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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648-XR007

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Low-Energy Geophysical Survey in the Southwest Atlantic Ocean

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; issuance of an incidental harassment authorization.

SUMMARY: In accordance with the regulations implementing the Marine Mammal Protection Act (MMPA) as amended, notification is hereby given that NMFS has issued an incidental harassment authorization (IHA) to the Scripps Institute of Oceanography (SIO) to incidentally harass, by Level A and Level B harassment, marine mammals during a low-energy marine geophysical survey in the Southwest Atlantic Ocean.

DATES: This Authorization is effective from September 12, 2019 through September 11, 2020.

FOR FURTHER INFORMATION CONTACT: Amy Fowler, Office of Protected Resources, NMFS, (301) 427-8401. Electronic copies of the application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *https://www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection-act.* In case of problems accessing these documents, please call the contact listed above.

SUPPLEMENTARY INFORMATION:

Background

The MMPA prohibits the "take" of marine mammals, with certain exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq*.) direct the Secretary of Commerce (as delegated to NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed incidental take authorization may be provided to the public for review.

Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses (where relevant). Further, NMFS must prescribe the permissible methods of taking and other "means of effecting the least practicable adverse impact" on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stocks for taking for certain subsistence uses (referred to in shorthand as "mitigation"); and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth.

Summary of Request

On March 13, 2019, NMFS received a request from SIO for an IHA to take marine mammals incidental to conducting a low-energy marine geophysical survey in the Southwest Atlantic Ocean. The application was deemed adequate and complete on May 20, 2019. SIO's request was for take of a small number of 49 species of marine mammals by Level B harassment. Neither SIO nor NMFS expects serious injury or mortality to result from this activity and, therefore, an IHA is appropriate.

Description of Specified Activity

SIO plans to conduct low-energy marine seismic surveys in the Southwest Atlantic Ocean during September-October 2019. The seismic surveys would be conducted in the Exclusive Economic Zone (EEZ) of the Falkland Islands and International Waters, with water depths ranging from ~50–5700 meters (m) (See Figure 1 in the IHA application). A total of ~7,500 kilometers (km) of seismic data would be collected. The surveys would involve one source vessel, R/V *Thomas G. Thompson* (R/V *Thompson*). The *Thompson* would deploy up to two 45-in^3 GI airguns at a depth of 2–4 m with a maximum total volume of ~90 in^3. The receiving system would consist of one hydrophone streamer, 200–1,600 m in length, which would receive the returning acoustic signals and transfer the data to the on-board processing system.

The airgun array would be operated in one of two different types of array modes. The first would be highest-quality survey mode to collect the highest-quality seismic reflection data at approximately 18 potential drill sites. The second mode would be a reconnaissance mode, which is quicker, and will occur at approximately 75 coring locations, primarily in Survey Area 2 (see Figure 1 in the IHA application). The reconnaissance mode also allows for operations to occur in poor weather where the use of streamer longer than 200-m may not be possible safely.

The reconnaissance mode is carried out using either one or two 45-in^3 airguns, with airguns spaced 8 m apart (if 2 are being used) at a water depth of 2–4 m, with a 200 m hydrophone streamer and with the vessel traveling at 8 knots (kn). The highest-quality mode is carried out using a pair of 45-in^3 airguns, with airguns spaced 2 m apart at a depth of 2–4 m, with a 400, 800, or 1,600 m hydrophone streamer and with the vessel traveling at to 5 kn to achieve high-quality seismic reflection data.

Comments and Responses

A notice of NMFS's proposal to issue an IHA to SIO was published in the **Federal Register** on August 12, 2019 (84 FR 39896). That notice described, in detail, SIO's activity, the marine mammal species that may be affected by the activity, and the anticipated effects on marine mammals. During the 30-day public comment period, NMFS received comment letters from the Marine Mammal Commission (Commission) and Falklands Conservation, and a comment from the Falkland Islands Director of Natural Resources.

Comment 1: The Commission recommended NMFS specify why it believes that sound channels with downward refraction, as well as seafloor refractions, are not likely to occur during SIO's survey and the degree to which both of these parameters would affect the estimation (or underestimation) of Level B harassment zones in deep and intermediate water depths. Additionally, the Commission recommended NMFS specify how it has validated use of Lamont-Doherty Earth Observatory's (L-DEO's) acoustic modeling correction factors and ratios to account for differing water depths, tow depths, and airgun spacing for surveys that occur in both intermediate and shallow water.

Response: The L-DEO approach to the modeling is generally conservative as supported by data collected from calibration and other field data along with modeling results. The L-DEO approach does not rely on incorporating every possible environmental factor in the marine environment. Published results from Tolstoy (2009), Diebold (2010), and Crone *et al.* (2014, 2017), along with nearly 20 years of PSO observations from previous NSF-funded seismic surveys in various water depths validate the approach. L-DEO has presented their modeling approach to NMFS and the Commission on several occasions. Given the information presented, numerous discussions, and observations from past NSF-funded seismic surveys that used the L-

DEO modeling approach, NMFS remains confident that the methodology used is appropriate and conservatively protects marine mammals.

Comment 2: The Commission noted tables depicting source levels in both the IHA application and the **Federal Register** notice contained inadequate information and that the appendices of SIO's IHA application did not contain necessary information. The Commission recommended that NMFS ensure that all source levels, modified source levels, and related adjustment factors are specified and all relevant isopleth figures and user spreadsheet tables are included in all future NSF-funded and –affiliated applications prior to processing them.

Response: NMFS has added clarification on the tables noted by the Commission and provided the Commission the requested information. NMFS will ensure that all applications contain the necessary information required for adequate understanding of the acoustic modeling prior to publishing the notice of proposed IHA.

Comment 3: The Commission recommended that, instead of using the L-DEO modeling described in the IHA application, NMFS require SIO to re-estimate the proposed Level A and Level B harassment zones and associated takes of marine mammals using (1) 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 at a minimum) parameters, (2) a comprehensive source model (i.e., Gundalf Optimizer or AASM) and (3) an appropriate sound propagation model for the proposed incidental harassment authorization. Specifically, the Commission reiterates that L-DEO should be using the ray-tracing propagation 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, and recommends NMFS specify why it

believes that L-DEO's modeling approaches provide more accurate, realistic, and appropriate Level A and Level B harassment zones than BELLHOP.

Response: NMFS acknowledges the Commission's concerns about L-DEO's current modeling approach for estimating Level A and Level B harassment zones and takes. SIO's application and the **Federal Register** notice of the proposed IHA (84 FR 39896; August 12, 2019) describe the applicant's approach to modeling Level A and Level B harassment zones. The model L-DEO currently uses does not allow for the consideration of environmental and site-specific parameters as requested by the Commission, but as described below, field measurements support the use of the model used.

SIO's application describes L-DEO's approach to modeling Level A and Level B harassment zones. In summary, L-DEO acquired field measurements for several array configurations at shallow, intermediate, and deep-water depths during acoustic verification studies conducted in the northern Gulf of Mexico in 2007 and 2008 (Tolstoy *et al.*, 2009). Based on the empirical data from those studies, L-DEO developed a sound propagation modeling approach that predicts received sound levels as a function of distance from a particular airgun array configuration in deep water. For this survey, L-DEO modeled Level A and Level B harassment zones based on the empirically-derived measurements from the Gulf of Mexico calibration survey (Appendix H of NSF-USGS 2011). L-DEO used the deep-water radii obtained from model results down to a maximum water depth of 2,000 meters (m) (Figures 2 and 3 in Appendix H of NSF-USGS 2011).

In 2015, LDEO explored the question of whether the Gulf of Mexico calibration data described above adequately informs the model to predict exclusion isopleths in other areas by conducting a retrospective sound power analysis of one of the lines acquired during L-DEO's

seismic survey offshore New Jersey in 2014 (Crone, 2015). NMFS presented a comparison of the predicted radii (*i.e.*, modeled exclusion zones) with radii based on in situ measurements (*i.e.*, the upper bound [95th percentile] of the cross-line prediction) in a previous notice of issued Authorization for LDEO (see 80 FR 27635, May 14, 2015, Table 1). Briefly, the analysis presented in Crone (2015), specific to the survey site offshore New Jersey, confirmed that in-situ, site specific measurements and estimates of 160 decibel (dB) and 180 dB isopleths collected by the hydrophone streamer of the R/V *Langseth* in shallow water were smaller than the modeled (i.e., predicted) zones for two seismic surveys conducted offshore New Jersey in shallow water in 2014 and 2015. In that particular case, Crone's (2015) results showed that L-DEO's modeled 180 decibel (dB) and 160 dB zones were approximately 28 percent and 33 percent larger, respectively, than the in-situ, site-specific measurements, thus confirming that L-DEO's model was conservative in that case.

The following is a summary of two additional analyses of in-situ data that support L-DEO's use of the modeled Level A and Level B harassment zones in this particular case. In 2010, L-DEO assessed the accuracy of their modeling approach by comparing the sound levels of the field measurements acquired in the Gulf of Mexico study to their model predictions (Diebold *et al.*, 2010). They reported that the observed sound levels from the field measurements fell almost entirely below the predicted mitigation radii curve for deep water (i.e., greater than 1,000 m; 3,280.8 ft) (Diebold *et al*., 2010). In 2012, L-DEO used a similar process to model distances to isopleths corresponding to Level A and Level B harassment thresholds for a shallow-water seismic survey in the northeast Pacific Ocean offshore Washington State. LDEO conducted the shallow-water survey using a 6,600 in^3 airgun configuration aboard the R/V *Langseth* and recorded the received sound levels on both the shelf and slope using the *Langseth's* 8 km

hydrophone streamer. Crone *et al*. (2014) analyzed those received sound levels from the 2012 survey and confirmed that in-situ, site specific measurements and estimates of the 160 dB and 180 dB isopleths collected by the *Langseth's* hydrophone streamer in shallow water were two to three times smaller than L-DEO's modeling approach had predicted. While the results confirmed the role of bathymetry in sound propagation, Crone *et al*. (2014) were also able to confirm that the empirical measurements from the Gulf of Mexico calibration survey (the same measurements used to inform L-DEO's modeling approach for the planned surveys in the northwest Atlantic Ocean) overestimated the size of the exclusion and buffer zones for the shallow-water 2012 survey off Washington State and were thus precautionary, in that particular case.

NMFS continues to work with L-DEO to address the issue of incorporating site-specific information for future authorizations for seismic surveys. However, L-DEO's current modeling approach (supported by the three data points discussed previously) represents the best available information for NMFS to reach determinations for this IHA. As described earlier, the comparisons of L-DEO's model results and the field data collected at multiple locations (i.e., the Gulf of Mexico, offshore Washington State, and offshore New Jersey) illustrate a degree of conservativeness built into L-DEO's model for deep water, which NMFS expects to offset some of the limitations of the model to capture the variability resulting from site-specific factors. Based upon the best available information (i.e., the three data points, two of which are peer-reviewed, discussed in this response), NMFS finds that the Level A and Level B harassment zone calculations are appropriate for use in this particular IHA.

The use of models for calculating Level A and Level B harassment zones and for developing take estimates is not a requirement of the MMPA incidental take authorization process. Further, NMFS does not prescribe specific model parameters nor a specific model for

applicants as part of the MMPA incidental take authorization process at this time, although we do review methods to ensure they adequately predict take. There is a level of variability not only with parameters in the models, but also the uncertainty associated with data used in models, and therefore, the quality of the model results submitted by applicants. NMFS considers this variability when evaluating applications and the take estimates and mitigation measures that the model informs. NMFS takes into consideration the model used, and its results, in determining the potential impacts to marine mammals; however, it is just one component of the analysis during the MMPA authorization process as NMFS also takes into consideration other factors associated with the activity (*e.g.*, geographic location, duration of activities, context, sound source intensity, etc.).

Comment 4: The Commission noted that monitoring and reporting requirements adopted 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. 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. The Commission recommended that NMFS require L-DEO to use the Commission's method as described in the Commission's Addendum to better estimate the numbers of marine mammals taken by Level A and B harassment for the incidental harassment authorization. The Commission stated that all other NSF-affiliated entities and all seismic operators should use this method as well.

Response: We thank the Commission for their recommendation. NMFS is in the process of determining the appropriate method for deriving post-survey estimates of the total number of animals taken by activities such as Scripps' marine geophysical survey.

Comment 5: The Commission recommended NMFS require SIO to specify in the final monitoring report (1) the number of days the survey occurs and the array is active and (2) the percentage of time and total time the array is active during daylight vs nighttime hours (including dawn and dusk).

Response: NMFS will require SIO to include this information in their final monitoring report.

Comment 6: The Commission recommended that NMFS refrain from using the proposed renewal process for SIO's authorization based on the complexity of analysis and potential for impacts on marine mammals, and the potential burden on reviewers of reviewing key documents and developing comments quickly. Additionally, the Commission recommends that NMFS use the IHA renewal process sparingly and selectively for activities expected to have the lowest levels of impacts to marine mammals and that require less complex analysis.

Response: We appreciate the Commission's input and direct the reader to our recent response to the same comment, which can be found at 84 FR 31032 (June 28, 2019), pg. 31035-31036. If and when SIO requests a Renewal, we will consider the Commission's comment further and address the concerns specific to this project. We will consider this comment further when and if Scripp's requests a renewal.

Comment 7: The Commission noted that the proposed surveys are scheduled to begin immediately after the public comment period closes and expressed concern that NMFS did not have adequate time to consider public comments before issuing the IHA. The Commission recommended NMFS more thoroughly review applications, draft **Federal Register** notices, and draft proposed authorizations prior to submitting any proposed authorizations to the **Federal Register,** as well as require earlier submission of applications and other documentation to ensure

sufficient time to prepare the proposed authorization and consider comments received from the public.

Response: NMFS thanks the Commission for its concerns regarding the IHA process. NMFS thoroughly reviewed the comments received and considered all comments in making appropriate revisions to the final IHA. NMFS encourages all applicants to submit applications for IHAs five to eight months in advance of the intended project start date and for rulemakings/LOAs at least nine months, and preferably 15 months, in advance of the intended project start date. More generally, NMFS publishes **Federal Register** notices for proposed IHAs as quickly as possible once the application is received and aims to allow more time on the back end of the comment period, but there are situations where the length of processing times are driven by the exigency of an applicant's activity start date or by the need to work with applicants to ensure we have the necessary information to deem an application adequate and complete. Here, NMFS provided the required 30-day notice for public comment, and has adequately considered the comments received in making the necessary findings for this IHA.

Comment 8: Falklands Conservation requested clarity on the species occurrence determinations in Table 2 in the **Federal Register** notice of proposed IHA (and Table 3 in SIO's IHA application).

Response: The occurrence as noted is for the survey area at the proposed time of the survey and is our professional opinion based on all of the available data for the area, as well as the known population size in the overall area. This is best professional judgement and is mainly meant to serve as a guide to the seismic operator so that they can anticipate what species are likely to be encountered during the survey and which are not. As noted by Falklands Conservation, data are lacking for the area, so it is difficult to make such predictions. The take

estimates are not based on the occurrence but on the densities, which as noted by Falklands Conservation, may not always be ideally representative either as they are taken from different areas, but which do represent the best available science paired with best professional judgement.

Comment 9: Falklands Conservation noted that the **Federal Register** notice of proposed IHA inaccurately referred to the Falkland Islands as a "known or historic breeding area" for southern right whales. Falklands Conservation also noted that large numbers of southern right whales have been recorded off the northeast coast of the Falklands seasonally since 2017 and suggested that the occurrence of southern right whales might be higher than the "uncommon" assessment provided in the **Federal Register** notice. Additionally, Falklands Conservation indicated they did not support the assessment of "uncommon" for fin whales and sei whales.

Response: We thank Falklands Conservation for their recommended correction and suggestions. However, no references were provided to support any change in density or abundance estimates for these species, and as noted above, these designations have no impact on the take estimation. As such, we have determined that this comment does not necessitate any changes in our assessment and has no effect on our authorized take or findings.

Comment 10: Falklands Conservation suggested that because the planned survey occurs in mostly international waters where few abundance or density surveys for marine mammals have been conducted, that there are not enough available datasets from comparable areas (with regard to the criteria that influence marine mammals such as water depth, sea surface temperature, and latitudes) for the take requests to be robust.

Response: As noted by Falklands Conservation, there are limited density and abundance surveys available for this region and regions with similar environmental qualities. Accordingly, and as described in the application and elsewhere in this notice, SIO and NMFS used the best

available information to determine the appropriate densities for estimating take for this project. Falklands Conservation provided no references to suggest other densities and abundance information should be used in place of those used by SIO and NMFS in the take estimation. Therefore, NMFS has not made any changes to the density and abundance information presented in the **Federal Register** notice of proposed IHA.

Comment 11: Falklands Conservation commented on SIO's discussion of the timing of the survey in their IHA application and suggested that the survey be scheduled outside of the core periods of baleen whale presence.

Response: SIO's specified activity includes the timing of the survey that best represents their goals of acquiring seismic, based on the availability of the survey vessel and other logistical issues. NMFS has made the necessary findings to issue an IHA for the specified activity included in SIO's request, and there is no justification to require SIO to completely change their specified activity to occur at a different time.

Comment 12: Falklands Conservation questioned whether the proposed mitigation and monitoring measures are sufficient reduce impacts to marine mammals. Specifically, Falklands Conservation noted that since observers are not required during nighttime operations, passive acoustic monitoring (PAM) is the only way to achieve mitigation for protected species at night, as well as during adverse sea conditions. Falklands Conservation recommended requiring PAM to assist visual observation and noted that the **Federal Register** notice of proposed IHA mentioned acoustic monitoring in the summary of the proposed mitigation measures.

Response: The inclusion of acoustic monitoring in the list of proposed mitigation measures was inadvertent. NMFS recognizes that PAM can be an effective tool in marine mammal detection during nighttime operations or when visual observations are otherwise

obscured. However, given the small Level A and Level B harassment zones and limited reduction of impacts anticipated to be gained by the use of PAM, in consideration of the cost of implementing PAM systems, we do not require PAM for surveys of this nature and size and it is not warranted here. As described in the Mitigation section, we have included the necessary measures to ensure the least practicable adverse impact on the affected species and stocks and their habitat.

Comment 13: Falklands Conservation requested clarification on the adequacy of night vision equipment to be used in the planned survey.

Response: NMFS does not prescribe any specific equipment be used, but examples of night vision equipment include Exelis PVS-7 night vision goggles, Night Optics D-300 night vision monocular, and FLIR M324XP thermal imaging camera or equivalents.

Comment 14: Falklands Conservation questioned the rationale for requiring a 500-meter (m) exclusion zone for southern right whales, but a 100-m exclusion zone for other endangered cetaceans such as blue whales and sei whales.

Response: For small airgun arrays, such as those utilized by SIO here, NMFS requires a 100-m exclusion zone for all marine mammal species and an extended exclusion zone of 500 m for species or circumstances that warrant additional protection. In the northern hemisphere, North Atlantic right whales and North Pacific right whales are included in the group of species for which we require an extended exclusion zone. While southern right whales are not nearly as imperiled as their northern hemisphere counterparts, NMFS determined that given the similarities between the species, an extended exclusion zone was warranted. The 100-m exclusion zone for other species, including listed cetaceans, is sufficiently protective for these

animals, given the sizes of the Level A and Level B harassment zones (up to 6.5 m and 1,400 m, respectively), as described in the Mitigation section.

Comment 15: Falklands Conservation suggested that excepting specific delphinid species from the shutdown requirement does not comply with best practice recommendations which recommend shutting down the acoustic source for all species approaching the zone of impact.

Response: The available information does not suggest that delphinid perceived attraction to vessels is likely to have meaningful energetic effects to individuals such that the effectiveness of such measures outweighs the practicability concerns of requiring the operator to shutdown operations when dolphins approach the vessel. NMFS has included this delphinid exception in numerous recent authorizations and believes it to be an appropriate measure. For additional information, please see NMFS discussion of delphinid shutdown exceptions in the **Federal Register** notice of issuance of IHAs to take marine mammals incidental to geophysical surveys in the Atlantic Ocean (83 FR 63303; December 7, 2018).

Comment 16: The Falkland Islands Director of Natural Resources requested clarification on the meaning of "take" in regards to this IHA.

Response: Take is defined under the MMPA as "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 U.S.C. 1362). As noted on page 39915 of the **Federal Register** notice of proposed IHA (84 FR 39896; August 12, 2019), harassment is the only type of take expected to result from these activities. The MMPA defines harassment as any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding,

feeding, or sheltering (Level B harassment). Additional information on the definition of take is available on NMFS's website at *https://www.fisheries.noaa.gov/national/laws-and-policies/glossary-permits-protected-resources.*

Changes from Proposed to Final IHA

Minor corrections have been made to typographical errors in the estimated take table. Additionally, while no take by Level A harassment was proposed for any species, some take by Level A harassment has been authorized for three species of marine mammals (see Estimated Take section).

Description of Marine Mammals in the Area of Specified Activities

Section 4 of the application summarizes available information regarding status and trends, distribution and habitat preferences, and behavior and life history, of the potentially affected species. Additional information about these species (*e.g.*, physical and behavioral descriptions) may be found on NMFS's website (*https://www.fisheries.noaa.gov/find*-species).

The populations of marine mammals considered in this document do not occur within the U.S. EEZ and are therefore not assigned to stocks and are not assessed in NMFS' Stock Assessment Reports (SARs). As such, information on potential biological removal (PBR; defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population) and on annual levels of serious injury and mortality from anthropogenic sources are not available for these marine mammal populations. Abundance estimates for marine mammals in the survey location are lacking; therefore estimates of abundance presented here are based on a variety of proxy sources including International Whaling Commission population estimates (IWC 2019), the U.S. Atlantic SARs (Hayes *et al*.,

2018), and various literature estimates (see IHA application for further detail), as this is considered the best available information on potential abundance of marine mammals in the area. However, as described above, the marine mammals encountered by the planned survey are not assigned to stocks. All abundance estimate values presented in Table 1 are the most recent available at the time of publication and are available in the 2018 U.S. Atlantic SARs (e.g., Hayes *et al*. 2018) available online at: *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments*, except where noted otherwise.

Table 1 lists all species with expected potential for occurrence in the Argentine Basin, Southwest Atlantic Ocean, and summarizes information related to the population, including regulatory status under the MMPA and ESA. For taxonomy, we follow Committee on Taxonomy (2018).

Table 1: Marine Mammal Species Potentially Present in the Project Area Expected To Be Affected by the Specified Activities

Common name	Scientific name	Stock[1]	ESA/MMPA status; Strategic (Y/N)[2]	Abundance	PBR	Relative occurrence in project area
Order Cetartiodactyla – Cetacea – Superfamily Mysticeti (baleen whales)						
Family Balaenidae						
Southern right whale	Eubalaena australis	n/a	E/D;N	12,000[3] 3,300[4]	N.A.	Uncommon
Family Cetotheriidae						
Pygmy right whale	Caperea marginata	n/a		N.A.	N.A.	Rare
Family Balaenopteridae (rorquals)						
Blue whale	Balaenoptera musculus	n/a	E/D;Y	2,300 true[3] 1,500 pygmy[5]	N.A.	Rare
Fin whale	Balaenoptera physalus	n/a	E/D;Y	15,000[5]	N.A.	Uncommon
Sei whale	Balaenoptera borealis	n/a	E	10,000[5]	N.A.	Uncommon
Common minke whale	Balaenoptera acutorostrata	n/a	-	515,000[3,6]	N.A.	Common
Antarctic minke whale	Balaenoptera bonaerensis	n/a	-	515,000[3,6]	N.A.	Common

Humpback whale	Megaptera novaeangliae	n/a	-	42,000[3]	N.A.	Rare
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)						
Family Physeteridae						
Sperm whale	Physeter macrocephalus	n/a	E	12,069[8]	N.A.	Uncommon
Family Kogiidae						
Pygmy sperm whale	Kogia breviceps	n/a	-	N.A.	N.A.	Rare
Dwarf sperm whale	Kogia sima	n/a	-	N.A.	N.A.	Rare
Family Ziphiidae (beaked whales)						
Arnoux's beaked whale	Berardius arnuxii	n/a	-	599,300[9]	N.A.	Uncommon
Cuvier's beaked whale	Ziphius cavirostris	n/a	-	599,300[9]	N.A.	Uncommon
Southern bottlenose whale	Hyperoodon planifrons	n/a	-	599,300[9]	N.A.	Uncommon
Shepherd's beaked whale	Tasmacetus sheperdi	n/a	-	N.A.	N.A.	Uncommon
Blainville's beaked whale	Mesoplodon densirostris	n/a	-	N.A.	N.A.	Rare
Gray's beaked whale	Mesoplodon grayi	n/a	-	599,300[9]	N.A.	Uncommon
Hector's beaked whale	Mesoplodon hectori	n/a	-	N.A.	N.A.	Rare
True's beaked whale	Mesoplodon mirus	n/a	-	N.A.	N.A.	Rare
Strap-toothed beaked whale	Mesoplodon layardii	n/a	-	599,300[9]	N.A.	Uncommon
Andrews' beaked whale	Mesoplodon bowdoini	n/a	-	N.A.	N.A.	Rare
Spade-toothed beaked whale	Mesoplodon traversii	n/a	-	N.A.	N.A.	Rare
Family Delphinidae						
Risso's dolphin	Grampus griseus	n/a	-	18,250[10]	N.A.	Uncommon
Rough-toothed dolphin	Steno bredanensis	n/a	-	N.A.	N.A.	Rare
Common bottlenose dolphin	Tursiops truncatus	n/a	-	77,532[10]	N.A.	Uncommon
Pantropical spotted dolphin	Stenella attenuata	n/a	-	3,333[10]	N.A.	Rare
Atlantic spotted dolphin	Stenella frontalis	n/a	-	44715[10]	N.A.	Rare
Spinner dolphin	Stenella longirostris	n/a	-	N.A.	N.A.	Uncommon
Clymene dolphin	Stenella clymene	n/a	-	N.A.	N.A.	Rare
Striped dolphin	Stenella coeruleoalba	n/a	-	54,807[10]	N.A.	Uncommon
Short-beaked common	Delphinus delphis	n/a	-	70,184[10]	N.A.	Uncommon

dolphin						
Fraser's dolphin	Lagenodelphis hosei	n/a	-	N.A.	N.A.	Rare
Dusky dolphin	Lagenorhynchus obscurus	n/a	-	7,252[11]	N.A.	Uncommon
Hourglass dolphin	Lagenorhynchus cruciger	n/a	-	150,000[5]	N.A.	Common
Peale's dolphin	Lagenorhynchus australis	n/a	-	20,000[12]	N.A.	Common
Southern right whale dolphin	Lissodelphis peronii	n/a	-	N.A.	N.A.	Uncommon
Commerson's dolphin	Cephalorhynchus commersonii	n/a	-	21,000[13]	N.A.	Common
Killer whale	Orcinus orca	n/a	-	25,000[14]	N.A.	Uncommon
Short-finned pilot whale	Globicephala macrorhynchus	n/a	-	200,000[5]	N.A.	Rare
Long-finned pilot whale	Globicephala melas	n/a	-	200,000[5]	N.A.	Common
False killer whale	Pseudorca crassidens	n/a	-	N.A.	N.A.	Rare
Family Phocoenidae (porpoises)						
Spectacled porpoise	Phocoena dioptrica	n/a	-	N.A.	N.A.	Uncommon
Order Carnivora – Superfamily Pinnipedia						
Family Otariidae (eared seals and sea lions)						
Antarctic fur seal	Arctocephalus gazella	n/a	-	4.5 – 6.2 million[15]	N.A.	Rare
South American fur seal	Arctocephalus australis	n/a	-	99,000[16]	N.A.	Common
Subantarctic fur seal	Arctocephalus tropicalis	n/a	-	400,000[17]	N.A.	Uncommon
South American sea lion	Otaria flavescens	n/a	-	445,000[16]	N.A.	Common
Family Phocidae (earless seals)						
Crabeater seal	Lobodon carcinophaga	n/a	-	5 – 10 million[18]	N.A.	Rare
Leopard seal	Hydrurga leptonyx	n/a	-	222,000 – 440,000[19]	N.A.	Rare
Southern elephant seal	Mirounga leonina	n/a	-	750,000[20]	N.A.	Uncommon

N.A. = data not available

1 The populations of marine mammals considered in this document do not occur within the U.S. EEZ and are therefore not assigned to stocks

2 Endangered Species Act (ESA) status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock

3 Southern Hemisphere (IWC 2019)

4 Southwest Atlantic (IWC 2019)

5 Antarctic (Boyd 2002)

6 Dwarf and Antarctic minke whales combined

7 There are 14 distinct population segments (DPSs) of humpback whales recognized under the ESA; the Brazil DPS is not listed (NOAA 2017)

8 Estimate for the Antarctic, south of 60° S(Whitehead 2002)

9 All beaked whales south of the Antarctic Convergence; mostly southern bottlenose whales (Kasamatsu and Joyce 1995)
10 Estimate for the western North Atlantic (Hayes *et al.*, 2018)
11 Estimate for Patagonian coast (Dans *et al.*, 1997)
12 Estimate for Southern Patagonian waters, Argentina (Dellabianca *et al.*, 2016)
13 Total world population (Dawson 2018)
14 Minimum estimate for Southern Ocean (Branch and Butterworth 2001)
15 South Georgia population (Dawson 2018)
16 Total population (Cárdenas-Alayza *et al.*, 2016a)
17 Global population (Hofmeyr and Bester 2018)
18 Global population (Bengston and Stewart 2018)
19 Global population (Rogers 2018)
20 Total world population (Hindell *et al.*, 2016)

All species that could potentially occur in the planned survey areas are included in Table 2. As described below, all 49 species temporally and spatially co-occur with the activity to the degree that take is reasonably likely to occur, and we have authorized it.

A detailed description of the species likely to be affected by the planned geophysical surveys, including brief introductions to the species and relevant stocks as well as available information regarding population trends and threats, information regarding local occurrence, and marine mammal hearing were provided in the **Federal Register** notice for the proposed IHA (84 FR 39896; August 12, 2019). Since that time, we are not aware of any changes in the status of these species and stocks; therefore, detailed descriptions are not provided here. Please refer to that **Federal Register** notice for these descriptions. Please also refer to NMFS's website (*https://www.fisheries.noaa.gov/find-species*) for generalized species accounts.

Potential Effects of Specified Activities on Marine Mammals and their Habitat

The effects from underwater noise from SIO's planned geophysical surveys have the potential to result in harassment of marine mammals in the vicinity of the action area. The **Federal Register** notice for the proposed IHA (84 FR 39896; August 12, 2019) included a discussion of the effects of anthropogenic noise on marine mammals and their habitat, therefore that information is not repeated here; please refer to that **Federal Register** notice (84 FR 39896;

August 12, 2019) for that information. No instances of serious injury or mortality are expected as a result of the planned activities.

Estimated Take

This section provides an estimate of the number of incidental takes authorized through this IHA, which will inform both NMFS' consideration of "small numbers" and the negligible impact determination.

Harassment is the only type of take expected to result from these activities. Except with respect to certain activities not pertinent here, section 3(18) of the MMPA defines "harassment" as any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

Authorized takes would primarily be by Level B harassment, as use of the acoustic sources (*i.e.*, seismic airgun) has the potential to result in disruption of behavioral patterns for individual marine mammals. There is also some small potential for auditory injury (Level A harassment) for high frequency cetaceans (*i.e.*, Kogiidae and Lagenorhynchus spp., and spectacled porpoise). Auditory injury is unlikely to occur for low frequency cetaceans, mid frequency cetaceans, otariid pinnipeds, or phocid pinnipeds given the very small modeled zones of injury for those hearing groups (up to 6.5 m). The mitigation and monitoring measures are expected to minimize the severity of such taking to the extent practicable. As described previously, no mortality is anticipated or authorized for this activity. Below we describe how the take is estimated.

Generally speaking, we estimate take by considering: (1) acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; (2) the area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and, (4) and the number of days of activities. We note that while these basic factors can contribute to a basic calculation to provide an initial prediction of takes, additional information that can qualitatively inform take estimates is also sometimes available (e.g., previous monitoring results or average group size). Below, we describe the factors considered here in more detail and present the authorized take.

Acoustic Thresholds

Using the best available science, NMFS has developed acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals would be reasonably expected to be behaviorally harassed (equated to Level B harassment) or to incur PTS of some degree (equated to Level A harassment).

Level B Harassment for non-explosive sources – Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source (*e.g.*, frequency, predictability, duty cycle), the environment (*e.g.*, bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Southall *et al.*, 2007, Ellison *et al.*, 2012). Based on what the available science indicates, and the practical need to use a threshold based on a factor that is both predictable and measurable for most activities, NMFS uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS predicts that marine mammals are likely to be behaviorally harassed in a

manner we consider Level B harassment when exposed to underwater anthropogenic noise above received levels of 120 dB re 1 μPa (rms) for continuous (*e.g.,* vibratory pile-driving, drilling) and above 160 dB re 1 μPa (rms) for non-explosive impulsive (*e.g.*, seismic airguns) or intermittent (*e.g.*, scientific sonar) sources.

SIO's activity includes the use of impulsive seismic sources, and therefore the 160 dB re 1 μPa (rms) is applicable.

Level A harassment for non-explosive sources - NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) (Technical Guidance, 2018) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). SIO's activity includes the use of impulsive seismic sources.

These thresholds are provided in the table below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS 2018 Technical Guidance, which may be accessed at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance.*

Table 2. Thresholds identifying the onset of Permanent Threshold Shift

	PTS Onset Acoustic Thresholds* **(Received Level)**	
Hearing Group	**Impulsive**	**Non-impulsive**
Low-Frequency (LF) Cetaceans	*Cell 1* $L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	*Cell 2* $L_{E,LF,24h}$: 199 dB
Mid-Frequency (MF) Cetaceans	*Cell 3* $L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	*Cell 4* $L_{E,MF,24h}$: 198 dB

High-Frequency (HF) Cetaceans	*Cell 5* $L_{pk,flat}$: 202 dB $L_{E,HF,24h}$: 155 dB	*Cell 6* $L_{E,HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	*Cell 7* $L_{pk,flat}$: 218 dB $L_{E,PW,24h}$: 185 dB	*Cell 8* $L_{E,PW,24h}$: 201 dB
Otariid Pinnipeds (OW) (Underwater)	*Cell 9* $L_{pk,flat}$: 232 dB $L_{E,OW,24h}$: 203 dB	*Cell 10* $L_{E,OW,24h}$: 219 dB

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

Note: Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (L_E) has a reference value of 1µPa²s. In this Table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI 2013). However, 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. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.

Ensonified Area

Here, we describe operational and environmental parameters of the activity that will feed into identifying the area ensonified above the acoustic thresholds, which include source levels and transmission loss coefficient.

The planned survey would entail the use of a 2-airgun array with a total discharge of 90 in^3 at a two depth of 2-4 m. Lamont-Doherty Earth Observatory (L-DEO) model results are used to determine the 160 dB_{rms} radius for the 2-airgun array in deep water (> 1,000 m) down to a maximum water depth of 2,000 m. Received sound levels were predicted by L-DEO's model (Diebold *et al.*, 2010) as a function of distance from the airguns, for the two 45 in^3 airguns. This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogenous ocean layer, unbounded by a seafloor). In

addition, propagation measurements of pulses from a 36-airgun array at a tow depth of 6 m have been reported in deep water (~1,600 m), intermediate water depth on the slope (~600-1,100 m), and shallow water (~50 m) in the Gulf of Mexico in 2007-2008 (Tolstoy *et al.*, 2009; Diebold *et al.*, 2010).

For deep and intermediate water cases, the field measurements cannot be used readily to derive the Level A and Level B harassment isopleths, as at those sites the calibration hydrophone was located at a roughly constant depth of 350-550 m, which may not intersect all the SPL isopleths at their widest point from the sea surface down to the maximum relevant water depth (~2,000 m) for marine mammals. At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data at the deep sites are suitable for comparison with modeled levels at the depth of the calibration hydrophone. At longer ranges, the comparison with the model – constructed from the maximum SPL through the entire water column at varying distances from the airgun array – is the most relevant.

In deep and intermediate water depths, comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and model results for the same array tow depth are in good agreement (see Figures 12 and 14 in Appendix H of NSF-USGS 2011). Consequently, isopleths falling within this domain can be predicted reliably by the L-DEO model, although they may be imperfectly sampled by measurements recorded at a single depth. At greater distances, the calibration data show that seafloor-reflected and sub-seafloor-refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent. Aside from local topography effects, the region around the critical distance is where the observed levels rise closest to the model curve. However, the observed sound levels are found to fall almost entirely below the model curve. Thus, analysis of the Gulf of Mexico calibration measurements

demonstrates that although simple, the L-DEO model is a robust tool for conservatively estimating isopleths.

The planned surveys would acquire data with two 45-in^3 guns at a tow depth of 2–4 m. For deep water (>1000 m), we use the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2000 m for the airgun array with 2-m and 8-m airgun separation. The radii for intermediate water depths (100–1000 m) are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (see Figure 16 in Appendix H of NSF-USGS 2011). The shallow-water radii are obtained by scaling the empirically derived measurements from the Gulf of Mexico calibration survey to account for the differences in source volume and tow depth between the calibration survey (6000 in^3; 6-m tow depth) and the planned survey (90 in^3; 4-m tow depth); whereas the shallow water in the Gulf of Mexico may not exactly replicate the shallow water environment at the planned survey sites, it has been shown to serve as a good and very conservative proxy (Crone *et al*., 2014). A simple scaling factor is calculated from the ratios of the isopleths determined by the deep-water L-DEO model, which are essentially a measure of the energy radiated by the source array.

L-DEO's modeling methodology is described in greater detail in SIO's IHA application. The estimated distances to the Level B harassment isopleths for the two planned airgun configurations in each water depth category are shown in Table 3.

Table 3. Predicted Radial Distances from R/V *Thompson* Seismic Source to Isopleths Corresponding to Level B Harassment Threshold

Airgun configuration	**Water depth (m)**	**Predicted Distances (m) to 160 dB received south level**
Two 45 in^3 guns, 2-m	> 1,000	539[a]

separation	100 – 1,000	809[b]
	< 100	1,295[c]
Two 45 in^3 guns, 8-m separation	> 1,000	578[a]
	100 – 1,000	867[b]
	< 100	1,400[c]

[a] Distance based on L-DEO model results.
[b] Distance based on L-DEO model results with a 1.5 x correction factor between deep and intermediate water depths.
[c] Distance based on empirically derived measurements in the Gulf of Mexico with scaling applied to account for differences in tow depth.

Predicted distances to Level A harassment isopleths, which vary based on marine mammal hearing groups, were calculated based on modeling performed by L-DEO using the NUCLEUS software program and the NMFS User Spreadsheet, described below. The updated acoustic thresholds for impulsive sounds (*e.g.*, airguns) contained in the Technical Guidance were presented as dual metric acoustic thresholds using both SEL_{cum} and peak sound pressure metrics (NMFS 2016a). As dual metrics, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the two metrics is exceeded (i.e., metric resulting in the largest isopleth). The SEL_{cum} metric considers both level and duration of exposure, as well as auditory weighting functions by marine mammal hearing group. In recognition of the fact that the requirement to calculate Level A harassment ensonified areas could be more technically challenging to predict due to the duration component and the use of weighting functions in the new SEL_{cum} thresholds, NMFS developed an optional User Spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to facilitate the estimation of take numbers.

The SEL_{cum} for the 2-GI airgun array is derived from calculating the modified farfield signature. The farfield signature is often used as a theoretical representation of the source level. To compute the farfield signature, the source level is estimated at a large distance (right) below the array (*e.g.*, 9 km), and this level is back projected mathematically to a notional distance of 1 m from the array's geometrical center. However, it has been recognized that the source level

from the theoretical farfield signature is never physically achieved at the source when the source is an array of multiple airguns separated in space (Tolstoy *et al*., 2009). Near the source (at short ranges, distances <1 km), the pulses of sound pressure from each individual airgun in the source array do not stack constructively as they do for the theoretical farfield signature. The pulses from the different airguns spread out in time such that the source levels observed or modeled are the result of the summation of pulses from a few airguns, not the full array (Tolstoy *et al*., 2009). At larger distances, away from the source array center, sound pressure of all the airguns in the array stack coherently, but not within one time sample, resulting in smaller source levels (a few dB) than the source level derived from the farfield signature. Because the farfield signature does not take into account the interactions of the two airguns that occur near the source center and is calculated as a point source (single airgun), the modified farfield signature is a more appropriate measure of the sound source level for large arrays. For this smaller array, the modified farfield changes will be correspondingly smaller as well, but we use this method for consistency across all array sizes.

SIO used the same acoustic modeling as Level B harassment with a small grid step in both the inline and depth directions to estimate the SEL_{cum} and peak SPL. The propagation modeling takes into account all airgun interactions at short distances from the source including interactions between subarrays using the NUCLEUS software to estimate the notional signature and the MATLAB software to calculate the pressure signal at each mesh point of a grid. For a more complete explanation of this modeling approach, please see "Appendix A: Determination of Mitigation Zones" in SIO's IHA application.

Table 4. Modeled Source Levels (dB) for R/V *Thompson* 90 in^3 Airgun Arrays.

Functional Hearing Group	8-kt survey with 8-m airgun	8-kt survey with 8-m airgun	5-kt survey with 2-m airgun	5-kt survey with 2-m airgun

	separation: Peak SPL_{flat}	**separation: SEL_{cum}**	**separation: Peak SPL_{flat}**	**separation: SEL_{cum}**
Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	228.8	207	232.8	206.7
Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB)	N/A[1]	206.7	229.8	206.9
High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	233	207.6	232.9	207.2
Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	230	206.7	232.8	206.9
Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB; $L_{E,HF,24h}$: 203 dB)	N/A[1]	203	225.6	207.4

[1] There are no source level values for this airgun configuration for the MF cetaceans and Otariids (maximum peak value is 221dB so less than 230 or 232dB). Therefore, we cannot provide any radial distance or modified peak far-field values for these two hearing groups.

In order to more realistically incorporate the Technical Guidance's weighting functions over the seismic array's full acoustic band, unweighted spectrum data for the *Thompson's* airgun array (modeled in 1 Hz bands) was used to make adjustments (dB) to the unweighted spectrum levels, by frequency, according to the weighting functions for each relevant marine mammal hearing group. These adjusted/weighted spectrum levels were then converted to pressures (μPa) in order to integrate them over the entire broadband spectrum, resulting in broadband weighted source levels by hearing group that could be directly incorporated within the User Spreadsheet (*i.e.*, to override the Spreadsheet's more simple weighting factor adjustment). Using the User Spreadsheet's "safe distance" methodology for mobile sources (described by Sivle *et al*., 2014) with the hearing group-specific weighted source levels, and inputs assuming spherical spreading propagation and source velocities and shot intervals provided in SIO's IHA application, potential

radial distances to auditory injury zones were calculated for SEL_{cum} thresholds, for both array configurations.

Inputs to the User Spreadsheet in the form of estimated SLs are shown in Table 5. User Spreadsheets used by SIO to estimate distances to Level A harassment isopleths for the two potential airgun array configurations are shown in Tables A-4 and A-5 in Appendix A of SIO's IHA application. Outputs from the User Spreadsheet in the form of estimated distances to Level A harassment isopleths are shown in Table 5. As described above, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the dual metrics (SEL_{cum} or Peak SPL_{flat}) is exceeded (*i.e.*, metric resulting in the largest isopleth).

Table 5. Modeled Radial Distances to Isopleths Corresponding to Level A Harassment Thresholds.

Functional Hearing Group (Level A harassment thresholds)	**8-kt survey with 8-m airgun separation: Peak SPL_{flat}**	**8-kt survey with 8-m airgun separation: SEL_{cum}**	**5-kt survey with 2-m airgun separation: Peak SPL_{flat}**	**5-kt survey with 2-m airgun separation: SEL_{cum}**
Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	3.08	2.4	4.89	6.5
Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB)	0	0	0.98	0
High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	34.84	0	34.62	0
Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	4.02	0	5.51	0.1
Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB;	0	0	0.48	0

$L_{E,HF,24h}$: 203 dB)				

Note that because of some of the assumptions included in the methods used, isopleths produced may be overestimates to some degree, which will ultimately result in some degree of overestimate of Level A take. However, these tools offer the best way to predict appropriate isopleths when more sophisticated 3D modeling methods are not available, and NMFS continues to develop ways to quantitatively refine these tools and will qualitatively address the output where appropriate. For mobile sources, such as the planned seismic survey, the User Spreadsheet predicts the closest distance at which a stationary animal would not incur PTS if the sound source traveled by the animal in a straight line at a constant speed.

Marine Mammal Occurrence

In this section we provide the information about the presence, density, or group dynamics of marine mammals that informed the take calculations.

For the planned survey area in the southwest Atlantic Ocean, SIO determined that the preferred source of density data for marine mammal species that might be encountered in the project area north of the Falklands was AECOM/NSF (2014). For certain species not included in the AECOM database, data from the NOAA Southwest Fisheries Science Center (SWFSC) Letter of Authorization (LOA) (2013, in AECOM/NSF 2014) was used. Better data on hourglass dolphins, southern bottlenose whales, and southern elephant seals were found in White *et al.*, (2002). When density estimates were not available in the above named sources, densities were estimated using sightings and effort during aerial- and vessel-based surveys conducted in and adjacent to the planned project area. The three other major sources of animal abundance included White *et al.* (2002), DeTullio *et al.* (2016) and Garaffo *et al.* (2011). Data sources and density calculations are described in detail in Appendix B of SIO's IHA application. For some species,

the densities derived from past surveys may not be representative of the densities that would be encountered during the planned seismic surveys. However, the approach used is based on the best available data. Estimated densities used to inform take estimates are presented in Table 6.

Table 6. Marine Mammal Densities in the Planned Survey Area

Species	**Estimated density (#/km^2)[a]**
LF Cetaceans	
Southern right whale	0.00080
Pygmy right whale	N.A.
Blue whale	0.00005
Fin whale	0.01820
Sei whale	0.00636
Common (dwarf) minke whale	0.07790
Antarctic minke whale	0.07790
Humpback whale	0.00066
MF Cetaceans	
Sperm whale	0.00207
Arnoux's beaked whale	0.01138
Cuvier's beaked whale	0.00055
Southern bottlenose whale	0.00791
Shepherd's beaked whale	0.00627
Blainville's beaked whale	0.00005
Gray's beaked whale	0.00189
Hector's beaked whale	0.00021
True's beaked whale	0.00005
Strap-toothed beaked whale	0.00058
Andrew's beaked whale	0.00016
Spade-toothed beaked whale	0.00005
Risso's dolphin	0.00436
Routh-toothed dolphin	0.00595
Common bottlenose dolphin	0.05091
Pantropical spotted dolphin	0.00377
Atlantic spotted dolphin	0.22517
Spinner dolphin	0.01498
Clymene dolphin	0.01162
Striped dolphin	0.00719
Short-beaked common dolphin	0.71717
Fraser's dolphin	N.A.
Dusky dolphin	0.12867[b]
Southern right whale dolphin	0.00616
Killer whale	0.01538
Short-finned pilot whale	0.00209

Long-finned pilot whale	0.21456
False killer whale	N.A.
HF Cetaceans	
Pygmy sperm whale	N.A.
Dwarf sperm whale	N.A.
Hourglass dolphin	0.14871
Peale's dolphin	0.03014
Commerson's dolphin	0.06763[b]
Spectacled porpoise	0.00150[b]
Otariids	
Antarctic fur seal	0.00017
South American fur seal	0.01642
Subantarctic fur seal	0.00034
South American sea lion	0.00249
Phocids	
Crabeater seal	0.00649
Leopard seal	0.00162
Southern elephant seal	0.00155

N.A. indicates density estimate is not available.
[a] See Appendix B in SIO's IHA application for density sources.
[b] Density provided is for shallow water (< 100 m depth). A correction factor for densities in deeper water was applied (see Appendix B in the IHA application).

Take Calculation and Estimation

Here we describe how the information provided above is brought together to produce a quantitative take estimate. In order to estimate the number of marine mammals predicted to be exposed to sound levels that would result in Level A harassment or Level B harassment, radial distances from the airgun array to predicted isopleths corresponding to the Level A harassment and Level B harassment thresholds are calculated, as described above. Those radial distances are then used to calculate the area(s) around the airgun array predicted to be ensonified to sound levels that exceed the Level A harassment and Level B harassment thresholds. The area estimated to be ensonified in a single day of the survey is then calculated (Table 7), based on the areas predicted to be ensonified around the array and the estimated trackline distance traveled per day. This number is then multiplied by the number of survey days. The product is then multiplied by 1.25 to account for the additional 25 percent contingency. This results in an estimate of the

total area (km^2) expected to be ensonified to the Level A and Level B harassment thresholds for each survey type (Table 7).

Table 7. Areas (km^2) to be Ensonified to Level A and Level B Harassment Thresholds

Survey type	Criteria	Relevant isopleth (m)	Daily Ensonified Area (km^2)	Total survey days	25 percent increase	Total ensonified area (km^2)
5-kt survey with 2-m airgun separation	Level B Harassment (160 dB)					
	Deep water	539	18.8	16	1.25	376
	Intermediate water	809	147.32	16	1.25	2,946.4
	Shallow water	1,295	133.44	16	1.25	2,668.8
	Level A Harassment					
	LF cetacean	6.5	2.89	16	1.25	57.8
	MF cetacean	1	0.44	16	1.25	8.8
	HF cetacean	34.6	15.37	16	1.25	307.4
	Phocids	5.5	2.44	16	1.25	48.8
	Otariids	0.5	0.22	16	1.25	4.4
8-kt survey with 8-m airgun separation	Level B Harassment (160 dB)					
	Deep water	578	25.64	12	1.25	384.6
	Intermediate water	867	284.93	12	1.25	4,273.95
	Shallow water	1,400	220.58	12	1.25	3308.7
	Level A Harassment					
	LF cetacean	3.1	2.22	12	1.25	33.3
	MF cetacean	0	0	12	1.25	0
	HF cetacean	34.8	24.93	12	1.25	373.95
	Phocids	4	2.86	12	1.25	42.9
	Otariids	0	0	12	1.25	0

The total ensonified areas (km^2) for each criteria presented in Table 7 were summed to determine the total ensonified area for all survey activities (Table 8).

Table 8. Total Ensonified Areas (km^2) for All Surveys

Criteria	Total ensonified area (km^2) for all surveys
160 dB Level B (all depths)	13,958.45
160 dB Level B (shallow water)	760.60
160 dB Level B (intermediate water)	7,220.35
160 dB Level B (deep water)	5,977.50
LF cetacean Level A	91.10

MF cetacean Level A	8.80
HF cetacean Level A	681.35
Phocids Level A	91.70
Otariids Level A	4.40

The marine mammals predicted to occur within these respective areas, based on estimated densities (Table 6), are assumed to be incidentally taken. While some takes by Level A harassment have been estimated, based on the nature of the activity and in consideration of the required mitigation measures (see Mitigation section below), Level A take of low frequency cetaceans, mid frequency cetaceans, otariid pinnipeds, and phocid pinnipeds is not expected to occur and has not been authorized. While mitigation is expected to minimize the potential for Level A harassment, some Level A take of high-frequency cetaceans has been authorized. Estimated exposures for the planned survey are shown in Table 9.

Table 9. Calculated and Authorized Level A and Level B Exposures, and Percentage of Stock Exposed.

Species	**Calculated Level B**	**Calculated Level A**	**Authorized Level B**	**Authorized Level A**	**Total Take**	**Percent of population**
LF Cetaceans						
Southern right whale	11	0	11	0	11	0.3
Pygmy right whale	-	-	2[a]	0	2	-
Blue whale	1	0	3[a]	0	3	< 0.1
Fin whale	252	2	254	0	254	1.7
Sei whale	88	1	89	0	89	0.9
Common (dwarf) minke whale	1080	7	1087	0	1087	0.2
Antarctic minke whale	1080	7	1087	0	1087	0.2
Humpback whale	9	0	9	0	9	< 0.1
MF Cetaceans						
Sperm whale	29	0	29	0	29	0.2
Arnoux's	159	0	159	0	159	< 0.1

beaked whale						
Cuvier's beaked whale	8	0	8	0	8	< 0.1
Southern bottlenose whale	110	0	110	0	110	< 0.1
Shepherd's beaked whale	88	0	88	0	88	-
Blainville's beaked whale	7	0	7[a]	0	7	-
Gray's beaked whale	26	0	26	0	26	< 0.1
Hector's beaked whale	3	0	3	0	3	-
True's beaked whale	1	0	2[a]	0	2	-
Strap-toothed beaked whale	8	0	8	0	8	< 0.1
Andrew's beaked whale	2	0	2[a]	0	2	-
Spade-toothed beaked whale	1	0		0	2	-
Risso's dolphin	61	0	61	0	61	0.3
Rough-toothed dolphin	83	0	83	0	83	-
Common bottlenose dolphin	711	0	711	0	711	0.9
Pantropical spotted dolphin	53	0	53	0	53	1.6
Atlantic spotted dolphin	3,143	0	3,143	0	3,143	7.0
Spinner dolphin	209	0	209	0	209	-
Clymene dolphin	162	0	162	0	162	-
Striped dolphin	100	0	100	0	100	0.2
Short-beaked common dolphin	10,004	6	10,010	0	10,010	14.3
Fraser's dolphin	-	-	283[a]	0	283	-

Dusky dolphin	1,034	1	1,035	0	1,035	14.3
Southern right whale dolphin	86	0	86	0	86	-
Killer whale	215	0	215	0	215	0.9
Short-finned pilot whale	29	0	41[a]	0	41	< 0.1
Long-finned pilot whale	2,993	2	2,995	0	2,995	1.5
False killer whale	-	-	5[a]	0	5	-
HF Cetaceans						
Pygmy sperm whale	-	-	2[b]	0	2	-
Dwarf sperm whale	-	-	2[b]	0	2	-
Hourglass dolphin	1,975	101	2,026	50[c]	2,076	1.4
Peale's dolphin	400	21	411	20[c]	421	2.1
Commerson's dolphin	94	46	117	23[c]	140	0.7
Spectacled porpoise	2	1	3	0	3	-
Otariids						
Antarctic fur seal	2	0	2	0	2	< 0.1
South American fur seal	229	0	229	0	229	0.2
Subantarctic fur seal	5	0	5	0	5	< 0.1
South American sea lion	35	0	35	0	35	< 0.1
Phocids						
Crabeater seal	90	1	91	0	91	< 0.1
Leopard seal	23	0	23	0	23	< 0.1
Southern elephant seal	22	0	22	0	22	< 0.1

[a] Authorized take increased to mean group size from Bradford (2017) if available. Mean group sizes for pygmy right whale and false killer whale from Jefferson *et al.* (2015) and Mobley *et al.* (2000), respectively.
[b] Authorized take increased to maximum group size from Barlow (2016).
[c] Authorized Level A takes revised from proposed to reflect potential for Level A exposures when mitigation not practicable.

For some marine mammal species, we authorize a different number of incidental takes than the number requested by SIO (see Table 4 in the IHA application for requested take numbers). SIO requested Level A takes of fin whales, sei whales, common and Antarctic minke whales, short-beaked common dolphins, dusky dolphins, long-finned pilot whales, and crabeater seals; however, due to very small zones corresponding to Level A harassment for low-frequency cetaceans, mid-frequency cetaceans, and phocid pinnipeds, we have determined the likelihood of Level A take occurring for species from these functional hearing groups is so low as to be discountable, therefore we do not authorize Level A take of these species. Note that the Level A takes that were calculated for these species have been added to the number of Level B takes.

While we initially discounted the calculated Level A takes of hourglass dolphins, Peale's dolphins, Commerson's dolphins, and spectacled porpoises, due to the very small zone corresponding to Level A harassment for high-frequency cetaceans, after informal discussions with the Commission, we have determined that authorization of some Level A take of hourglass dolphins, Peale's dolphins, and Commerson's dolphins may be warranted, due to their higher relative densities, and have therefore authorized one half of the calculated Level A takes of these species (Table 9). The other half of the calculated Level A takes of these species have been added to their respective Level B takes. While the Level A harassment zone for spectacled porpoises is equal to that of hourglass dolphins, Peale's dolphins, and Commerson's dolphins, due to their lower density, we have determined that the likelihood of Level A take occurring for spectacled porpoises is so low as to be discountable. Therefore, we have not authorized Level A take of this species, and the calculated Level A takes have been added to the number of Level B takes.

It should be noted that the authorized take numbers shown in Table 9 are expected to be conservative for several reasons. First, in the calculations of estimated take, 25 percent has been added in the form of operational survey days to account for the possibility of additional seismic operations associated with airgun testing and repeat coverage of any areas where initial data quality is sub-standard, and in recognition of the uncertainties in the density estimates used to estimate take as described above. Additionally, marine mammals would be expected to move away from a loud sound source that represents an aversive stimulus, such as an airgun array, potentially reducing the likelihood of takes by Level A harassment. However, the extent to which marine mammals would move away from the sound source is difficult to quantify and is, therefore, not accounted for in the take estimates.

Mitigation

In order to issue an IHA under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for taking for certain subsistence uses (latter not applicable for this action). NMFS regulations require applicants for incidental take authorizations to include information about the availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks and their habitat (50 CFR 216.104(a)(11)).

In evaluating how mitigation may or may not be appropriate to ensure the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, we carefully consider two primary factors:

(1) The manner in which, and the degree to which, the successful implementation of the measure(s) is expected to reduce impacts to marine mammals, marine mammal species or stocks, and their habitat This considers the nature of the potential adverse impact being mitigated (likelihood, scope, range). It further considers the likelihood that the measure will be effective if implemented (probability of accomplishing the mitigating result if implemented as planned), the likelihood of effective implementation (probability implemented as planned); and

(2) The practicability of the measures for applicant implementation, which may consider such things as cost, impact on operations, and, in the case of a military readiness activity, personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

SIO has reviewed mitigation measures employed during seismic research surveys authorized by NMFS under previous incidental harassment authorizations, as well as recommended best practices in Richardson *et al*. (1995), Pierson *et al*. (1998), Weir and Dolman (2007), Nowacek *et al*. (2013), Wright (2014), and Wright and Cosentino (2015), and has incorporated a suite of required mitigation measures into their project description based on the above sources.

To reduce the potential for disturbance from acoustic stimuli associated with the activities, SIO is required to implement mitigation measures for marine mammals. Mitigation measures that are required to be implemented during the planned surveys include (1) Vessel-based visual mitigation monitoring; (2) Establishment of a marine mammal exclusion zone (EZ) and buffer zone; (3) shutdown procedures; (4) ramp-up procedures; and (4) vessel strike avoidance measures.

Vessel-Based Visual Mitigation Monitoring

Visual monitoring requires the use of trained observers (herein referred to as visual PSOs) to scan the ocean surface visually for the presence of marine mammals. PSO observations must take place during all daytime airgun operations and nighttime start ups (if applicable) of the airguns. If airguns are operating throughout the night, observations must begin 30 minutes prior to sunrise. If airguns are operating after sunset, observations must continue until 30 minutes following sunset. Following a shutdown for any reason, observations must occur for at least 30 minutes prior to the planned start of airgun operations. Observations must also occur for 60 minutes after airgun operations cease for any reason. Observations must also be made during daytime periods when the *Thompson* is underway without seismic operations, such as during transits, to allow for comparison of sighting rates and behavior with and without airgun operations and between acquisition periods. Airgun operations must be suspended when marine mammals are observed within, or about to enter, the designated EZ (as described below).

During seismic operations, three visual PSOs must be based aboard the *Thompson*. PSOs must be appointed by SIO with NMFS approval. One dedicated PSO must monitor the EZ during all daytime seismic operations. PSO(s) must be on duty in shifts of duration no longer than 4 hours. Other vessel crew must also be instructed to assist in detecting marine mammals and in implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew must be given additional instruction in detecting marine mammals and implementing mitigation requirements.

The *Thompson* is a suitable platform from which PSOs would watch for marine mammals. Standard equipment for marine mammal observers would be 7 x 50 reticule binoculars and optical range finders. At night, night-vision equipment would be available. The observers must be in communication with ship's officers on the bridge and scientists in the

vessel's operations laboratory, so they can advise promptly of the need for avoidance maneuvers or seismic source shutdown.

The PSOs must have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements. PSO resumes must be provided to NMFS for approval. At least one PSO must have a minimum of 90 days at-sea experience working as PSOs during a seismic survey. One "experienced" visual PSO must be designated as the lead for the entire protected species observation team. The lead will serve as primary point of contact for the vessel operator.

Exclusion Zone and Buffer Zone

An EZ is a defined area within which occurrence of a marine mammal triggers mitigation action intended to reduce the potential for certain outcomes, *e.g.*, auditory injury, disruption of critical behaviors. The PSOs must establish a minimum EZ with a 100 m radius for the airgun array. The 100-m EZ must be based on radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). With certain exceptions (described below), if a marine mammal appears within, enters, or appears on a course to enter this zone, the acoustic source must be shut down (see Shutdown Procedures below).

The 100-m radial distance of the standard EZ is precautionary in the sense that it would be expected to contain sound exceeding injury criteria for all marine mammal hearing groups (Table 5) while also providing a consistent, reasonably observable zone within which PSOs would typically be able to conduct effective observational effort. In this case, the 100-m radial distance is also expected to contain sound that would exceed the Level A harassment threshold based on sound exposure level (SEL_{cum}) criteria for all marine mammal hearing groups (Table 5).

In the 2011 Programmatic Environmental Impact Statement for marine scientific research funded by the National Science Foundation or the U.S. Geological Survey (NSF-USGS 2011), Alternative B (the Preferred Alternative) conservatively applied a 100-m EZ for all low-energy acoustic sources in water depths >100 m, with low-energy acoustic sources defined as any towed acoustic source with a single or a pair of clustered airguns with individual volumes of $\leq$250 in^3. Thus the 100-m EZ required for this survey is consistent with the PEIS.

Our intent in prescribing a standard EZ distance is to (1) encompass zones within which auditory injury could occur on the basis of instantaneous exposure; (2) provide additional protection from the potential for more severe behavioral reactions (*e.g.*, panic, antipredator response) for marine mammals at relatively close range to the acoustic source; (3) provide consistency for PSOs, who need to monitor and implement the EZ; and (4) define a distance within which detection probabilities are reasonably high for most species under typical conditions.

PSOs must also establish and monitor a 200-m buffer zone. During use of the acoustic source, occurrence of marine mammals within the buffer zone (but outside the EZ) must be communicated to the operator to prepare for potential shutdown of the acoustic source. The buffer zone is discussed further under *Ramp Up Procedures* below.

An extended EZ of 500 m must be enforced for all beaked whales, *Kogia* species, and Southern right whales. SIO must also enforce a 500-m EZ for aggregations of six or more large whales (*i.e.*, sperm whale or any baleen whale) that does not appear to be traveling (*e.g.*, feeding, socializing, etc.) or a large whale with a calf (calf defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult).

Shutdown Procedures

If a marine mammal is detected outside the EZ but is likely to enter the EZ, the airguns must be shut down before the animal is within the EZ. Likewise, if a marine mammal is already within the EZ when first detected, the airguns must be shut down immediately.

Following a shutdown, airgun activity must not resume until the marine mammal has cleared the 100-m EZ. The animal is considered to have cleared the 100-m EZ if the following conditions have been met:

- it is visually observed to have departed the 100-m EZ;
- it has not been seen within the 100-m EZ for 15 min in the case of small odontocetes and pinnipeds; or
- it has not been seen within the 100-m EZ for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, beaked whales, pilot whales, and Risso's dolphins.

This shutdown requirement must be in place for all marine mammals, with the exception of small delphinoids under certain circumstances. As defined here, the small delphinoid group is intended to encompass those members of the Family Delphinidae most likely to voluntarily approach the source vessel for purposes of interacting with the vessel and/or airgun array (*e.g.*, bow riding). This exception to the shutdown requirement applies solely to specific genera of small dolphins – *Delphinus*, *Lagenodelphis*, *Lagenorhynchus*, *Lissodelphis*, *Stenella*, *Steno*, and *Tursiops* – and only applies if the animals were traveling, including approaching the vessel. If, for example, an animal or group of animals is stationary for some reason (*e.g.*, feeding) and the source vessel approaches the animals, the shutdown requirement applies. An animal with sufficient incentive to remain in an area rather than avoid an otherwise aversive stimulus could either incur auditory injury or disruption of important behavior. If there is uncertainty regarding

identification (*i.e.*, whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, shutdown must be implemented.

We include this small delphinoid exception because shutdown requirements for small delphinoids under all circumstances represent practicability concerns without likely commensurate benefits for the animals in question. Small delphinoids are generally the most commonly observed marine mammals in the specific geographic region and would typically be the only marine mammals likely to intentionally approach the vessel. As described above, auditory injury is extremely unlikely to occur for mid-frequency cetaceans (*e.g.*, delphinids), as this group is relatively insensitive to sound produced at the predominant frequencies in an airgun pulse while also having a relatively high threshold for the onset of auditory injury (*i.e.*, permanent threshold shift).

A large body of anecdotal evidence indicates that small delphinoids commonly approach vessels and/or towed arrays during active sound production for purposes of bow riding, with no apparent effect observed in those delphinoids (*e.g.*, Barkaszi *et al.*, 2012). The potential for increased shutdowns resulting from such a measure would require the *Thompson* to revisit the missed track line to reacquire data, resulting in an overall increase in the total sound energy input to the marine environment and an increase in the total duration over which the survey is active in a given area. Although other mid-frequency hearing specialists (*e.g.*, large delphinoids) are no more likely to incur auditory injury than are small delphinoids, they are much less likely to approach vessels. Therefore, retaining a power-down / shutdown requirement for large delphinoids would not have similar impacts in terms of either practicability for the applicant or corollary increase in sound energy output and time on the water. We do anticipate some benefit for a shutdown requirement for large delphinoids in that it simplifies somewhat the total range of

decision-making for PSOs and may preclude any potential for physiological effects other than to the auditory system as well as some more severe behavioral reactions for any such animals in close proximity to the source vessel.

Shutdown of the acoustic source is also required upon observation of a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized number of takes are met, observed approaching or within the Level A or Level B harassment zones.

Ramp-up Procedures

Ramp-up of an acoustic source is intended to provide a gradual increase in sound levels following a shutdown, enabling animals to move away from the source if the signal is sufficiently aversive prior to its reaching full intensity. Ramp-up is required after the array is shut down for any reason for longer than 15 minutes. Ramp-up must begin with the activation of one 45 in^3 airgun, with the second 45 in^3 airgun activated after 5 minutes.

Two PSOs are required to monitor during ramp-up. During ramp up, the PSOs must monitor the EZ, and if marine mammals were observed within the EZ or buffer zone, a shutdown must be implemented as though the full array were operational. If airguns have been shut down due to PSO detection of a marine mammal within or approaching the 100 m EZ, ramp-up must not be initiated until all marine mammals have cleared the EZ, during the day or night. Criteria for clearing the EZ is as described above.

Thirty minutes of pre-clearance observation are required prior to ramp-up for any shutdown of longer than 30 minutes (*i.e.*, if the array were shut down during transit from one line to another). This 30-minute pre-clearance period may occur during any vessel activity (*i.e.*, transit). If a marine mammal were observed within or approaching the 100 m EZ during this pre-

clearance period, ramp-up must not be initiated until all marine mammals cleared the EZ. Criteria for clearing the EZ would be as described above. If the airgun array has been shut down for reasons other than mitigation (*e.g.*, mechanical difficulty) for a period of less than 30 minutes, it may be activated again without ramp-up if PSOs have maintained constant visual observation and no detections of any marine mammal have occurred within the EZ or buffer zone. Ramp-up must be planned to occur during periods of good visibility when possible. However, ramp-up is allowed at night and during poor visibility if the 100 m EZ and 200 m buffer zone have been monitored by visual PSOs for 30 minutes prior to ramp-up.

The operator is required to notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO; the notification time must not be less than 60 minutes prior to the planned ramp-up. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed. The operator must provide information to PSOs documenting that appropriate procedures were followed. Following deactivation of the array for reasons other than mitigation, the operator is required to communicate the near-term operational plan to the lead PSO with justification for any planned nighttime ramp-up.

Vessel Strike Avoidance Measures

Vessel strike avoidance measures are intended to minimize the potential for collisions with marine mammals. These requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply.

The required measures include the following: Vessel operator and crew must maintain a vigilant watch for all marine mammals and slow down or stop the vessel or alter course to avoid

striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone may be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena. Vessel strike avoidance measures must be followed during surveys and while in transit.

The vessel must maintain a minimum separation distance of 100 m from large whales (*i.e.*, baleen whales and sperm whales). If a large whale is within 100 m of the vessel, the vessel must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established. If the vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m. The vessel must maintain a minimum separation distance of 50 m from all other marine mammals (with the exception of delphinids of the genera *Delphinus*, *Lagenodelphis*, *Lagenorhynchus*, *Lissodelphis*, *Stenella*, *Steno*, and *Tursiops* that approach the vessel, as described above). If an animal is encountered during transit, the vessel must attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course. Vessel speeds must be reduced to 10 kt or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near the vessel.

Based on our evaluation of the required measures, NMFS has determined that the required mitigation measures provide the means effecting the least practicable impact on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Monitoring and Reporting

In order to issue an IHA for an activity, Section 101(a)(5)(D) of the MMPA states that NMFS must set forth requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 CFR 216.104 (a)(13) indicate that requests for authorizations must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the planned action area. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

Monitoring and reporting requirements prescribed by NMFS should contribute to improved understanding of one or more of the following:

- Occurrence of marine mammal species or stocks in the area in which take is anticipated (*e.g.*, presence, abundance, distribution, density).
- Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) action or environment (*e.g.*, source characterization, propagation, ambient noise); (2) affected species (*e.g.*, life history, dive patterns); (3) co-occurrence of marine mammal species with the action; or (4) biological or behavioral context of exposure (*e.g.*, age, calving or feeding areas).
- Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors.
- How anticipated responses to stressors impact either: (1) long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks.

- Effects on marine mammal habitat (*e.g.*, marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat).
- Mitigation and monitoring effectiveness.

SIO submitted a marine mammal monitoring and reporting plan in their IHA application. Monitoring that is designed specifically to facilitate mitigation measures, such as monitoring of the EZ to inform potential shutdowns of the airgun array, are described above and are not repeated here. SIO's monitoring and reporting plan includes the following measures:

Vessel-Based Visual Monitoring

As described above, PSO observations must take place during daytime airgun operations and nighttime start-ups (if applicable) of the airguns. During seismic operations, three visual PSOs must be based aboard the *Thompson*. PSOs must be appointed by SIO with NMFS approval. The PSOs must have successfully completed relevant training, including completion of all required coursework and passing a written and/or oral examination developed for the training program, and must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate training, including (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

During the majority of seismic operations, one PSO is required to monitor for marine mammals around the seismic vessel. PSOs must be on duty in shifts of duration no longer than 4

hours. Other crew must also be instructed to assist in detecting marine mammals and in implementing mitigation requirements (if practical). During daytime, PSOs must scan the area around the vessel systematically with reticle binoculars (e.g., 7×50 Fujinon) and with the naked eye. At night, PSOs must be equipped with night-vision equipment.

PSOs must record data to estimate the numbers of marine mammals exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data must be used to estimate numbers of animals potentially 'taken' by harassment (as defined in the MMPA). They must also provide information needed to order a shutdown of the airguns when a marine mammal is within or near the EZ. When a sighting is made, the following information about the sighting must be recorded:

1) Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (*e.g.*, none, avoidance, approach, paralleling, etc.), and behavioral pace; and

2) Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare.

All observations and shutdowns must be recorded in a standardized format. Data must be entered into an electronic database. The accuracy of the data entry must be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures allow initial summaries of data to be prepared during and shortly after the field program and facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving. The time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare must also be recorded at the start and end of each

observation watch, and during a watch whenever there is a change in one or more of the variables.

Results from the vessel-based observations must provide:

1) The basis for real-time mitigation (*e.g.*, airgun shutdown);

2) Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS;

3) Data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted;

4) Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity; and

5) Data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity.

Reporting

A draft report must be submitted to NMFS within 90 days after the end of the survey. The report must describe the operations that were conducted and sightings of marine mammals near the operations. The report must provide full documentation of methods, results, and interpretation pertaining to all monitoring and would summarize the dates and locations of seismic operations, including percentage of time and total time the array is active during daylight vs nighttime hours (including dawn and dusk), and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities). The report must also include estimates of the number and nature of exposures that occurred above the harassment threshold based on PSO observations.

The draft report must also include geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines must include points recording any change in airgun status (*e.g.*, when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa). GIS files must be provided in ESRI shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates must be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data must be made available to NMFS. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments on the draft report.

Negligible Impact Analysis and Determination

NMFS has defined negligible impact as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival (50 CFR 216.103). A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (*i.e.*, population-level effects). An estimate of the number of takes alone is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be "taken" through harassment, NMFS considers other factors, such as the likely nature of any responses (*e.g.*, intensity, duration), the context of any responses (*e.g.*, critical reproductive time or location, migration), as well as effects on habitat, and the likely effectiveness of the mitigation. We also assess the number, intensity, and context of estimated takes by evaluating this information relative to population

status. Consistent with the 1989 preamble for NMFS's implementing regulations (54 FR 40338; September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into this analysis via their impacts on the environmental baseline (*e.g.*, as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality, or ambient noise levels).

To avoid repetition, our analysis applies to all the species listed in Table 1, given that NMFS expects the anticipated effects of the planned seismic survey to be similar in nature. Where there are meaningful differences between species or stocks, or groups of species, in anticipated individual responses to activities, impact of expected take on the population due to differences in population status, or impacts on habitat, NMFS has identified species-specific factors to inform the analysis.

NMFS does not anticipate that serious injury or mortality would occur as a result of SIO's planned seismic survey, even in the absence of required mitigation. Thus the authorization does not authorize any mortality. As discussed in the *Potential Effects* section, non-auditory physical effects, stranding, and vessel strike are not expected to occur.

We authorized a limited number of instances of Level A harassment (Table 9) for three species. However, we believe that any PTS incurred in marine mammals as a result of the planned activity would be in the form of only a small degree of PTS (not total deafness), because of the constant movement of both the *Thompson* and of the marine mammals in the project area, as well as the fact that the vessel is not expected to remain in any one area in which individual marine mammals would be expected to concentrate for an extended period of time (*i.e.*, since the duration of exposure to loud sounds will be relatively short). A small degree of PTS that would not be likely to affect the fitness of any individuals, much less the population. Also, as described

above, we expect that marine mammals would be likely to move away from a sound source that represents an aversive stimulus, especially at levels that would be expected to result in PTS, given sufficient notice of the *Thompson's* approach due to the vessel's relatively low speed when conducting seismic surveys. We expect that the majority of takes would be in the form of short-term Level B behavioral harassment in the form of temporary avoidance of the area or decreased foraging (if such activity were occurring), reactions that are considered to be of low severity and with no lasting biological consequences (*e.g.*, Southall et al., 2007).

Potential impacts to marine mammal habitat were discussed in the Federal Register Notice for the Proposed IHA (see *Potential Effects of the Specified Activity on Marine Mammals and their Habitat*). Marine mammal habitat may be impacted by elevated sound levels, but these impacts would be temporary. Prey species are mobile and are broadly distributed throughout the project area; therefore, marine mammals that may be temporarily displaced during survey activities are expected to be able to resume foraging once they have moved away from areas with disturbing levels of underwater noise. Because of the temporary nature of the disturbance, the availability of similar habitat and resources in the surrounding area, and the lack of important or unique marine mammal habitat, the impacts to marine mammals and the food sources that they utilize are not expected to cause significant or long-term consequences for individual marine mammals or their populations. In addition, there are no feeding, mating or calving areas known to be biologically important to marine mammals within the planned project area.

As described above, marine mammals in the survey area are not assigned to NMFS stocks. For purposes of the small numbers analysis we rely on the best available information on the abundance estimates for the species of marine mammals that could be taken. The activity is expected to impact a very small percentage of all marine mammal populations that would be

affected by SIO's planned survey (less than 15 percent each for all marine mammal populations where abundance estimates exist). Additionally, the acoustic "footprint" of the planned survey would be very small relative to the ranges of all marine mammals that would potentially be affected. Sound levels would increase in the marine environment in a relatively small area surrounding the vessel compared to the range of the marine mammals within the planned survey area. The seismic array would be active 24 hours per day throughout the duration of the planned survey. However, the very brief overall duration of the planned survey (28 days) would further limit potential impacts that may occur as a result of the planned activity.

The required mitigation measures are expected to reduce the number and/or severity of takes by allowing for detection of marine mammals in the vicinity of the vessel by visual and acoustic observers, and by minimizing the severity of any potential exposures via shutdowns of the airgun array. Based on previous monitoring reports for substantially similar activities that have been previously authorized by NMFS, we expect that the required mitigation will be effective in preventing at least some extent of potential PTS in marine mammals that may otherwise occur in the absence of the required mitigation.

Of the marine mammal species under our jurisdiction that are likely to occur in the project area, the following species are listed as endangered under the ESA: fin, sei, blue, sperm, and southern right whales. We are proposing to authorize very small numbers of takes for these species (Table 9), relative to their population sizes (again, for species where population abundance estimates exist), therefore we do not expect population-level impacts to any of these species. The other marine mammal species that may be taken by harassment during SIO's seismic survey are not listed as threatened or endangered under the ESA. There is no designated critical habitat for any ESA-listed marine mammals within the project area; of the non-listed

marine mammals for which we have authorized take, none are considered "depleted" or "strategic" by NMFS under the MMPA.

NMFS concludes that exposures to marine mammal species due to SIO's planned seismic survey would result in only short-term (temporary and short in duration) behavioral disruption of individuals exposed, or some small degree of PTS to a very small number of individuals of four species. Marine mammals may temporarily avoid the immediate area, but are not expected to permanently abandon the area. Major shifts in habitat use, distribution, or foraging success are not expected. NMFS does not anticipate the authorized take to impact annual rates of recruitment or survival.

In summary and as described above, the following factors primarily support our determination that the impacts resulting from this activity are not expected to adversely affect the species or stock through effects on annual rates of recruitment or survival:

- No mortality is anticipated or authorized;
- The anticipated impacts of the planned activity on marine mammals would primarily be temporary behavioral changes due to avoidance of the area around the survey vessel. The relatively short duration of the planned survey (28 days) would further limit the potential impacts of any temporary behavioral changes that would occur;
- The number of instances of PTS that may occur are expected to be very small in number (Table 9). Instances of PTS that are incurred in marine mammals would be of a low level, due to constant movement of the vessel and of the marine mammals in the area, and the nature of the survey design (not concentrated in areas of high marine mammal concentration);

- The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the survey area during the planned survey to avoid exposure to sounds from the activity;
- The planned project area does not contain areas of significance for feeding, mating or calving;
- The potential adverse effects on fish or invertebrate species that serve as prey species for marine mammals from the planned survey would be temporary and spatially limited; and
- The required mitigation measures, including visual monitoring and shutdowns, are expected to minimize potential impacts to marine mammals.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the required monitoring and mitigation measures, NMFS finds that the total marine mammal take from the planned activity will have a negligible impact on all affected marine mammal species or stocks.

Small Numbers

As noted above, only small numbers of incidental take may be authorized under Sections 101(a)(5)(A) and (D) of the MMPA for specified activities other than military readiness activities. The MMPA does not define small numbers and so, in practice, where estimated numbers are available, NMFS compares the number of individuals taken to the most appropriate estimation of abundance of the relevant species or stock in our determination of whether an authorization is limited to small numbers of marine mammals. Additionally, other qualitative factors may be considered in the analysis, such as the temporal or spatial scale of the activities.

The numbers of marine mammals that we authorize to be taken would be considered small relative to the relevant populations (less than 15 percent for all species) for the species for which abundance estimates are available. No known current worldwide or regional population estimates are available for 16 species under NMFS jurisdiction that could be incidentally taken as a result of the planned survey: the pygmy right whale, pygmy sperm whale, dwarf sperm whale, Shepherd's beaked whale, Blainville's beaked whale, Hector's beaked whale, True's beaked whale, Andrew's beaked whale, spade-toothed beaked whale, rough-toothed dolphin, spinner dolphin, Clymene dolphin, Fraser's dolphin, southern right whale dolphin, false killer whale, and spectacled porpoise.

NMFS has reviewed the geographic distributions and habitat preferences of these species in determining whether the numbers of takes authorized herein are likely to represent small numbers. Pygmy right whales have a circumglobal distribution and occur throughout coastal and oceanic waters in the Southern Hemisphere (between 30 to 55° S) (Jefferson *et al*., 2008). Pygmy and dwarf sperm whales occur in deep waters on the outer continental shelf and slope in tropical to temperate waters of the Atlantic, Indian, and Pacific Oceans. Based on stranding records and the known habitat preferences of beaked whales in general, Shepherd's beaked whales are assumed to have a circumpolar distribution in deep, cold temperate waters of the Southern Ocean (Pitman *et al.*, 2006). Blainville's beaked whale is the most widely distributed beaked *Mesoplodon* species with sightings and stranding records throughout the North and South Atlantic Ocean (MacLeod *et al*., 2006). Hector's beaked whales are found in cold temperate waters throughout the southern hemisphere between 35° S and 55° S (Zerbini and Secchi 2001). True's beaked whales occur in the Southern hemisphere from the western Atlantic Ocean to the Indian Ocean to the waters of southern Australia and possibly New Zealand (Jefferson *et al.*,

2008). Andrew's beaked whales have a circumpolar distribution north of the Antarctic Convergence to 32° S (MacLeod *et al.*, 2006). Stranding records of spade-toothed beaked whales suggest a Southern hemisphere distribution in temperate waters between 33° and 44° S in the South Pacific, with potential occurrence in the southern Atlantic Ocean (MacLeod *et al.*, 2006). Rough-toothed dolphins occur in tropical and warm temperate seas around the world, preferring deep offshore waters (Lodi 1992). Spinner dolphins are found in tropical, subtropical, and, less frequently, warm temperate waters throughout the world (Secchi and Siciliano 1995). The Clymene dolphin is found in tropical and warm temperate waters of both the North and South Atlantic Oceans (Fertl *et al.*, 2003). Fraser's dolphins are distributed in tropical oceanic waters worldwide, between 30° N and 30° S (Moreno *et al.*, 2003). Southern right whale dolphins have a circumpolar distribution and generally occur in deep temperate to sub-Antarctic waters in the Southern hemisphere (between 30 to 65° S) (Jefferson *et al.*,2008). Short-finned pilot whales are found in warm temperate to tropical waters throughout the world, generally in deep offshore areas (Olson and Reilly, 2002). Spectacled porpoises occur in oceanic cool temperate to Antarctic waters and are circumpolar in high latitude Southern hemisphere distribution (Natalie *et al.*, 2018).

Based on the broad spatial distributions and habitat preferences of these species relative to the areas where SIO's planned survey will occur, NMFS concludes that the authorized take of these species likely represent small numbers relative to the affected species' overall population sizes, though we are unable to quantify the take numbers as a percentage of population.

Based on the analysis contained herein of the planned activity (including the required mitigation and monitoring measures) and the anticipated take of marine mammals, NMFS finds

that small numbers of marine mammals will be taken relative to the population size of the affected species or stocks.

Unmitigable Adverse Impact Analysis and Determination

There are no relevant subsistence uses of the affected marine mammal stocks or species implicated by this action. Therefore, NMFS has determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

National Environmental Policy Act

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*) and NOAA Administrative Order (NAO) 216-6A, NMFS must review our action (*i.e.*, the issuance of an incidental harassment authorization) with respect to potential impacts on the human environment.

This action is consistent with categories of activities identified in Categorical Exclusion B4 (incidental harassment authorizations with no anticipated serious injury or mortality) of the Companion Manual for NOAA Administrative Order 216-6A, which do not individually or cumulatively have the potential for significant impacts on the quality of the human environment and for which we have not identified any extraordinary circumstances that would preclude this categorical exclusion. Accordingly, NMFS has determined that the issuance of the IHA qualifies to be categorically excluded from further NEPA review.

Endangered Species Act (ESA)

Section 7(a)(2) of the Endangered Species Act of 1973 (ESA: 16 U.S.C. 1531 *et seq.*) requires that each Federal agency insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in

the destruction or adverse modification of designated critical habitat. To ensure ESA compliance for the issuance of IHAs, NMFS consults internally, in this case with the ESA Interagency Cooperation Division, whenever we propose to authorize take for endangered or threatened species.

The NMFS Office of Protected Resources Interagency Cooperation Division issued a Biological Opinion on September 11, 2019, under section 7 of the ESA, on the issuance of an IHA to SIO under section 101(a)(5)(D) of the MMPA by the NMFS Permits and Conservation Division. The Biological Opinion concluded that the proposed action is not likely to jeopardize the continued existence of fin whale, sei whale, blue whale, sperm whale, and southern right whale, and is not likely to destroy or modify critical habitat of listed species because no critical habitat exists for these species in the action area.

Authorization

NMFS has issued an IHA to SIO for the potential harassment of small numbers of 49 marine mammal species incidental to a marine geophysical survey in the southwest Atlantic Ocean, provided the previously mentioned mitigation, monitoring, and reporting are incorporated.

Dated: October 7, 2019.

Donna S. Wieting,

Director, Office of Protected Resources,

National Marine Fisheries Service.

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