposed for G&G activities in the Atlantic Ocean to shut down the airgun array if a beaked whale or *Kogia* spp. is observed visually *or acoustically* at any distance and if a diving sperm whale is observed visually at any distance centered forward of the vessel's track. The Commission questions why acoustic detections were not included in the current requirement and more importantly, why shutting down for sperm whales was absent from the proposed authorization except when observed with a calf.

For G&G activities in the Atlantic Ocean, NMFS based the mitigation measures for deep-diving species (i.e., sperm whales, beaked whales, and *Kogia* spp.) on the possibility that disturbance could provoke a severe behavioral response leading to injury (82 Fed. Reg. 26254)[59]. NMFS also indicated that beaked whales and *Kogia* spp. generally have low detection probabilities and that many individuals of those species may go undetected. Thus, NMFS proposed to require that shut-down procedures be implemented whenever beaked whales or *Kogia* spp. are detected either visually or acoustically for G&G activities (82 Fed. Reg. 26254-26455). These same measures should have been included in LDEO's proposed authorization[60].

Although sperm whales may be easier to observe visually than beaked whales or *Kogia* spp., they still dive for long periods (45 minutes on average (Watwood et al. 2006)), thus limiting their availability for visual detection. Fortunately, sperm whales can be detected reliably within 4 to 6 km[61] (see Figure 7b) and localized in a relatively short timeframe using a towed acoustic array (see Figure 2 and the method described in Barlow and Taylor 2005). Thus, the Commission considers it feasible and practicable for NMFS to require implementation of shut-down procedures based on both visual and acoustic detection for sperm whales. The acoustic detection methods also would bolster mitigation efforts as a whole, affording NMFS the ability to further reduce the impacts on those deep-diving species. Therefore, the Commission recommends that NMFS require LDEO to use (1) both visual observations and passive acoustic methods to implement shut-down procedures when any sperm whale, beaked whale, or *Kogia* spp. are detected[62] and (2) a consistent approach for requiring all geophysical and seismic survey operators to abide by the same general mitigation measures.

Monitoring measures

The Commission maintains 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

[59] NMFS did not provide any justification for this measure in the proposed authorization.
[60] In addition to shutting down if a sperm whale with a calf is observed.
[61] Which is comparable to or within the Level B harassment zones stipulated in Table 5 of the *Federal Register* notice.
[62] If NMFS requires implementation of this measure for sperm whales, it can remove sperm whales from the 'large whale' shut-down measure for both a large whale with a calf and an aggregation of large whales. This measure would obviate both of those measures.

the manner of taking and the numbers of animals taken incidental to the specified activity. 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 is achieved by incorporating g(0) and f(0) values [63]. 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 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[64]).

The Commission recently recommended that NMFS use that same approach for UH's survey off Hawaii[65]. NMFS indicated that it had provided the method to UH and affiliated entities and that they were concerned with some aspects of the Commission's method[66]. Although NMFS did not prescribe a particular method for estimating numbers of animals taken in the final authorization, UH would be required to incorporate in its monitoring report an estimate that accounts for all animals incidentally taken, including those on the trackline but not detected (82 Fed. Reg. 44567). The Commission understands that some of the concerns were related to vessel-based line transect surveys in general[67], while other concerns regarding observers' abilities to estimate Beaufort sea state and distance to sightings could be ameliorated with appropriate training. These latter concerns are disconcerting since the observers are required to implement specific mitigative actions at certain distances and in various sea states. The Commission currently is unaware of a better method to estimate the numbers of marine mammals taken but would welcome suggestions. It contends that continuing to assume that only those marine mammals visually observed were taken during any geophysical survey is inappropriate.

In addition, the Commission continues to believe that LDEO and other NSF-affiliated entities should pool the sightings data from their monitoring reports across all surveys and derive *f*(0) values specific to geophysical surveys[68] for the various species or genera (i.e., *Kogia* spp.,

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[63] These values vary based on, among other things, platform characteristics, observer skill, environmental conditions, and sightability and detectability of the species.
[64] A similar method should be used for pinnipeds with applicable *g*(0) and *f*(0) values.
[65] And a similar approach for G&G activities in the Atlantic Ocean.
[66] The Commission notes that LDEO and other NSF-affiliated entities historically corrected the estimates of numbers of marine mammals taken in their previous monitoring reports based on published *g*(0) and *f*(0) values, see LGL, Limited (LGL; 2008) as one example. LGL (2008) stated that use of correction factors derived from other studies is not ideal, but it provides *more realistic* estimates of numbers present (i.e., taken) than could be obtained without using data from other studies.
[67] Many of which could be accounted for in covariates and the models that underpin them if and when geophysical survey-specific *f*(0) values are derived.
[68] *g*(0) values from the literature would still need to be used. LGL (2008) indicated that the *f*(0) values that were used for that monitoring report were taken from results of previous work, not from observations made during that particular survey. It further stated that sighting rates during the present survey were either too small or, at most, marginal to provide meaningful data on *f*(0) based on group size. This implies that LDEO and other NSF-affiliated entities either have incorporated or could incorporate *f*(0) values specific to geophysical surveys.

Mesoplodon spp., *Delphinus* spp., etc.). The Commission's recommended method of using published data does not absolve action proponents from fulfilling this analytical need, which has been recommended and discussed between the agencies for many years. Therefore, until such time that a better method is developed or LDEO and other NSF-affiliated entities derive geophysical survey-specific $f(0)$ values, the Commission recommends that NMFS require LDEO to use the Commission's method as described in the Addendum[62] to better estimate the numbers of marine mammals taken by Level A and B harassment for the incidental harassment authorization. All other NSF-affiliated entities[69] and all seismic operators should use the Commission's method as well.

The Commission trusts that NMFS will consider fully these comments and recommendations before issuing an authorization for the proposed activities. Please contact me if you have questions concerning the Commission's recommendations.

Sincerely,

Rebecca J. Lent, Ph.D.,
Executive Director

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[69] Including 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[70] 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

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

[70] 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[71] 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-

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

sided dolphins are observed approaching the vessel[72] 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

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

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

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