Request by Scripps Institution of Oceanography for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Low-Energy Marine Geophysical Survey by the R/V *Roger Revelle* in the Tropical Western Pacific Ocean, September–October 2013

submitted by

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4 April 2013

LGL Report TA8268-2

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SUMMARY

The Scripps Institution of Oceanography (SIO), with funding from the U.S. National Science Foundation (NSF), plans to conduct low-energy seismic and sediment coring surveys at 10 sites in the tropical western Pacific Ocean in September–October 2013. The seismic survey would use a pair of low-energy Generator-Injector (GI) airguns with a total discharge volume of ~90 in^3. The seismic survey would take place in water depths 450–3000 m in International Waters and in the Exclusive Economic Zones (EEZs) of the Federated States of Micronesia (Micronesia), the Independent State of Papua New Guinea (Papua New Guinea), the Republic of Indonesia (Indonesia), and the Republic of the Philippines (Philippines). On behalf of SIO, the U.S. State Department will seek authorization from those nations for clearance to work in their EEZs. SIO requests that it be issued an Incidental Harassment Authorization (IHA) allowing non-lethal takes of marine mammals incidental to the planned seismic survey. This request is submitted pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371(a)(5).

Numerous species of marine mammals inhabit the tropical western Pacific Ocean. Several of these species are listed as ***endangered*** under the U.S. Endangered Species Act (ESA): the sperm, humpback, sei, fin, and blue whales. SIO is proposing a marine mammal monitoring and mitigation program to minimize the potential impacts of the proposed activity on marine mammals present during conduct of the proposed research, and to document the nature and extent of any effects.

The items required to be addressed pursuant to 50 C.F.R. § 216.104, "Submission of Requests", are set forth below. They include descriptions of the specific operations to be conducted, the marine mammals occurring in the study area, proposed measures to mitigate against any potential injurious effects on marine mammals, and a plan to monitor any behavioral effects of the operations on those marine mammals.

I. OPERATIONS TO BE CONDUCTED

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

Overview of the Activity

SIO plans to conduct low-energy seismic and sediment coring surveys at 10 sites in the tropical western Pacific Ocean in September–October 2013. The proposed survey sites are located between ~4°S–8°N and ~126.5–144.5°E in International Waters and in the EEZs of Micronesia, Papua New Guinea, Indonesia, and the Philippines (Fig. 1). Water depths in the survey area range from 450–3000 m. The seismic surveys are scheduled to occur for 14–20 h at each of the 10 sites during 6 September–

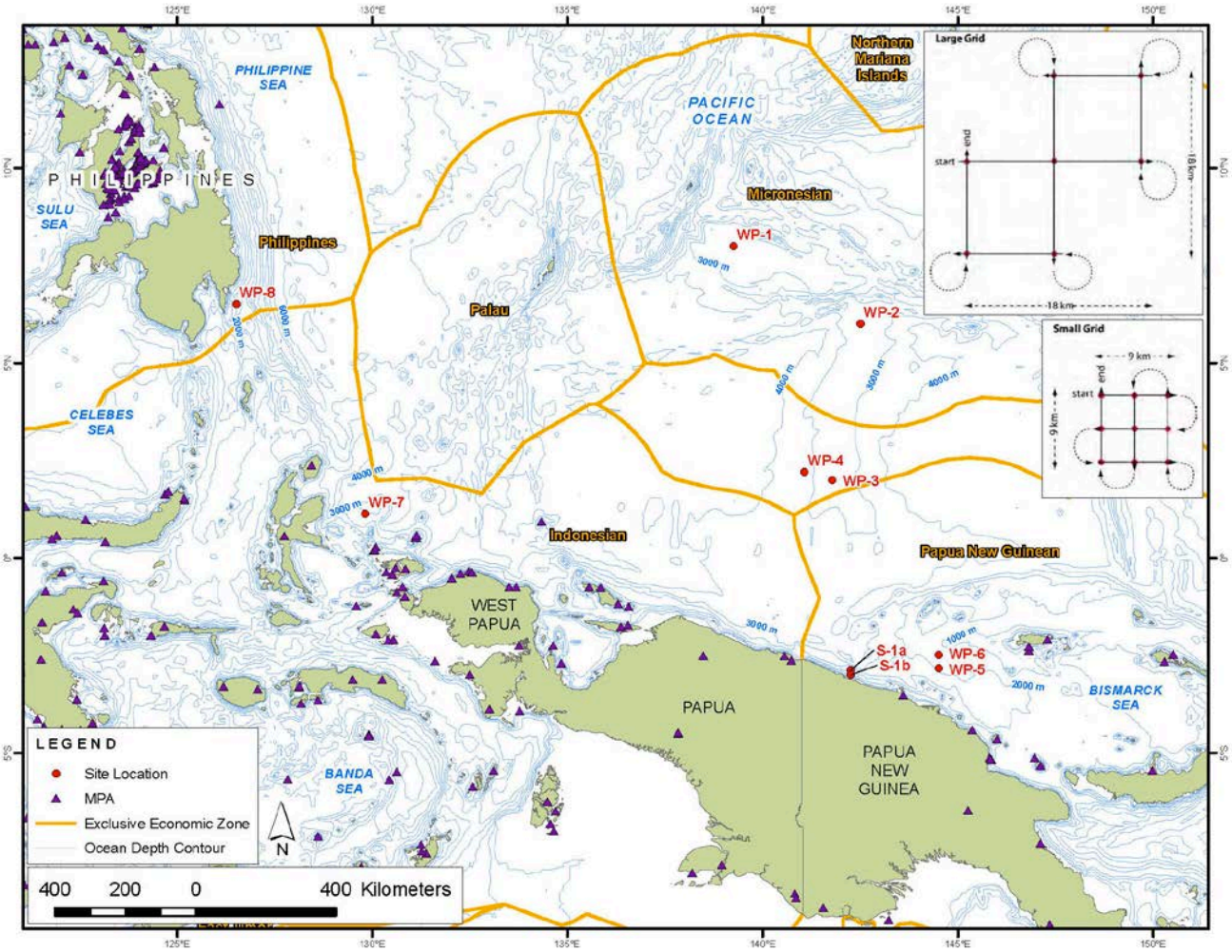

FIGURE 1. Locations of the proposed low-energy seismic survey sites in the tropical western Pacific Ocean during September–October 2013, and marine protected areas (MPA) in the survey area.

1 October 2013. Some minor deviation from these dates would be possible, depending on logistics and weather.

The proposed surveys would fill gaps in equatorial Pacific data sets, namely the lack of high-resolution records from the eastern part of the Western Pacific Warm Pool (WPWP) to better assess the controls on the hydrologic cycle in the WPWP, and a limited meridional coverage to test hypotheses related to the Plio-Pleistocene evolution of the WPWP. To achieve the project's goals, the Principal Investigators (PIs), Drs. Y. Rosenthal and G. Mountain (Rutgers University) propose to collect low-energy, high-resolution multi-channel seismic (MCS) profiles and sediment cores in the heart of the WPWP. Survey data would also be included in a research proposal submitted to the Integrated Ocean Drilling Program (IODP) for funding consideration to extend the record of millennial climate variability in the western equatorial Pacific Ocean back to the mid Miocene. Survey and site characterization data would assist the IODP in determining the viability of the sites for potential future drilling.

The procedures to be used for the surveys would be similar to those used during previous seismic surveys by SIO and would use conventional seismic methodology. The surveys would involve one source

vessel, the R/V *Roger Revelle*. The *Revelle* would deploy a pair of 45-in^3 GI airguns as an energy source with a total volume of ~90 in^3. The receiving system would consist of one 600-m hydrophone streamer. As the airguns are towed along the survey lines, the hydrophone streamer would receive the returning acoustic signals and transfer the data to the on-board processing system.

Straight survey lines whose lengths and orientations have been chosen by the anticipated complexity of subseafloor geologic features at each site would be collected in a grid of intersecting lines. Seven sites (see Table 1) would be centered in 'small' 9 x 9 km grids of six intersecting lines (see inset in upper right of Figure 1.) One site warrants slightly longer lines and would be surveyed in a 'large' 18 x 18 km grid of six intersecting lines (see inset in upper right of Figure 1.) Finally, Sites S-1a and S-1b are close enough that efficiency in ship use would be achieved by covering both with a single grid of intersecting lines in a 30 x 26 km area. Individual survey lines in this grid would be 5–10 km apart. The total track distance of survey data, including turns, would be 1033 km. Barring re-organization because of weather considerations or results that develop from data analyzed as sites are completed, sites would be surveyed in the order summarized in Table 1.

There would be additional seismic operations in the survey area associated with airgun testing and repeat coverage of any areas where initial data quality is sub-standard. In our calculations (see § VII), 25% has been added for those additional operations.

In addition to the operations of the airgun array, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) would also be operated from the *Revelle* continuously throughout the cruise between the first and last survey sites. All planned geophysical data acquisition activities would be conducted by SIO with on-board assistance by the scientists who have proposed the study. The vessel would be self-contained, and the crew would live aboard the vessel for the entire cruise.

TABLE 1. Survey patterns and lengths at each proposed survey site in the tropical western Pacific Ocean during September–October 2013.

Survey site[1]	Survey pattern (km)	Survey length (km)
WP-5	9 x 9	82.2
WP-6	9 x 9	82.2
S-1a, S-1b	30 x 26	349.5
WP-3	9 x 9	82.2
WP-4	9 x 9	82.2
WP-2	9 x 9	82.2
WP-1	9 x 9	82.2
WP-7	9 x 9	82.2
WP-8	18 x 18	108.0
Total		1032.9

[1] Sites are listed in the intended order in which surveys would be conducted

Source Vessel Specifications

The R/V *Roger Revelle* has a length of 83 m, a beam of 16.0 m, and a maximum draft of 5.2 m. The ship is powered by two 3,000 hp Propulsion General Electric motors and a 1180 hp azimuthing jet bow thruster. An operation speed of 9.3 km/h (5 kt) would be used during seismic acquisition. When not towing seismic survey gear, the *Revelle* cruises at 22.2–23.1 km/h (12–12.5 kt) and has a maximum speed of 27.8 km/h (15 kt). It has a normal operating range of ~27,780 km.

The *Revelle* would also serve as the platform from which vessel-based protected species observers (PSOs) would watch for marine mammals and sea turtles before and during airgun operations. The characteristics of the *Revelle* that make it suitable for visual monitoring are described in § XI.

Other details of the *Revelle* include the following:

Owner:	U.S. Navy
Operator:	Scripps Institution of Oceanography of the University of California
Flag:	United States of America
Date Built:	1996
Gross Tonnage:	3180
Compressors for GI Airguns:	Price Air Compressors, 300 cfm at 1750 psi
Accommodation Capacity:	22 crew plus 37 scientists

Airgun Description

The *Revelle* would tow a pair of 45-in^3 GI airguns and a 600-m streamer containing hydrophones along predetermined lines. Seismic pulses would be emitted at intervals of ~10 seconds (25 m). At a speed of 5 knots (11.1 km/h), the 6–10 s spacing would correspond to a shot interval of ~18.5–31 m.

The generator chamber of each GI airgun, the one responsible for introducing the sound pulse into the ocean, is 45 in^3. The larger (105 in^3) injector chamber injects air into the previously generated bubble to maintain its shape, and does not introduce more sound into the water. The two 45 in^3 GI airguns would be towed 8 m apart side by side, 21 m behind the *Revelle*, at a depth of 2 m.

GI Airgun Specifications

Energy Source	Two GI airguns of 45 in^3
Source output (downward)	0-peak is 3.4 bar-m (230.6 dB re 1 μPa·m); peak-peak is 6.2 bar-m (235.8 dB re 1 μPa·m)
Towing depth of energy source	2 m
Air discharge volume	Approx. 90 in^3
Dominant frequency components	0–188 Hz
Gun positions used	Two side-by-side airguns 8 m apart
Gun volumes at each position (in^3)	45, 45

As the airguns are towed along the survey lines, the towed hydrophone array in the 600-m streamer would receive the reflected signals and transfers the data to the on-board processing system. Given the relatively short streamer length behind the vessel, the turning rate of the vessel with gear deployed would be much higher than the limit of 5º per minute for a seismic vessel towing a streamer of more typical length (>>l km), ~20º. Thus, the maneuverability of the vessel would not be limited much during operations.

The nominal downward-directed source levels indicated above do not represent actual sound levels that can be measured at any location in the water. Rather, they represent the level that would be found 1 m from a hypothetical point source emitting the same total amount of sound as is emitted by the combined GI airguns. The actual received level at any location in the water near the GI airguns would not exceed the source level of the strongest individual source. In this case, that would be ~224.6 dB re 1μPa-m peak, or 229.8 dB re 1μPa-m peak-to-peak. Actual levels experienced by any organism more than 1 m from either GI airgun would be significantly lower.

A further consideration is that the rms[1] (root mean square) received levels that are used as impact criteria for marine mammals are not directly comparable to the peak (p or 0–p) or peak to peak (p–p) values normally used to characterize source levels of airgun arrays. The measurement units used to describe airgun sources, peak or peak-to-peak decibels, are always higher than the rms decibels referred to in biological literature. A measured received level of 160 dB re 1 μPa_{rms} in the far field would typically correspond to ~170 dB re 1 μPa_{p}, and to ~176–178 dB re 1 $\mu Pa_{p\text{-}p}$, as measured for the same pulse received at the same location (Greene 1997; McCauley et al. 1998, 2000). The precise difference between rms and peak or peak-to-peak values depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or peak-to-peak level for an airgun-type source.

Received sound levels have been modeled by Lamont-Doherty Earth Observatory of Columbia University (L-DEO) for a number of airgun configurations, including two 45-in^3 Nucleus G. Guns, in relation to distance and direction from the airguns (Fig. 2). The model does not allow for bottom interactions, and is most directly applicable to deep water.

Empirical data on the 180- and 160-dB distances have been acquired for various airgun arrays based on measurements during acoustic verification studies conducted by L-DEO in the northern Gulf of Mexico in 2003 (6-, 10-, 12-, and 20-airgun arrays, and 2 GI airguns; Tolstoy et al. 2004) and 2007–2008 (18- and 36-airgun arrays; Tolstoy et al. 2009; Diebold et al. 2010). The empirical data for the 6-, 10-, 12-, and 20-airgun arrays indicate that, for deep water (>1000 m), the L-DEO model tends to overestimate the received sound levels at a given distance (Tolstoy et al. 2004). Measurements were not made for the 2 GI airguns in deep water, but we propose to use the "Safety Zone" radii predicted by L-DEO's model for the proposed GI airgun operations in deep water, although they are likely conservative given the empirical results for the other arrays.

The data also showed that radii around the airguns where the received level would be 180 dB re 1 μPa (rms), the safety criterion applicable to cetaceans (NMFS 2000), varies with water depth. Correction factors were developed for water depths 100–1000 m and <100 m. The proposed surveys would occur in depths 450–3000 m, so only the correction factor for intermediate water depths is relevant here. The only empirical measurements made for intermediate depths (100–1000 m) were for the 36-aigun array in 2007–2008 (Diebold et al. 2010). The intermediate-water radii 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 (Fig. 16 *in* Diebold et al. [2010]).

The Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (June 2011) and Record of Decision (June 2012), referred to herein as the PEIS, defined a low-energy source as any towed acoustic source whose received level is ≤180 dB at 100 m, including any single or any two GI airguns and a single pair of clustered airguns with individual volumes of ≤250 in^3. In § 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applied a 100-m exclusion zone (EZ) for all low-energy acoustic sources in water depths >100 m.

Consistent with the PEIS, that approach is used here for the pair of 45-in^3 GI airguns. A fixed full mitigation zone, or 160-dB "Safety Zone" was not defined in the PEIS for the same suite of low-energy sources; therefore, L-DEO model results for 45-in^3 G Guns are used here to determine the 160-dB radius for the pair of 45-in^3 GI airguns.

[1] The rms (root mean square) pressure is an average over the pulse duration.

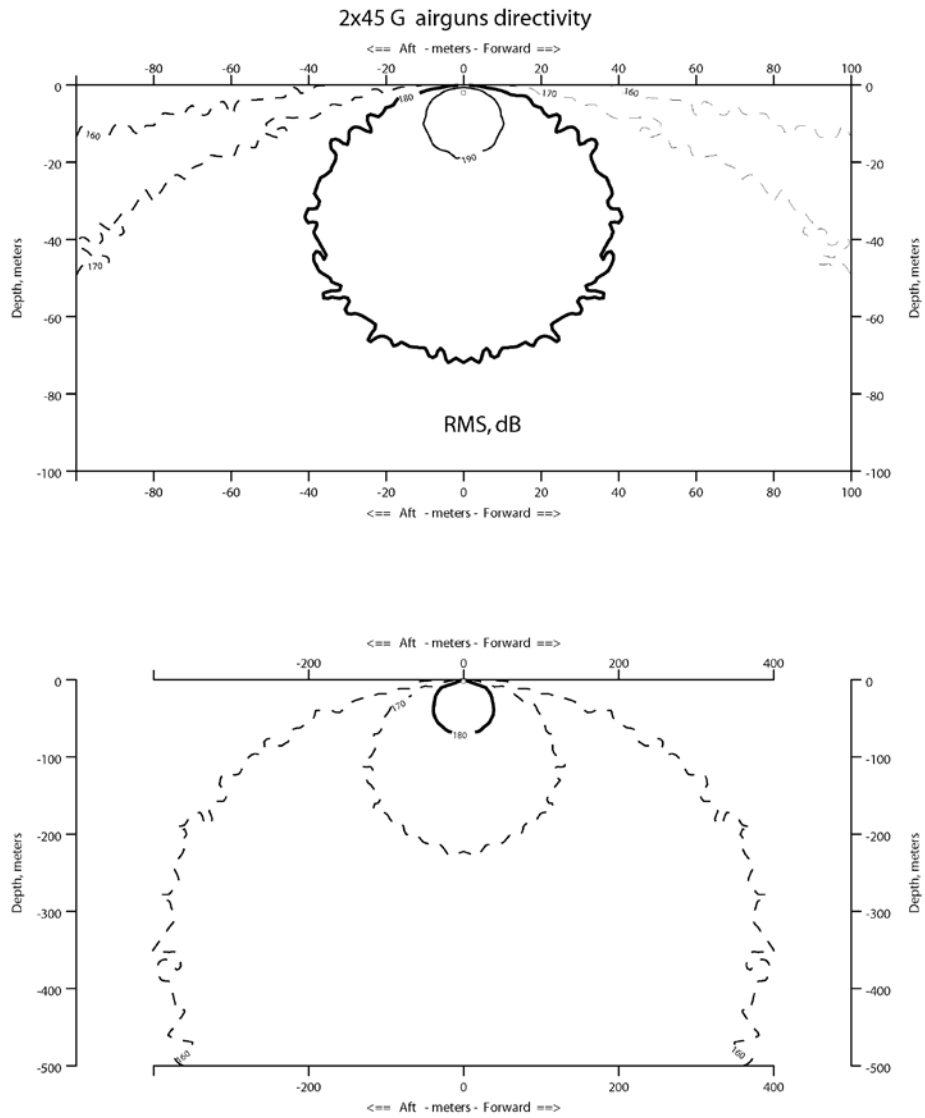

FIGURE 2. Modeled received sound levels from two 45-in^3 G. Guns, similar to the two 45-in^3 GI airguns that would be used during the SIO surveys in the tropical western Pacific Ocean during September–October 2013. Model results were provided by L-DEO.

Table 2 shows the 180-dB EZ for the pair of 45-in^3 GI airguns based on the PEIS and the L-DEO modeled measurements for the 160-dB safety zone, the distances at which the rms sound levels are expected to be received in >1000-m and 100–1000 m water. Because the model results are for G Guns, which have more energy than GI airguns of the same size, the distances are overestimated. The 180-dB re 1 μPa_{rms} distance is the safety criterion as specified by the National Marine Fisheries Service (NMFS 2000) for cetaceans. The 180-dB distance would also be used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects (e.g., Holst and Beland 2008; Holst and Smultea 2008; Hauser et al. 2008; Holst 2009; Antochiw et al. n.d.). If marine mammals or sea turtles are detected in or about to enter the appropriate EZ, the airguns would be shut down immediately.

TABLE 2. Predicted distances to which 160 dB re 1 μPa$_{rms}$ sound levels could be received from two 45-in^3 G guns, similar to the two 45-in^3 GI airguns that would be used during the seismic surveys in the tropical western Pacific Ocean during September–October 2013 (model results provided by L-DEO). Distances to which 180 dB re 1 μPa$_{rms}$ sound levels could be received are based on the standard EZ established in the PEIS.

Water depth	Predicted or established distances at received levels	
	180 dB	160 dB
>1000 m	100 m	400 m
100–1000 m	100 m	600 m

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. Currently, NMFS is using those proposed levels as a starting point to revise the current acoustic criteria, but they have not yet been finalized (NMFS 2013). NSF would be prepared to revise its procedures for estimating numbers of mammals should NMFS implement new acoustic criteria guidelines. However, currently the procedures are based on best practices noted by Pierson et al. (1998) and Weir and Dolman (2007).

Description of Operations

Seismic surveys

The surveys would involve one source vessel, the R/V *Roger Revelle*. The *Revelle* would tow a pair of 45-in^3 GI airguns and a 600-m streamer containing hydrophones along predetermined lines. Seismic pulses would be emitted at intervals of ~10 seconds (25 m). At a speed of 5 knots (11.1 km/h), the 6–10 s spacing would correspond to a shot interval of ~18.5–31 m. As the GI airguns are towed along the survey lines, the hydrophone streamer would receive the returning acoustic signals and transfer the data to the on-board processing system.

Straight survey lines would be collected in a grid of intersecting lines. Seven sites (see Table 1) would be centered in 'small' 9 x 9 km grids of six intersecting lines (see inset in upper right of Figure 1.) One site warrants slightly longer lines and would be surveyed in a 'large' 18 x 18 km grid of six intersecting lines (see inset in upper right of Figure 1.) Finally, Sites S-1a and S-1b are close enough that efficiency in ship use would be achieved by covering both with a single grid of intersecting lines in a 30 x 26 km area. Individual survey lines in this grid would be 5–10 km apart. The total track distance of survey data, including turns, would be 1033 km. Barring re-organization because of weather considerations or results that develop from data analyzed as sites are completed, sites would be surveyed in the order summarized in Table 1.

Piston Core, Gravity Core, and Multicore Description and Deployment

The piston corer to be used on the *Revelle* consists of (1) a piston core with a 10-cm diameter steel barrel up to ~18 m long with a 2300-kg weight and (2) a trigger core with a 10-cm diameter PVC plastic barrel 3 m long with a 230-kg weight, which are lowered concurrently into the ocean floor with 1.4-cm diameter steel cables.

The gravity corer consists of a 6-m long core pipe that takes a core sample ~10 cm in diameter, a head weight ~45 cm in diameter, and a stabilizing fin. It is lowered to the ocean floor with 1.4-cm diameter steel cable at 100 m/min speed.

The multicorer consists of an outer 8-legged cone-shaped frame and a weighted inner frame that holds up to 8 plastic core sampling tubes 80 cm long and ~10 cm in diameter. The outer frame is lowered to the bottom, and the inner frame is then released to allow the sampling tubes to penetrate the sediment.

At each of the 10 sites, one of each type of core would be collected.

Multibeam Echosounder and Sub-bottom Profilers

Along with the airgun operations, two additional acoustical data acquisition systems would be operated during the entire cruise. The ocean floor would be mapped with the Kongsberg EM 122 MBES and a Knudsen Chirp 3260 SBP. These sources are described in § 2.2.3.1 of the PEIS.

II. Dates, Duration, and Region of Activity

The date(s) and duration of such activity and the specific geographical region where it will occur.

The proposed survey sites are located between ~4°S–8°N and ~126.5–144.5°E in International Waters and in the EEZs of Micronesia, Papua New Guinea, Indonesia, and the Philippines (Fig. 1). Water depths in the survey area range from 450–3000 m. The exact dates of the activities depend on logistics and weather conditions. The *Revelle* would depart from Lae, Papua New Guinea, on 6 September and transit to Manila, Philippines, after the last survey for arrival on 1 October (see Table 1 for proposed order of survey sites). Seismic operations would take 14–20 h at each of the 10 sites, and total transit time to the first site, between all sites, and from the last site would be 13 days. The remainder of the time, ~6 days, would be spent collecting sediment cores at the 10 sites, for a total of 26 operational days.

III. Species and Numbers of Marine Mammals in Area

The species and numbers of marine mammals likely to be found within the activity area

Twenty-six species of marine mammals, including 19 odontocetes and 7 mysticetes, could occur at or near the proposed survey sites in the western tropical Pacific Ocean (Table 3). To avoid redundancy, we have included the required information about the species and (insofar as it is known) numbers of these species in § IV, below.

IV. Status, Distribution and Seasonal Distribution of Affected Species or Stocks of Marine Mammals

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities

Sections III and IV are integrated here to minimize repetition.

Five of the 26 species that could occur at or near the proposed survey sites in the western tropical Pacific Ocean are listed under the U.S. ESA as ***Endangered***: the humpback, blue, fin, sei, and sperm whales. In addition, there are four species known to occur in coastal waters of the study area: the Australian snubfin dolphin (*Orcaella heinsohni*), Indo-Pacific humpback dolphin (*Sousa chinensis*), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), and the dugong (*Dugong dugon*). However, these species do not occur in slope or deep, offshore waters where the proposed activities would take place. No pinnipeds are known to occur in the proposed survey area.

TABLE 3. The habitat, regional abundance, and conservation status of marine mammals that could occur in or near the proposed survey sites in the western tropical Pacific.

Species	Occurrence near survey sites	Habitat	Abundance in the Pacific	ESA[1]	IUCN[2]	CITES[3]
Mysticetes						
Humpback whale	Uncommon	Mainly nearshore waters and banks	3520[4]	EN	LC	I
Common minke whale	Uncommon	Coastal, offshore	25,000[5]	NL	LC	I
Bryde's whale	Common–Uncommon	Coastal, offshore	21,000[6]	NL	DD	I
Omura's whale	Common–Uncommon	Coastal, offshore	N.A.	NL	DD	I
Sei whale	Uncommon	Mostly pelagic	7260–12,620[7]	EN	EN	I
Fin whale	Uncommon	Slope, mostly pelagic	13,620–18,680[8]	EN	EN	I
Blue whale	Rare	Coastal, shelf, pelagic	N.A.	EN	EN	I
Odontocetes						
Sperm whale	Common–Uncommon	Usually deep pelagic, steep topography	29,674[9]	EN	VU	I
Pygmy sperm whale	Uncommon	Deep waters off shelf	N.A.	NL	DD	II
Dwarf sperm whale	Uncommon	Deep waters off shelf	11,200[10]	NL	DD	II
Cuvier's beaked whale	Common–Uncommon	Slope and pelagic	20,000[10]	NL	LC	II
Longman's beaked whale	Rare	Pelagic	N.A.	NL	DD	II
Ginkgo-toothed beaked whale	Rare	Pelagic	25,300[11]	NL	DD	II
Blainville's beaked whale	Uncommon	Pelagic	25,300[11]	NL	DD	II
Rough-toothed dolphin	Common–Uncommon	Pelagic	107,633[12]	NL	LC	II
Common bottlenose dolphin	Common–Uncommon	Coastal, shelf, pelagic	168,792[13]	NL	LC	II
Pantropical spotted dolphin	Common–Uncommon	Coastal, pelagic	438,064[13]	NL	LC	II
Spinner dolphin	Common	Coastal, pelagic	734,837[14]	NL	DD	II
Striped dolphin	Common–Uncommon	Off continental shelf	570,038[13]	NL	LC	II
Fraser's dolphin	Common–Uncommon	Pelagic	289,300[10]	NL	LC	II
Risso's dolphin	Common–Uncommon	Shelf, slope, seamounts	83,289[13]	NL	LC	II
Melon-headed whale	Common–Uncommon	Pelagic	45,400[10]	NL	LC	II
Pygmy killer whale	Common–Uncommon	Pelagic	38,900[10]	NL	DD	II
False killer whale	Common–Uncommon	Pelagic	16,668[13]	NL	DD	II
Killer whale	Common–Uncommon	Coastal, widely distributed	8500[10]	NL	DD	II
Short-finned pilot whale	Common–Uncommon	Mostly pelagic, high-relief	53,608[13]	NL	DD	II

N.A. Not available or not assessed.
[1] U.S. Endangered Species Act: EN = Endangered, NL = Not listed (ECOS 2013)
[2] Codes for IUCN classifications: EN = Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient. Classifications are from the IUCN Red List of Threatened Species (IUCN 2012)
[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2012); Appendix I = Threatened with extinction; Appendix II = not necessarily now threatened with extinction but may become so unless trade is closely controlled
[4] Oceania (Constantine et al. 2010)
[5] Northwest Pacific and Okhotsk Sea (IWC 2013)
[6] Western North Pacific (IWC 2013)
[7] North Pacific (Tillman 1977)
[8] North Pacific (Ohsumi and Wada 1974)
[9] Western North Pacific (Whitehead 2002)
[10] Eastern Tropical Pacific or ETP (Wade and Gerrodette 1993)
[11] ETP; all *Mesoplodon* spp. (Wade and Gerrodette 1993)
[12] ETP (Gerrodette et al. 2008)
[13] Western North Pacific (Miyashita 1993)
[14] Whitebelly stock in ETP (Gerrodette et al. 2008)

General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of marine mammals are given in § 3.6.1 and § 3.7.1 of the PEIS. One of the qualitative analysis areas (QAAs) defined in the PEIS, the Marianas, is located ~800 km to the north of the proposed study area, at 17ºN, 145ºE. The general distribution of mysticetes and odontocetes in the western North Pacific Ocean is discussed in § 3.6.3.7 and § 3.7.3.7 of the PEIS, respectively. The rest of this section deals specifically with species distribution in the proposed survey area in the western tropical Pacific.

Few systematic surveys have been conducted in the western tropical Pacific Ocean, and none have taken place during September–October. Borsa and Nugroho (2010) conducted 1561 km of surveys of Raja Ampat waters, including the Halmahera Sea, in West Papua during November–December 2007. Visser (2002 *in* Visser and Bonoccorso 2003) conducted preliminary surveys in Kimbe Bay, New Britain, Papua New Guinea. Miyazaki and Wada (1978) surveyed 11,249 km in the wider tropical Pacific, including Micronesia, and the waters off Papua New Guinea and the Solomon Islands during January–March 1976. Shimada and Miyashita (2001) conducted 8721 km of surveys in Micronesia, the Solomon Islands, and north of Papua New Guinea during February–March from 1999–2001. Oremus (2011) described 4523 km of surveys in the Solomon Islands during November of 2009 and 2010. Dolar et al. (2006) surveyed the waters of the central Philippines, including the Sulu Sea, during May–June 1994 and 1995; 2747 km were covered. In May 1996, Dolar et al. (1997) surveyed 825 km in the southern Sulu Sea. Another survey of relevance to the proposed survey area is one that took place during January–April 2007 in the waters of Guam and the Commonwealth of the Northern Mariana Islands; a total of 11,033 km were surveyed in the area 10–18°N and 142–148°E (SRS-Parsons 2007; Fulling et al. 2011). The aforementioned surveys took place in shallow coastal waters as well as deeper offshore waters. Records from the Ocean Biogeographic Information System (OBIS) database hosted by Rutgers and Duke University (Read et al. 2009) were also considered below.

Mysticetes

Humpback Whale (*Megaptera novaeangliae*)

Humpback whales occur throughout most of the Pacific, but are rare in the equatorial region (Jefferson et al. 2008). In the western North Pacific, humpback whales are known to winter and calve around Ogasawara and Ryukyu Islands in southern Japan, Taiwan, and the Babuyan Islands in Luzon Strait in the northern Philippines (Perry et al. 1999; Acebes and Lesaca 2003; Acebes et al. 2007; Calambokidis et al. 2008). Singing humpbacks have been detected in both deep and shallow waters of the Mariana Islands, suggesting a small wintering population in the region (SRS-Parsons et al. 2007). However, Shimada and Miyashita (2001) did not report any sightings of humpback whales during February–March surveys of the Mariana Islands or Micronesia.

There are several distinct breeding grounds in the South Pacific Ocean, including eastern Australia and Oceania (Anderson et al. 2010; Garrigue et al. 2011a). Although genetic evidence also indicates several discrete breeding grounds within Oceania, including New Caledonia, Tonga, and French Polynesia (Olavarría et al. 2003, 2007), some movement has been shown between breeding areas within Oceania (Garrigue et al. 2002, 2011a; Clapham et al. 2008) and between Oceania and eastern Australia (Anderson et al. 2010; Garrigue et al. 2011b). Constantine et al. (2010) noted that Oceania is the least abundant breeding ground in the Southern Hemisphere, with an estimated population size of 3520.

During surveys in February–March 1999–2001, Shimada and Miyashita (2001) did not report any sightings of humpback whales north of Papua New Guinea or near the Solomon Islands. However, there are records of humpback whales for Papua New Guinea (SPREP 2012) and unconfirmed records for the Solomon Islands (Miller 2007). There is one OBIS record for humpback whales in the proposed survey

area, off western Papua New Guinea; there are an additional two records for the Solomon Islands (IOC 2013). The occurrence of humpback whales in Indonesia is unconfirmed; there has been a possible sighting in the Celebes Sea (Rudolph et al. 1997).

The available evidence suggests that humpback whales would be uncommon throughout the proposed survey area. However, it is possible that some individuals could be encountered off Papua New Guinea. Encounters in other parts of the study area, particularly north of the equator would be unlikely, as most humpbacks would be on higher-latitude feeding grounds during the time of the proposed surveys.

Minke Whale (*Balaenoptera* spp.)

There are two species of minke whale, the common minke whale (*B. acutorostrata*) and the Antarctic minke whale (*B. borealis*). In the North Pacific, the common minke whale occurs from tropical to polar waters (Reeves et al. 2002); its distribution in the South Pacific is not well known (Jefferson et al. 2008). Antarctic minke whales are found between 55°S and the ice edge during the austral summer; in the austral winter, they are mainly found between 10°S and 30°S and between 170°E and 100°W (Perrin and Brownell 2009). A smaller form (unnamed subspecies) of the common minke whale, known as the dwarf minke whale, occurs in the Southern Hemisphere where its distribution overlaps with that of the Antarctic minke whale (Perrin and Brownell 2009). Only the common minke whale could be encountered during the proposed surveys.

In the North Pacific, three stocks of minke whales are currently recognized: the Sea of Japan/East China Sea, the rest of the western Pacific, and the remainder of the Pacific (Donovan 1991). For the western Pacific stock, one group is thought to breed near the Bonin-Japan Trench during winter (Smith et al. 2003). Minke whales that occur in Southeast Asia are likely from the same population that winters off the coast of Japan (see Parsons et al. 1995). Minke whales are known to occur in the Yellow, East China, and South China seas (Parsons et al. 1995). There are only unconfirmed records of minke whales for Indonesia (Rudolph et al. 1997). During January–April 2007 surveys of the waters of Guam and the Northern Mariana Islands, minke whales were the baleen whale species most frequently detected acoustically (SRS-Parsons et al. 2007). There are also unconfirmed records of minke whales for Palau (Miller 2007). Minke whales have not been reported for Papua New Guinea (Miller 2007; SPREP 2012). However, there are OBIS records of common minke whales for the Solomon Islands and to the east of the study area at ~160°E (IOC 2013). Minke whales are likely to be uncommon throughout the proposed survey area.

Bryde's Whale (*Balaenoptera edeni/brydei*)

Bryde's whale's distribution is circumglobal, but it generally occurs in tropical and subtropical areas. A small form is known to occur in southwestern Japan, Hong Kong/Macau, and Australia, but this form has not been distinguished from the common Bryde's whale (Jefferson et al. 2008). Nonetheless, Wada et al. (2003) and Sasaki et al. (2006) suggested that smaller *B. edeni* (the pygmy Bryde's or Eden's whale) could be a distinct species from the larger *B. brydei* or Bryde's whale. However, here we follow Kato and Perrin (2009) in recognizing the uncertainty and using *B. edeni/brydei*. Also, whales in the East China Sea and coastal waters of Kochi, Japan, differ from the whales in offshore waters of the western North Pacific, perhaps at the subspecific level (Yoshida and Kato 1999). However, the reclassification of Bryde's whale remains unresolved (Jefferson et al. 2008).

Ohizumi et al. (2002) reported that Bryde's whales occur throughout the western North Pacific during winter, including the Mariana, Ogasawara, Kazan, and Philippine islands. Bryde's whales were also sighted during surveys of the central Philippines, including northern Mindanao, by Dolar et al. (2006), and Bryde's whales where marked off eastern Mindanao during 1972–1987 (Kishiro 1996).

Bryde's-like whales are known to occur in Palau (SPREP 2012) as well as in Indonesia (Rudolph et al. 1997; Kahn and Pet 2003). Kishiro (1996) reported that Bryde's whales were available for marking during Japanese marking operations off West Papua, Papua, as well as Papua New Guinea, and strandings have also been reported for West Papua (Wild and Science 2013). Miyazaki and Wada (1978) reported Bryde's whale sightings for January–March surveys in 1976 north of Papua New Guinea and in the Solomon Islands. Miyazaki et al. (1996) sighted Bryde's whales during January–March 1993–1995 surveys off eastern Mindanao, Philippines.

Bryde's whale sightings were also made during surveys in February–March 1999–2001 north of Papua New Guinea, in Micronesia, the Solomon Islands, and near the Mariana Islands (Shimada and Miyashita 2001). Bryde's whales were also taken in the Philippine fishery in the 1980s near the Caroline Islands of the Federated Sates of Micronesia (Perrin 2006). Bryde's whales are considered the most common baleen whale in the Marianas region, typically occurring from May to July and possibly August (Eldredge 2003; Kishiro 1996; Miyashita et al. 1996). During January–April 2007 surveys in the waters of Guam and the Northern Mariana Islands, Bryde's and sei whales were the most frequently encountered baleen whales (SRS-Parsons et al. 2007; Fulling et al. 2011). Ohsumi (1978) reported high densities of Bryde's whales along the equator between 130°W and 180°W.

There are no records of Bryde's whales in or near the proposed survey area in the OBIS database (IOC 2013). Nonetheless, this is the most likely baleen whale species that would be encountered during the proposed surveys according to other available information.

Omura's Whale (*Balaenoptera omurai*)

Omura's whale was first described in 2003 from records from the eastern Indian Ocean, Indonesia, the Philippines, the Sea of Japan, and the Solomon Islands (Wada et al. 2003). Aragones et al. (2010) reported two strandings of this species in the Philippines between 1998 and 2009. Wada and Numachi (1991) and Yoshida and Kato (1999) had noted that whales in the Solomon Islands were distinct from Bryde's whales from offshore waters of the western North Pacific and the East China Sea. In fact, this species is not as closely related to Bryde's, Eden's, or sei whales as previously thought (Sasaki et al. 2006). Omura's whale mostly occurs over the continental shelf in nearshore waters, and is generally seen alone or in pairs (Jefferson et al. 2008).

There are no records of this species in the OBIS database (IOC 2013), but it could occur in the proposed survey area.

Sei Whale (*Balaenoptera borealis*)

In the western North Pacific, the sei whale can be found across the Bering Sea and off the coasts of Japan and Korea in summer. Its occurrence in the South China Sea is unconfirmed (Rudolph and Smeenk 2009), although Chou (2004) reported on records for this species in Taiwan. Its winter distribution is concentrated at ~20°N. During January–April surveys of the Mariana Islands, Bryde's and sei whales were the most frequently encountered baleen whales (SRS-Parsons et al. 2007; Fulling et al. 2011). No breeding grounds have been identified for sei whales anywhere in its range; however, calving is thought to occur from September to March. Sei whales have not been reported for Palau (SPREP 2012).

Sei whales are generally not found north of 30ºS in the southern hemisphere, but could occasionally visit the southern portion of the proposed study area during the austral winter (Reeves et al. 1999). There are sei whale records for Papua New Guinea and New Caledonia, but they have not been reported for the Solomon Islands (Miller 2007; SPREP 2012). Although there are records of sei whales for Indonesia, no recent sightings have been made (Rudolph et al. 1997).

There are no records of sei whales within or near the proposed survey area in the OBIS database (IOC 2013). In addition, the range of the sei whale indicated by Jefferson et al. (2008) does not include the area where the proposed surveys would take place. Although sei whales are known to occur in the Mariana Islands, it is unlikely that they would occur in Micronesia during the time of the proposed surveys, as they prefer colder temperature waters during summer. It is possible, although unlikely, that sei whales could be encountered off Papua New Guinea.

Fin Whale (*Balaenoptera physalus*)

Northern and southern fin whale populations are distinct, and are sometimes recognized as different subspecies (Aguilar 2009). The current distribution of fin whales in the western North Pacific is largely unknown. Fin whales migrate in the open oceans and their winter breeding areas are mostly uncertain; however, they are known to winter in the Yellow, East China, and South China seas (Parsons et al. 1995; Rudoph and Smeenk 2002). Fin whales could be resident in the East China Sea (Jefferson et al. 2008). De Boer (2000) reported one fin whale sighting during surveys of the South China Sea. There are also a few records for Indonesia (Rudolph et al. 1997).

A recent review of fin whale distribution in the North Pacific noted the lack of sightings across the pelagic waters between eastern and western winter areas (Mizroch et al. 2009). No fin whales were sighted or detected acoustically during the January–April 2007 survey in the waters of the Mariana Islands (SRS-Parsons et al. 2007; Fulling et al. 2011). There are no records for Palau, Micronesia, Papua New Guinea, or the Solomon Islands (Miller 2007; SPREP 2012). In addition, there are no OBIS records of fin whales within or near the proposed survey area (IOC 2013). It is unlikely that fin whales would be encountered during the proposed surveys.

Blue Whale (*Balaenoptera musculus*)

The North Pacific stock of blue whales is thought to winter off Taiwan, Japan, and Korea. There have also been blue whale calls recorded off Midway and Oahu, Hawaii, suggesting that blue whales occur within several hundred kilometers of these islands (NMFS 1998). Blue whale calls monitored from the U.S. Navy Sound Surveillance System (SOSUS) and other offshore hydrophones suggest that separate populations occur in the eastern and western North Pacific (Stafford et al. 1999, 2001, 2007; Watkins et al. 2000; Stafford 2003). Moore et al. (2002) reported that blue whale calls are received in the North Pacific year-round. The current distribution of blue whales in the western North Pacific is largely unknown, and little information is available on blue whale wintering areas (Perry et al. 1999). However, few blue whales have been reported recently in the western North Pacific (Sears and Perrin 2009).

The blue whale is also considered rare in the Southern Hemisphere (Sears and Perrin 2009). However, there have been confirmed sightings in Indonesia (Rudolph et al. 1997; Kahn and Pet 2003) and the Solomon Islands (Miller 2007; SPREP 2012). There are no records of blue whales in or near the proposed survey area in the OBIS database (IOC 2013).

Odontocetes

Sperm Whale (Physeter macrocephalus)

The sperm whale is known to occur in Southeast Asia, including the South China Sea (De Boer 2000), Indonesia (Rudolph et al. 1997; Kahn and Pet 2003), and the Philippines (Acebes and Lesaca 2003; Dolar et al. 2006). Miyazaki et al. (1996) reported sperm whales during January–March surveys off eastern Mindanao, Philippines, during 1993–1995. During surveys off northern West Papua, Indonesia, Borsa and Nugroho (2010) reported five sightings of sperm whales and an encounter rate of

0.005 whales/km, but none of the sightings were made in the Halmahera Sea. Strandings have also been reported for Papua and West Papua (Wild And Science 2013).

The sperm whale is the most common large cetacean (except perhaps for Bryde's whale) in the Pacific Islands region (Reeves et al. 1999), and the most widespread cetacean species in that area (SPREP 2007). Sperm whales were sighted in and near the proposed study area during surveys in February–March 1999–2001 in Micronesia, north of Papua New Guinea, and the Solomon Islands (Shimada and Miyashita 2001). Miyazaki and Wada (1978) also reported sperm whale sightings during surveys in January–March 1976 north of Papua New Guinea and in the Solomon Islands. The Bismarck Sea in Papua New Guinea appears to be an important breeding ground for sperm whales; mother/calf pairs and mature males have been seen in this area (Madsen et al. 2002).

The sperm whale was the most frequently sighted cetacean during surveys in January–April 2007 in the Marianas (SRS-Parsons et al. 2007; Fulling et al. 2011); historically, they occurred there year-round (Townsend 1935). There are also known to occur in Palau (SPREP 2012). In the OBIS database, there is one sperm whale record at 13.5°N, 144°E, north of the proposed survey area, two records off northeastern Papua New Guinea, and three records for the Solomon Islands (IOC 2013). Thus, sperm whales are likely to be sighted during the proposed surveys.

Pygmy and Dwarf Sperm Whales (*Kogia breviceps* and *K. sima*)

Although there are few useful estimates of abundance for pygmy or dwarf sperm whales anywhere in their range, they are thought to be common in some areas. They are known to occur in tropical and warm temperate areas of the western Pacific. In Southeast Asia, pygmy sperm whales are known to occur in the South China Sea (Parsons et al. 1995), and there have been stranding reports for the Philippines (Aragones et al. 2010). Dwarf sperm whales have been sighted during surveys of the Sulu Sea and central Philippines, including northern Mindanao (Dolar et al. 1997, 2006). Dolar et al. (2006) provided density and abundance estimates of 0.01 whales/km^2 and 326 dwarf sperm whales, respectively, for the Sulu Sea. There are also records for pygmy and dwarf sperm whales for Indonesia, including West Papua (Rudolph et al. 1997; Kahn and Pet 2003).

Kogia spp. are known to occur in Papua New Guinea, but there are no records for Palau, Micronesia, or the Solomon Islands (Miller 2007; SPREP 2012). However, there are strandings records for Guam, including five strandings of dwarf sperm whales and one stranding of a pygmy sperm whale (Kami and Lujan 1976; Eldredge 1991, 2003; Reeves et al. 1999). There are no records of *Kogia* sp. in or near the proposed survey area in the OBIS database (IOC 2013). Nonetheless, *Kogia* spp. could be encountered during the proposed surveys.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

Cuvier's beaked whale occurs throughout the deep waters of the western Pacific. In Southeast Asia, it is known to occur in Indonesia, including West Papua (Rudolph et al. 1997; Kahn and Pet 2003), and the Philippines (Rudolph and Smeenk 2002; Perrin et al. 2005). Dolar et al. (1997) reported one Cuvier's beaked whale sighting in the Sulu Sea, and Dolar et al. (2006) reported an unidentified ziphiid whale sighting in the Sulu Sea. Cuvier's beaked whale has also been sighted in the Mariana Islands (Masaki 1972 *in* Eldredge 2003; NMFS 2007). Cuvier's beaked whales were sighted on surveys during January–March 1976 off Papua New Guinea (Miyazaki and Wada 1978). There have been unconfirmed records in Micronesia, Palau, and the Solomon Islands (Miller 2007).

There are no OBIS sightings of Cuvier's beaked whale in or near the proposed survey area (IOC 2013). Nonetheless, this species could be encountered during the proposed surveys.

Longman's Beaked Whale (*Indopacetus pacificus*)

Sightings of Longman's beaked whale have occurred at many locations in tropical waters of the Indo-Pacific region (Rudolph and Smeenk 2002; Jefferson et al. 2008). In Southeast Asia, records for this species include the Philippines (Acebes et al. 2005; Aragones et al. 2010). A possible sighting was made in the Sulu Sea during surveys of the central Philippines in 1994 (Dolar et al. 2006). There are no records of this species for Palau, Micronesia, Papua New Guinea, or the Solomon Islands, and there are no OBIS sightings of Longman's beaked whale in or near the proposed survey area (IOC 2013). It is unlikely that this species could be encountered during the proposed surveys.

Ginkgo-toothed Beaked Whale (*Mesoplodon ginkgodens*)

The ginkgo-toothed whale is hypothesized to occupy tropical and warm temperate waters of the Indian and Pacific oceans (Pitman 2009). However, this species is mainly known from stranding records (Mead 1989; Jefferson et al. 2008). There is a report of a juvenile ginkgo-toothed whale that was caught near the proposed study area by a Taiwanese longliner in Micronesia at 4.43°N, 152.20°E (Dalebout et al. 2008). The species' occurrence has been confirmed in the Yellow and East China seas (Perrin et al. 2005). Sixteen unidentified *Mesoplodon* sp. sightings were made in the Sulu Sea during surveys of the central Philippines in May–June 1994 and 1995 (Dolar et al. 2006). However, there are no confirmed sightings for Palau, Papua New Guinea (Miller 2007; SPREP 2012), or Indonesia (Rudolph et al. 1997). There are no OBIS sightings in or near the proposed survey area (IOC 2013).

Blainville's Beaked Whale (*Mesoplodon densirostris*)

Blainville's beaked whale occurs in temperate and tropical waters of the western Pacific. In Southeast Asia, sighting and stranding records exist for the Philippines (Perrin et al. 2005; Aragones et al. 2010) but there are no records for Indonesia (Rudolph et al. 1997). A Blainville's beaked whale sighting was made in the Sulu Sea during surveys of the central Philippines during May–June 1994 and 1995 (Dolar et al. 2006). There have been unconfirmed records of Blainville's beaked whales for Papua New Guinea and the Solomon Islands, but there are no records for Micronesia or Palau (Miller 2007).

There are no OBIS sightings of Blainville's beaked whale in or near the proposed survey area (IOC 2013). Nonetheless, this species could be encountered during the proposed surveys.

Rough-toothed Dolphin (*Steno bredanensis*)

In the western Pacific, the rough-toothed dolphin occurs from northern Japan to Australia. In Southeast Asia, it is known to occur in the South China Sea (Perrin et al. 2005). The rough-toothed dolphin is the most commonly encountered species during surveys in the Babuyan Islands, off northern Philippines (Perrin et al. 2005), and has been sighted during surveys of the central Philippines (Dolar et al. 2006). There are also records for Indonesia (Rudolph et al. 1997; Khan and Pet 2003).

Sightings of rough-toothed dolphins have also been made during surveys in January–April 2007 in the Mariana Islands (SRS-Parsons et al. 2007; Fulling et al. 2011), but there are no records for Palau or Micronesia (Miller 2007; SPREP 2012). A possible sighting of rough-toothed dolphin was made in the Bismarck Sea off Papua New Guinea (Visser 2007), and they are known to occur in the Solomon Islands (Miller 2007; SPREP 2012).

There are no OBIS sightings of rough-toothed dolphin in or near the proposed survey area (IOC 2013). Nonetheless, this species could be encountered during the proposed surveys.

Common Bottlenose Dolphin (*Tursiops truncatus*)

In the western Pacific, the bottlenose dolphin is distributed from Japan to Australia and New Zealand. Bottlenose dolphins are found throughout the East and South China seas (Perrin et al. 2005), and have been sighted during surveys of the Sulu Sea and central Philippines, including northern Mindanao (Dolar et al. 1997, 2006). Dolar et al. (2006) provided density and abundance estimates of 0.11/km^2 and 2628 for the Sulu Sea. Bottlenose dolphins are also known to occur in Indonesia (Rudolph et al. 1997). During surveys off northern West Papua, Indonesia, Borsa and Nugroho (2010) reported a sighting of 12 bottlenose dolphins, and an encounter rate of 0.013 dolphins/km, but this sighting was not made in the Halmahera Sea. Bottlenose dolphins have also been sighted during surveys in January–April 2007 in the Mariana Islands (SRS-Parsons et al. 2007; Fulling et al. 2011). Trianni and Kessler (2002) also reported that bottlenose dolphins are seen in coastal waters of Guam.

Bottlenose dolphins are also known to occur in Micronesia, and there are unconfirmed records for Palau (Miller 2007). Sightings have also been made in Papua New Guinea, including the Bismarck Sea (Miyazaki and Wada 1978; Visser 2007), and during surveys in the Solomon Islands (Miyazaki and Wada 1978; Oremus 2011). There are two OBIS records of bottlenose dolphins in the Bismarck Sea, Papua New Guinea (IOC 2013).

Pantropical Spotted Dolphin (*Stenella attenuata*)

In the western Pacific Ocean, the pantropical spotted dolphin occurs from Japan south to Australia. They are found throughout the East and South China seas, including the Philippines (Parsons et al. 1995; Perrin et al. 2005) and Indonesia (Rudolph et al. 1997; Khan and Pet 2003). Pantropical spotted dolphins have been sighted during surveys of the Sulu Sea and central Philippines, including northern Mindanao (Dolar et al. 1997, 2006). Dolar et al. (2006) provided density and abundance estimates of 0.65/km^2 and 14,930 for the Sulu Sea. They have also been sighted during surveys in January–April 2007 in the Mariana Islands (SRS-Parsons et al. 2007; Fulling et al. 2011). During surveys in January–March 1976, Miyazaki and Wada (1978) reported sightings of pantropical spotted dolphins near Micronesia, and in the EEZs of Papua New Guinea and the Solomon Islands. There are also unconfirmed records for Palau (Miller 2007). Oremus (2011) also reported sightings of pantropical spotted dolphins in the Solomon Islands.

There are no OBIS sightings of pantropical spotted dolphin within or near the proposed survey area (IOC 2013). Nonetheless, this species could be encountered during the proposed surveys.

Spinner Dolphin (*Stenella longirostris*)

Two subspecies of spinner dolphin occur in the western Pacific: the widespread, offshore spinner dolphin (*Stenella longirostris longirostris*) and the dwarf spinner dolphin (*S. l. roseiventris*). There is little or no genetic interchange between the two subspecies (Dizon et al. 1991). *S. l. longirostris* is pantropical, occurring from Japan, through to the Philippines, and south to Australia; *S. l. roseiventris* only inhabits the shallow waters of inner Southeast Asia (Perrin et al. 1999). The spinner dolphin has been sighted during surveys of the Sulu Sea and central Philippines, including northern Mindanao; it is the most abundant marine mammal species in the area (Dolar et al. 1997, 2006). Dolar et al. (2006) provided density and abundance estimates of 1.37/km^2 and 31,512 for the Sulu Sea. Miyazaki et al. (1996) reported spinner dolphins during surveys off eastern Mindanao, Philippines, in January–March 1993–1995. During surveys off northern West Papua, Indonesia, the spinner dolphin was the most common cetacean species sighted, with encounter rates of 0.137–0.388/km (Borsa and Nugroho 2010). During those surveys, 19 sightings of spinner dolphins were made, 11 of which were reported for the Halmahera Sea.

The spinner dolphin is expected to occur throughout the Mariana Islands (Trianni and Kessler 2002; Jefferson et al. 2008), but only one sighting was made during a January–April 2007 survey in the area (SRS-Parsons et al. 2007; Fulling et al. 2011). Spinner dolphins are also known to occur in Micronesia and Palau (SPREP 2012). They have also been sighted in Papua New Guinea during surveys by Visser and Bonoccorso (2003) and Visser (2007); sometimes they were seen in association with killer whales (Visser and Bonoccorso 2003). Miyazaki and Wada (1978) also reported sightings of spinner dolphins in the EEZ of Papua New Guinea, and there were two sightings near the proposed survey sites WP-3 and WP-4. Spinner dolphins have also been sighted during surveys in the Solomon Islands (Miyazaki and Wada 1978; Oremus 2011).

There are three OBIS records of spinner dolphins in or near the proposed study area: one off northwestern Papua New Guinea, one near west New Britain, Papua New Guinea, and one in the Solomon Islands (IOC 2013).

Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin occurs in temperate and tropical regions of the western Pacific, ranging from Russian waters south to Australia and New Zealand. Striped dolphins are not considered common in Southeast Asia, but they are known to occur in the South China Sea, including the Philippines (Parsons et al. 1995; Perrin et al. 2005). Its presence in Indonesia is not confirmed (Rudolph et al. 1997; Perrin et al. 2005).

Striped dolphins were sighted during surveys in January–April 2007 in the Mariana Islands (SRS-Parsons et al. 2007; Fulling et al. 2011) and during surveys in Micronesia (Miyazaki and Wada 1978). Striped dolphins are also known to occur in Palau and the Solomon Islands, but there are no records for Papua New Guinea (Miller 2007; SPREP 2012). There are no OBIS sightings of striped dolphins in or near the proposed survey area (IOC 2013).

Fraser's Dolphin (*Lagenodelphis hosei*)

In Asia, Fraser's dolphin is known to occur in the East and South China seas (Parsons et al. 1995; Perrin et al. 2005). It was sighted during surveys of the Sulu Sea and central Philippines, including northern Mindanao (Dolar et al. 1997, 2006). Dolar et al. (2006) provided density and abundance estimates of 0.58/km^2 and 13,518 for the Sulu Sea. Miyazaki et al. (1996) also reported Fraser's dolphins during surveys off eastern Mindanao, Philippines, during January–March 1993–1995. Sightings have also been made off West Papua and other provinces throughout Indonesia (Rudolph et al. 1997; Kahn and Pet 2003).

Fraser's dolphins have also been sighted in the EEZs of Micronesia and Papua New Guinea during surveys by Miyazaki and Wada (1978). Fraser's dolphins are also known to occur in the Solomon Islands, and there are unconfirmed records for Palau (Miller 2007). There are no OBIS sightings of Fraser's dolphin in or near the proposed survey area (IOC 2013).

Risso's Dolphin (*Grampus griseus*)

In the western Pacific Ocean, Risso's dolphin ranges from the Kuril Islands to New Zealand and Australia. They are known to occur in the East and South China seas (Parsons et al. 1995; Perrin et al. 2005) and have been sighted in the Philippines (Perrin et al. 2005) and Indonesia (Rudolph et al. 1997; Khan and Pet 2003). Risso's dolphins have been sighted during surveys of the Sulu Sea and central Philippines, including northern Mindanao (Dolar et al. 1997, 2006). Dolar et al. (2006) provided density and abundance estimates of 0.03/km^2 and 1514 for the Sulu Sea. During surveys off northern West Papua, Indonesia, Borsa and Nugroho (2010) reported two Risso's dolphin sightings, with an encounter

rate of 0.016/km, but this sighting was not made in the Halmahera Sea (Borsa and Nugroho 2010). Sightings have also been made off Papua New Guinea, including the Bismarck Sea (Miyazaki and Wada 1978; Visser 2007). In addition, Risso's dolphin has been sighted during surveys in the Solomon Islands (Miyazaki and Wada 1978; Oremus 2011). No Risso's dolphins were sighted during the January–April 2007 survey in the Mariana Islands (SRS-Parsons et al. 2007), but Miyazaki and Wada (1978) reported a sighting within the EEZ of Guam. There are unconfirmed records for Palau, but no records for Micronesia (Miller 2007).

There are no OBIS sightings of Risso's dolphin in or near the proposed survey area (IOC 2013). Nonetheless, this species could be encountered during the proposed surveys.

Melon-headed Whale (*Peponocephala electra*)

The range of the melon-headed whale in the western Pacific includes the waters from Japan to Australia. In Southeast Asia, it is known to occur in the South China Sea, including the Philippines (Perrin et al. 2005) and Indonesia (Rudoph et al. 1997; Khan and Pet 2003). Strandings have also been reported for Indonesia, including West Papua (Wild And Science 2013). Melon-headed whales were sighted during surveys of the central Philippines, including northern Mindanao, with an estimated density of 0.04/km^2 and an abundance of 921 for the Sulu Sea (Dolar et al. 2006).

There are also records of this species for the Mariana Islands (Kami and Hosmer 1982; Donaldson 1983; SRS-Parsons et al. 2007; Jefferson et al. 2008; Fulling et al. 2011), and they have been sighted in Micronesia during surveys by Miyazaki and Wada (1978), in Palau (SPREP 2012), and in the Bismarck Sea off Papua New Guinea (Visser 2007). Melon-headed whales are known to occur in the Solomon Islands (Miller 2007; SPREP 2012). There are no OBIS sightings of melon-headed whale in or near the proposed survey area (IOC 2013).

Pygmy Killer Whale (*Feresa attenuata*)

Little is known about the pygmy killer whale in most of its range, but it is sighted frequently in the eastern tropical Pacific, Hawaii, and Japan (Donahue and Perryman 2009). Dolar et al. (2006) made one sighting of pygmy killer whales during surveys of the central Philippines, north of Mindanao. Pygmy killer whales have also been reported for Indonesia (Rudolph et al. 1997; Khan and Pet 2003) and the South China Sea (De Boer 2000).

There was one sighting of a group of six pygmy killer whales during surveys in January–April 2007 in the Mariana Islands (SRS-Parsons et al. 2007; Fulling et al. 2011). They are also known to occur in Palau and Papua New Guinea, but not in Micronesia (SPREP 2012). There are no OBIS sightings of pygmy killer whale in or near the proposed survey area (IOC 2013).

False Killer Whale (*Pseudorca crassidens*)

In the western Pacific, the false killer whale is distributed from Japan south to Australia and New Zealand. In Southeast Asia, the false killer whale is known to occur in the South China Sea, including the Philippines (De Boer 2000; Perrin et al. 2005) and Indonesia (Rudoph et al. 1997; Khan and Pet 2003). During surveys off northern West Papua, Indonesia, Borsa and Nugroho (2010) reported two sightings of false killer whales, one of which was made in the Halmahera Sea (Borsa and Nugroho 2010). The encounter rates in the Halmahera Sea and adjacent waters were 0.006–0.008/km (Borsa and Nugroho 2010).

Sightings have also been reported during surveys in January–April 2007 in the Mariana Islands (SRS-Parsons et al. 2007; Fulling et al. 2011), where there are an estimated 6000 false killer whales (Miyashita 1993). There are also unconfirmed records for Palau, but none for Micronesia (Miller 2007),

although one sighting was made near Micronesia at ~4.9°N, 138.6°E (Miyazaki and Wada 1978). Sightings have also been reported for Papua New Guinea, including the Bismarck Sea (Miyazaki and Wada 1978; Visser 2007). False killer whales have also been sighted during surveys in the Solomon Islands (Oremus 2011). In the OBIS database, there are two records of pygmy killer whales near the Manus Islands, Papua New Guinea, and one record off southern Papua New Guinea (IOC 2013).

Killer Whale (*Orcinus orca*)

In Asia, the killer whale is known to occur in the East China Sea and the Philippines (Perrin et al. 2005) as well as Indonesia (Rudolph et al. 1997; Khan and Pet 2003). A killer whale sighting was made during 1994–1995 surveys in the central Philippines (Dolar et al. 2006). There are a few sightings (most unconfirmed) of killer whales off Guam (Eldredge 1991), and there was a badly decomposed killer whale found stranded on Guam in August 1981 (Kami and Hosmer 1982).

Killer whales are also known to occur off Palau and Micronesia (SPREP 2012) and in Papua New Guinea (Visser 2007). Most sighting records are for Kimbe Bay, west New Britain, but sightings have also been made in other parts of the Bismarck Sea, including six sightings near the proposed survey Sites WP-5 and WP-6, and in the Solomon Sea (Visser and Bonoccorso 2003). Killer whales have been reported for 10 months of the year there, with group sizes ranging from one to ~20 (Visser and Bonoccorso 2003). Calves were mostly seen during April (Visser 2007). Killer whales are also known to occur in the Solomon Islands (Miller 2007; SPREP 2012). In the OBIS database, there is one record of a killer whale for the Solomon Islands, but none in the proposed survey area (IOC 2013).

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

The range of the short-finned pilot whale in the western Pacific includes the waters from Sakhalin Island, Russia, south to Australia and New Zealand. In Southeast Asia, it is known to occur in the South China Sea, including the Philippines and Indonesia (Perrin et al. 2005). Short-finned pilot whales were sighted during surveys of the Sulu Sea and central Philippines, including northern Mindanao (Dolar et al. 1997, 2006). Dolar et al. (2006) provided density and abundance estimates of 0.32/km^2 and 7493 for the Sulu Sea. During surveys off northern West Papua, Indonesia, Borsa and Nugroho (2010) reported a sighting of 18 short-finned pilot whales, with an encounter rate of 0.019/km, but this sighting was not made in the Halmahera Sea (Borsa and Nugroho 2010).

Short-finned pilot whales are known to occur in Micronesia (Miller 2007; SPREP 2012) and in the Mariana Islands (Miyashita et al. 1996). There were four sightings of short-finned pilot whales during a January–April 2007 survey in the Mariana Islands (SRS-Parsons et al. 2007; Fulling et al. 2011). There are no records for Palau (Miller 2007; SPREP 2012). Short-finned pilot whales have been sighted during surveys in the Solomon Islands (Oremus 2011), and they were sighted off Papua New Guinea during surveys in January–March 1976 (Miyazaki and Wada 1978). There are no OBIS sightings of short-finned pilot whale in or near the proposed survey area (IOC 2013).

V. TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

SIO requests an IHA pursuant to Section 101 (a)(5)(D) of the MMPA for incidental take by harassment during its planned seismic surveys in the tropical western Pacific Ocean during September–October 2013.

The operations outlined in § I have the potential to take marine mammals by harassment. Sounds will be generated by the GI airguns used during the surveys, by echosounders, and by general vessel operations. "Takes" by harassment will potentially result when marine mammals near the activities are exposed to the pulsed sounds generated by the GI airguns or echosounders. The effects will depend on the species of marine mammal, the behavior of the animal at the time of reception of the stimulus, as well as the distance and received level of the sound (see § VII). Disturbance reactions are likely amongst some of the marine mammals near the tracklines of the source vessel. No take by serious injury is anticipated, given the nature of the planned operations and the mitigation measures that are planned (see § XI, MITIGATION MEASURES). No lethal takes are expected.

VI. NUMBERS OF MARINE MAMMALS THAT COULD BE TAKEN

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in [section V], and the number of times such takings by each type of taking are likely to occur.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

VII. ANTICIPATED IMPACT ON SPECIES OR STOCKS

The anticipated impact of the activity upon the species or stock of marine mammal.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

- First we summarize the potential impacts on marine mammals of airgun operations, as called for in § VII. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.
- Then we summarize the potential impacts of operations by the echosounders. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.
- Finally, we estimate the numbers of marine mammals that could be affected by the proposed survey in the tropical western Pacific during September–October 2013. This section includes a description of the rationale for the estimates of the potential numbers of harassment "takes" during the planned survey, as called for in § VI.

Summary of Potential Effects of Airgun Sounds

The effects of sounds from airguns could include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). Permanent hearing impairment (PTS), in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not an injury (Southall et al. 2007). Although the possibility cannot be entirely excluded, it is unlikely that the project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. If marine mammals encounter the survey while it is underway, some behavioral disturbance could result, but this would be localized and short-term.

Tolerance

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Several studies have shown that marine mammals at distances more than a few kilometers from operating seismic vessels often show no apparent response. That is often true even in cases when the pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales and toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times mammals of all three types have shown no overt reactions. The relative responsiveness of baleen and toothed whales are quite variable.

Masking

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the seismic pulses. The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking. In general, masking effects of seismic pulses are expected to be minor, given the normally intermittent nature of seismic pulses.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Based on NMFS (2001, p. 9293), NRC (2005), and Southall et al. (2007), we believe that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or "taking". By potentially significant, we mean, 'in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations'.

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson et al. 1995; Wartzok et al. 2004; Southall et al. 2007; Weilgart 2007). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (e.g., Lusseau and Bejder 2007; Weilgart 2007). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many marine mammals would be present within a particular distance of industrial activities and/or exposed to a particular level of industrial sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important degree by a seismic program are based primarily on behavioral observations of a few species. Detailed studies have been done on humpback, gray, bowhead, and sperm whales. Less detailed data are available for some other species of baleen whales and small toothed whales, but for many species, there are no data on responses to marine seismic surveys.

Baleen Whales.—Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the cases of migrating gray and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Responses of *humpback whales* to seismic surveys have been studied during migration, on summer feeding grounds, and on Angolan winter breeding grounds; there has also been discussion of effects on the Brazilian wintering grounds. Off Western Australia, avoidance reactions began at 5–8 km from the array, and that those reactions kept most pods ~3–4 km from the operating seismic boat; there was localized displacement during migration of 4–5 km by traveling pods and 7–12 km by more sensitive resting pods of cow-calf pairs. However, some individual humpback whales, especially males, approached within distances of 100–400 m.

In the Northwest Atlantic, sighting rates were significantly greater during non-seismic periods compared with periods when a full array was operating, and humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic vs. non-seismic periods. On their summer feeding grounds in southeast Alaska, there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re 1 μPa on an approximate rms basis. It has been suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys, but data from subsequent years indicated that there was no observable direct correlation between strandings and seismic surveys.

There are no data on reactions of *right whales* to seismic surveys, but results from the closely related *bowhead whale* show that their responsiveness can be quite variable depending on their activity (migrating vs. feeding). Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with substantial avoidance occurring out to distances of 20–30 km from a medium-sized airgun source. However, more recent research on bowhead whales corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources.

Reactions of migrating and feeding (but not wintering) *gray whales* to seismic surveys have been studied. Off St. Lawrence Island in the northern Bering Sea, it was estimated, based on small sample sizes, that 50% of feeding gray whales stopped feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB re 1 μPa_{rms}. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast, and western Pacific gray whales feeding off Sakhalin Island, Russia.

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses; sightings by observers on seismic vessels off the United Kingdom from 1997 to 2000 suggest that, during times of good sightability, sighting rates for mysticetes (mainly fin and sei whales) were similar when large arrays of airguns were shooting vs. silent, although there was localized avoidance. Singing fin whales in the Mediterranean moved away from an operating airgun array.

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have

continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades. The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year, and bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years.

Toothed Whales.—Little systematic information is available about reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales, and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies. Seismic operators and marine mammal observers on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels. In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance. The beluga, however, is a species that (at least at times) shows long-distance (10s of km) avoidance of seismic vessels. Captive bottlenose dolphins and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys, but the animals tolerated high received levels of sound before exhibiting aversive behaviors.

Most studies of *sperm whales* exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses; in most cases the whales do not show strong avoidance, and they continue to call, but foraging behavior can be altered upon exposure to airgun sound. There are almost no specific data on the behavioral reactions of *beaked whales* to seismic surveys. However, some northern bottlenose whales remained in the general area and continued to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys. Most beaked whales tend to avoid approaching vessels of other types, and may also dive for an extended period when approached by a vessel. In any event, it is likely that most beaked whales would also show strong avoidance of an approaching seismic vessel, although this has not been documented explicitly.

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive of the mysticetes and some other odontocetes. A ≥170 dB disturbance criterion (rather than ≥160 dB) is considered appropriate for delphinids, which tend to be less responsive than the more responsive cetaceans.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds exposed to strong sounds. However, there has been no specific documentation of TTS let alone permanent hearing damage, i.e., PTS, in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions. Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds with received levels ≥180 dB and 190 dB re 1 μPa_{rms}, respectively (NMFS 2000). These criteria have been used in establishing the exclusion (=shut-down) zones planned for the proposed seismic survey. However, those criteria were established before there was any information about minimum received levels of sounds necessary to cause auditory impairment in marine mammals.

Recommendations for science-based noise exposure criteria for marine mammals, frequency-weighting procedures, and related matters were published by Southall et al. (2007). Those recommendations were never formally adopted by NMFS for use in regulatory processes and during mitigation

programs associated with seismic surveys, although some aspects of the recommendations have been taken into account in certain environmental impact statements and small-take authorizations. NMFS is currently moving toward adoption of new procedures taking at least some of the Southall et al. recommendations into account (Scholik-Schlomer 2012; NMFS 2013). The new noise exposure criteria for marine mammals will account for the now-available scientific data on TTS, the expected offset between the TTS and PTS thresholds, differences in the acoustic frequencies to which different marine mammal groups are sensitive (e.g., M-weighting or generalized frequency weightings for various groups of marine mammals, allowing for their functional bandwidths), and other relevant factors.

Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment (see § XI and § XIII). Also, many marine mammals and (to a limited degree) sea turtles show some avoidance of the area where received levels of airgun sound are high enough such that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves would reduce or (most likely) avoid any possibility of hearing impairment.

Non-auditory physical effects may also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong transient sounds. However, there is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, are especially unlikely to incur non-auditory physical effects. The brief duration of exposure of any given mammal, the deep water in the study area, and the planned monitoring and mitigation measures would further reduce the probability of exposure of marine mammals to sounds strong enough to induce non-auditory physical effects.

Possible Effects of Multibeam Echosounder and Sub-bottom Profiler Signals

The PEIS concluded in § 3.6.4.3, § 3.7.4.3 that operation of an MBES and SBP is not likely to impact mysticetes or odontocetes because the intermittent and narrow, downward-directed nature of the MBES and SBP acoustic sources would result in no more than one or two brief ping exposures of any individual animal, given the movement and speed of the vessel.

Numbers of Marine Mammals that could be "Taken by Harassment"

All anticipated takes would be "takes by harassment", involving temporary changes in behavior. The mitigation measures to be applied will minimize the possibility of injurious takes. (However, as noted earlier, there is no specific information demonstrating that injurious "takes" would occur even in the absence of the planned mitigation measures.) In the sections below, we describe methods to estimate the number of potential exposures to various received sound levels and present estimates of the numbers of marine mammals that could be affected during the proposed seismic program. The estimates are based on a consideration of the number of marine mammals that could be disturbed appreciably by operations with the pair of GI airguns to be used during ~1033 km of seismic surveys in the tropical western Pacific Ocean. The sources of distributional and numerical data used in deriving the estimates are described in the next subsection.

It is assumed that, during simultaneous operations of the GI airguns and the other sources, any marine mammals close enough to be affected by the MBES and SBP would already be affected by the GI airguns. However, whether or not the GI airguns are operating simultaneously with the other sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to the MBES and SBP, given their characteristics (e.g., narrow downward-directed beam) and other considerations described in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS. Such reactions are not considered to constitute "taking" (NMFS 2001). Therefore, no additional allowance is included for animals that could be affected by sound sources other than GI airguns.

Basis for Estimating "Take by Harassment"

The estimates are based on a consideration of the number of marine mammals that could be within the area around the operating GI airguns where the received levels (RLs) of sound >160 dB re 1 μPa_{rms} are predicted to occur (see Table 2). The estimated numbers are based on the densities (numbers per unit area) of marine mammals expected to occur in the area in the absence of a seismic survey. To the extent that marine mammals tend to move away from seismic sources before the sound level reaches the criterion level and tend not to approach operating GI airguns, these estimates are likely to overestimate the numbers actually exposed to the specified level of sounds. The overestimation is expected to be particularly large when dealing with the higher sound-level criteria, e.g., 180 dB re 1 μPa_{rms}, as animals are more likely to move away before RL reaches 180 dB than they are to move away before it reaches (for example) 160 dB re 1 μPa_{rms}. Likewise, they are less likely to approach within the ≥180 dB re 1 μPa_{rms} radius than they are to approach within the considerably larger ≥160 dB radius.

The only densities reported for the overall proposed survey area are for eight species sighted during vessel-based surveys in coastal and oceanic waters of the Sulu Sea, Philippines, covering an area of ~23,000 km^2, during May–June 1994 and 1995 (Dolar et al. 2006). To supplement those density data, we used densities for seven other species expected to occur in the proposed survey area that were sighted during a systematic vessel-based marine mammal survey in Guam and the southern Commonwealth of the Northern Mariana Islands (CNMI) during January–April 2007 (Fulling et al. 2011). The cruise area was defined by the boundaries 10–18°N 142–148°E, encompassing an area ~585,000 km^2. For five species not sighted in either survey but expected to occur in the proposed survey area, we also used densities for the "outer EEZ stratum" of Hawaiian waters, covering ~2,240,000 km^2, based on a survey conducted in August–November 2002 (Barlow 2006). All three surveys used standard line-transect protocols developed by NMFS Southwest Fisheries Science Center (SWFSC). Survey effort was 2313 km in the Sulu Sea, 11,033 km in the CNMI, and 13,500 km in Hawaii.

The densities mentioned above had been corrected, by the original authors, for trackline detection probability bias, and in one of the three areas, for availability bias. Trackline detection probability bias is associated with diminishing sightability with increasing lateral distance from the track line [$f(0)$]. Availability bias refers to the fact that there is less-than 100% probability of sighting an animal that is present along the survey track line, and it is measured by $g(0)$. Dolar et al. (2006) and Fulling et al. (2011) did not correct the CNMI densities for $g(0)$, which, for all but large (>20) groups of dolphins (where $g(0) = 1$), resulted in underestimates of density. Although there is some uncertainty about the representativeness of the data and the assumptions used in the calculations below, the approach used here is believed to be the best available approach.

The estimated numbers of individuals potentially exposed presented below are based on the 160-dB re 1 μPa_{rms} criterion for all cetaceans. It is assumed that marine mammals exposed to airgun sounds that strong could change their behavior sufficiently to be considered "taken by harassment". Table 4 shows the density estimates calculated as described above and the estimates of the number of different individual

marine mammals that potentially could be exposed to ≥160 dB re 1 μPa_{rms} during the seismic survey if no animals moved away from the survey vessel. The *Requested Take Authorization* is given in the far right column of Table 4. We have included a *Requested Take Authorization* for the mean group size for species for which densities were not available but for which there were sighting records in the proposed survey area, and for species whose calculated takes were less than the mean group size for that species. Mean group sizes used were from the surveys whose densities were used, or from Jefferson et al. (2008) for species not sighted during the surveys.

It should be noted that the following estimates of exposures to various sound levels assume that the proposed survey would be completed; in fact, the ensonified areas calculated using the planned number of line-kilometers ***have been increased by 25%*** to accommodate turns, lines that may need to be repeated, equipment testing, etc. As is typical during offshore ship surveys, inclement weather and equipment malfunctions are likely to cause delays and may limit the number of useful line-kilometers of seismic operations that can be undertaken. Also, any marine mammal sightings within or near the designated exclusion zones would result in the shut down of seismic operations as a mitigation measure. Thus, the following estimates of the numbers of marine mammals potentially exposed to 160-dB re 1 μPa_{rms} sounds are precautionary and probably overestimate the actual numbers of marine mammals that could be involved. These estimates assume that there would be no weather, equipment, or mitigation delays, which is highly unlikely.

Consideration should be given to the hypothesis that delphinids are less responsive to airgun sounds than are mysticetes, as referenced in both the PEIS and "Summary of Potential Airgun Effects" of this document. The 160-dB (rms) criterion currently applied by NMFS, on which the following estimates are based, was developed based primarily on data from gray and bowhead whales. The estimates of "takes by harassment" of delphinids given below are thus considered precautionary. New criteria for behavioral harassment based on dose-response-type curves or risk functions are being considered by NMFS. Available data suggest that the current use of a 160-dB criterion may be improved upon, as behavioral response may not occur for some percentage of odontocetes and mysticetes exposed to received levels >160 dB, while other individuals or groups may respond in a manner considered as taken to sound levels <160 dB (NMFS 2013). It has become evident that the context of an exposure of a marine mammal to sound can affect the animal's initial response to the sound (NMFS 2013).

Potential Number of Marine Mammals Exposed

The number of different individuals that could be exposed to airgun sounds with received levels ≥160 dB re 1 μPa_{rms} on one or more occasions can be estimated by considering the total marine area that would be within the 160-dB radius around the operating seismic source on at least one occasion, along with the expected density of animals in the area. The number of possible exposures (including repeated exposures of the same individuals) can be estimated by considering the total marine area that would be within the 160-dB radius around the operating airguns, including areas of overlap. During the proposed survey, the transect lines are widely spaced relative to the 160-dB distance. Thus, the area including overlap is 1.07 x the area excluding overlap, so a marine mammal that stayed in the survey area during the entire survey could be exposed slightly more than once, on average. However, it is unlikely that a particular animal would stay in the area during the entire survey. The numbers of different individuals potentially exposed to ≥160 dB re 1 μPa_{rms} were calculated by multiplying the expected species density times the anticipated area to be ensonified to that level during airgun operations excluding overlap. The area expected to be ensonified was determined by entering the planned survey lines into a MapInfo GIS, using the GIS to identify the relevant areas by "drawing" the applicable 160-dB buffer (see Table 1) around each seismic line, and then calculating the total area within the buffers.

TABLE 4. Densities and estimates of the possible numbers of individuals that could be exposed to ≥160 dB re 1 μPa_{rms} during SIO's proposed seismic surveys in the tropical western Pacific during September–October 2013. The proposed sound source is two 45-in^3 GI guns. Species in italics are listed under the ESA. The column of numbers in boldface shows the numbers of Level B "takes" for which authorization is requested.

Species	Reported Density (#/1000 km^2) Fulling et al. (2011)	Barlow (2006)[1]	Dolar et al (2006)	Correction Factor[2]	Estimated Density (#/1000 km^2)	Ensonified Area (km^2)	Calculated Take[3]	% of Regional Pop'n[4]	Requested Level B Take Authorization
Mysticetes									
Humpback whale						*1063.8*	*0*	*0.03*	***1***[5]
Minke whale						1063.8	0	0.01	**3**[5]
Bryde's whale	0.41				0.41	1063.8	0	0.01	**2**[5]
Omura's whale						1063.8	0	N/A	**2**[5]
Sei whale	*0.29*				*0.29*	*1063.8*	*0*	*0.02*	***2***[5]
Fin whale						*1063.8*	*0*	*0.04*	***7***[5]
Blue whale						*1063.8*	*0*	*N/A*	***2***[5]
Odontocetes									
Sperm whale	*1.23*				*1.23*	*1063.8*	*1*	*0.02*	***5***[5]
Pygmy sperm whale		3.19			3.19	1063.8	3	N/A	**3**
Dwarf sperm whale			10.00	0.5	5.00	1063.8	5	0.05	**5**
Cuvier's beaked whale		6.80			6.80	1063.8	7	0.04	**7**
Longman's beaked whale		0.45			0.45	1063.8	0	N/A	**18**[5]
Ginkgo-toothed beaked whale						1063.8	0	0.01	**2**[5]
Blainville's beaked whale		1.28			1.28	1063.8	1	0.01	**2**[5]
Rough-toothed dolphin	0.29				0.29	1063.8	0	0.01	**9**[5]
Bottlenose dolphin			110.00	0.5	55.00	1063.8	59	0.03	**59**
Pantropical spotted dolphin			650.00	0.5	325.00	1063.8	346	0.08	**346**
Spinner dolphin			1370.00	0.5	685.00	1063.8	729	0.10	**729**
Striped dolphin	6.16				6.16	1063.8	7	<0.01	**27**[5]
Fraser's dolphin			430.00	0.5	215.00	1063.8	229	0.08	**229**
Risso's dolphin			30.00	0.5	15.00	1063.8	16	0.02	**16**
Melon-headed whale			40.00	0.5	20.00	1063.8	21	0.07	**31**[5]
Pygmy killer whale	0.14				0.14	1063.8	0	0.02	**6**[5]
False killer whale	1.11				1.11	1063.8	1	0.06	**10**[5]
Killer whale		0.16			0.16	1063.8	0	0.08	**7**[5]
Short-finned pilot whale			320.00	0.5	160.00	1063.8	170	0.32	**170**

[1] Densities calculated from Table 4 of Barlow (2006) using the abundance in the outer EEZ stratum and the surface area of the stratum given on p. 452 of Barlow (2006)

[2] A correction factor of 0.5 was applied to the densities of Dolar et al. (2006) because those densities were from surveys that included coastal waters, and ~50% of the total ensonified area for the proposed surveys is in deep water, far offshore, where marine mammal densities are expected to be lower; see, e.g., densities in Fulling et al. (2011) and Barlow (2006)

[3] Calculated take is estimated density (reported density x correction factor) multiplied by the 160-dB ensonified area (including the 25% contingency)

[4] Requested takes expressed as percentages of the regional populations (Table 4); N/A means not available

[5] Requested take authorization was increased to group size for species for which densities were not available but that have been sighted in the proposed survey area and for species whose calculated takes were less than group size

Applying the approach described above, ~851 km^2 (~1063.8 km^2 including the 25% contingency) would be within the 160-dB isopleth on one or more occasions during the proposed survey. Because this approach does not allow for turnover in the mammal populations in the area during the course of the survey, the actual number of individuals exposed may be underestimated, although the conservative (i.e., probably overestimated) line-kilometer distances used to calculate the area may offset this. Also, the approach assumes that no cetaceans would move away or toward the trackline as the *Revelle* approaches in response to increasing sound levels before the levels reach 160 dB. Another way of interpreting the estimates that follow is that they represent the number of individuals that are expected (in the absence of a seismic program) to occur in the waters that would be exposed to ≥160 dB re 1 μPa_{rms}.

The estimate of the number of individual cetaceans that could be exposed to seismic sounds with received levels ≥160 dB re 1 μPa_{rms} during the proposed surveys is 1595 (Table 4). That total includes one cetacean listed as ***Endangered*** under the ESA, the sperm whale (0.03% of the regional population).

In addition, eight beaked whales (mostly Cuvier's beaked whale) could be exposed during the surveys (Table 4). Most (98.9%) of the cetaceans potentially exposed are delphinids; the spinner dolphin, pantropical spotted dolphin, and Fraser's dolphin are estimated to be the most common delphinid species in the area, with estimates of 729 (0.10% of the regional population), 346 (0.08%), and 229 (0.08%) exposed to ≥160 dB re 1 μPa_{rms}, respectively.

Conclusions

The proposed seismic survey will involve towing a pair of 45-in^3 GI airguns that introduce pulsed sounds into the ocean, along with simultaneous operation of an MBES and SBP. Routine vessel operations, other than the proposed airgun operations, are conventionally assumed not to affect marine mammals sufficiently to constitute "taking". No "taking" of marine mammals is expected in association with echosounder operations given the considerations discussed in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.

Cetaceans.—In § 3.6.7 and 3.7.7, the PEIS concluded that airgun operations with implementation of the proposed monitoring and mitigation measures may result in a small number of Level B behavioral effects in some mysticete and odontocete species in the in the Marianas QAA; that Level A effects were highly unlikely; and that operations were unlikely to adversely affect ESA-listed species.

In this IHA Application, estimates of the numbers of marine mammals that could be exposed to strong airgun sounds during the proposed program have been presented, together with the requested "take authorization". The estimated numbers of animals potentially exposed to sound levels sufficient to cause appreciable disturbance are very low percentages of the regional population sizes (Table 4). The estimates are likely overestimates of the actual number of animals that would be exposed to and would react to the seismic sounds. The reasons for that conclusion are outlined above. The relatively short-term exposures are unlikely to result in any long-term negative consequences for the individuals or their populations.

VIII. ANTICIPATED IMPACT ON SUBSISTENCE

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

There is subsistence hunting for sperm whales, as well as other cetaceans and dugongs in Indonesia (Reeves 2002; Marsh et al. n.d.). The hunting of Bryde's whales in the Philippines appears to be prohibited now, but dugongs are still taken there, as well as in Papua New Guinea (Marsh et al. n.d). However, the proposed activities are not expected to have any impact on the availability of the species or stocks for subsistence users.

IX. ANTICIPATED IMPACT ON HABITAT

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

The proposed seismic survey would not result in any permanent impact on habitats used by marine mammals or to the food sources they use. The main impact issue associated with the proposed activity will be temporarily elevated noise levels and the associated direct effects on marine mammals, as discussed in § VII, above. This section briefly reviews the conclusions of the PEIS about effects of airguns on fish and invertebrates.

Effects of seismic sound on marine invertebrates (crustaceans and cephalopods), marine fish, and their fisheries are discussed in § 3.2.4 and § 3.3.4 and Appendix D of the PEIS. The PEIS concluded that there could be changes in behavior and other non-lethal, short-term, temporary impacts, and injurious or mortal impacts on a small number of individuals within a few meters of a high-energy acoustic source, but that there would be no significant impacts of NSF-funded marine seismic research on populations.

X. ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF HABITAT ON MARINE MAMMALS

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, because operations will be limited in duration. However, a small minority of the marine mammals that are present near the proposed activity may be temporarily displaced as much as a few kilometers by the planned activity.

XI. MITIGATION MEASURES

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, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Marine mammals and sea turtles are known to occur in the proposed study area. To minimize the likelihood that impacts will occur to the species and stocks, GI airgun operations will be conducted in accordance with regulations by NMFS under the MMPA and the ESA, including obtaining permission for incidental harassment or incidental 'take' of marine mammals and other endangered species. The proposed activities will take place in the EEZs of Micronesia, Papua New Guinea, Indonesia, and the Philippines.

The following subsections provide more detailed information about the mitigation measures that are an integral part of the planned activities. The procedures described here are based on protocols used during previous SIO seismic research cruises as approved by NMFS, and on best practices recommended in Richardson et al (1995), Pierson et al. (1998), and Weir and Dolman (2007).

Vessel-based observers will watch for marine mammals (and sea turtles) near the seismic sources when they are in use. Mitigation and monitoring measures proposed to be implemented for the proposed seismic survey have been developed and refined in cooperation with NMFS during previous SIO and L-

DEO seismic studies and associated EAs, IHA applications, and IHAs. The mitigation and monitoring measures described herein represent a combination of the procedures required by past IHAs for other SIO and L-DEO projects. The measures are described in detail below.

The number of individual animals expected to be approached closely during the proposed activity will be small in relation to regional population sizes. With the proposed monitoring and shut-down provisions (see below), any effects on individuals are expected to be limited to behavioral disturbance. That is expected to have negligible impacts on the species and stocks.

The following subsections provide more detailed information about the mitigation measures that are an integral part of the planned activity.

Proposed Exclusion Zones

Received sound levels have been modeled by L-DEO's for two 45-in^3 Nucleus G. Guns in relation to distance and direction from the airguns (Fig. 2). In addition, propagation measurements of pulses from 2 GI airguns have been reported for shallow water (~30 m depth) in the Gulf of Mexico (Tolstoy et al. 2004). However, measurements were not made for the 2 GI airguns in deep water. Nonetheless, we propose to use the "Safety Zone" radii predicted by L-DEO's model for the proposed GI airgun operations in deep water, although they are likely conservative given that empirical results for other arrays (e.g., 6-, 10-, 12-and 20-airgun arrays) indicated that, for deep water (>1000 m), the L-DEO model tends to overestimate the received sound levels at a given distance (Tolstoy et al. 2004).

The PEIS defined a low-energy source as any towed acoustic source whose received level is ≤180 dB at 100 m, including any single or any two GI airguns and a single pair of clustered airguns with individual volumes of ≤250 in^3. In § 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applied a 100-m exclusion zone (EZ) for all low-energy acoustic sources in water depths >100 m. Consistent with the PEIS, that approach is used here for the pair of 45-in^3 GI airguns. A fixed full mitigation zone, or 160 dB EZ was not defined in the PEIS for the same suite of low-energy sources; therefore, L-DEO model results for 45-in^3 G Guns are used here to determine the 160 dB radius for the pair of 45-in^3 GI airguns.

Table 2 shows the 180-dB EZ for the pair of 45-in^3 GI guns based on the PEIS and the L-DEO modeled measurements for the 160-dB safety zone, the distances at which the rms sound levels are expected to be received in >1000-m and 100–1000 m water. Because the model results are for G Guns, which have more energy than GI airguns of the same size, the distances are overestimated. The 180-dB re 1 μPa_{rms} distance is the safety criterion as specified by NMFS (2000) for cetaceans. The 180-dB distance would also be used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects (e.g., Holst and Beland 2008; Holst and Smultea 2008; Hauser et al. 2008; Holst 2009; Antochiw et al. n.d.). If marine mammals or sea turtles are detected in or about to enter the appropriate EZ, the airguns would be shut down immediately.

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. Currently, NMFS is using those proposed levels as a starting point to revise the current acoustic criteria for determining at what received sound levels marine mammals are likely to incur injury from seismic operations; however, these updated criteria have not yet been finalized (NMFS 2013). NSF would be prepared to revise its procedures for estimating numbers of mammals should NMFS implement new acoustic criteria guidelines. However, currently the procedures are based on best practices noted by Pierson et al. (1998) and Weir and Dolman (2007).

Mitigation During Operations

Mitigation measures that will be adopted will include (1) vessel speed or course alteration, provided that doing so will not compromise operational safety requirements, (2) GI-airgun shut down within calculated exclusion zones, (3) ramp-up procedures. Although power-down procedures are often standard operating practice for seismic surveys, they will not be used here because powering down from two airguns to one airgun would make only a small difference in the 180- or 190-dB radius—probably not enough to allow continued one-airgun operations if a mammal or turtle came within the safety radius for two airguns.

Speed or Course Alteration

If a marine mammal or sea turtle is detected outside the EZ, based on its position and the relative motion, is likely to enter the EZ, the vessel's speed and/or direct course could be changed. This would be done if operationally practicable while minimizing the effect on the planned science objectives. The activities and movements of the marine mammal or sea turtle (relative to the seismic vessel) will then be closely monitored to determine whether the animal is approaching the applicable EZ. If the animal appears likely to enter the EZ, further mitigative actions will be taken, i.e., either further course alterations or a shut down of the seismic source. Typically, during seismic operations, the source vessel is unable to change speed or course and one or more alternative mitigation measures (see below) will need to be implemented.

Shut-down Procedures

If a marine mammal or turtle is detected outside the EZ but is likely to enter the EZ, and if the vessel's speed and/or course cannot be changed to avoid having the animal enter the EZ, the GI airguns will be shut down before the animal is within the EZ. Likewise, if a mammal or turtle is already within the EZ when first detected, the GI airguns will be shut down immediately.

Following a shut down, seismic activity will not resume until the marine mammal or turtle has cleared the EZ, or until the PSO is confident that the animal has left the vicinity of the vessel. The animal will be considered to have cleared the EZ zone if

- it is visually observed to have left the EZ, or
- it has not been seen within the zone for 15 min in the case of small odontocetes, and sea turtles, or
- it has not been seen within the zone for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales.

Ramp-up Procedures

A ramp-up procedure will be followed when the pair of GI airguns begins operating after a specified period without GI airgun operations. It is proposed that, for the present survey, this period would be 15 min. Ramp up will not occur if a marine mammal or sea turtle has not cleared the EZ as described earlier.

Ramp up will begin with one GI airgun 45 in^3, and the second GI airgun will be added after 5 min. During ramp up, the PSOs will monitor the EZ, and if marine mammals or turtles are sighted, a shut down will be implemented as though the full array were operational.

If the EZ has not been visible for at least 30 min prior to the start of operations in either daylight or nighttime, ramp up will not commence. If one GI airgun has operated, ramp up to full power will be permissible at night or in poor visibility, on the assumption that marine mammals and turtles will be alerted to the approaching seismic vessel by the sounds from the single GI airgun and could move away if they choose. A ramp up from a shut down may occur at night, but only where the safety radius is small

enough to be visible. Ramp up of the GI airguns will not be initiated if a sea turtle or marine mammal is sighted within or near the applicable exclusion zones during day or night.

XII. PLAN OF COOPERATION

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

Not applicable. The proposed activity will take place in the tropical western Pacific Ocean, and no activities will take place in or near a traditional Arctic subsistence hunting area.

XIII. MONITORING AND REPORTING PLAN

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding...

SIO proposes to sponsor marine mammal monitoring during the present project, in order to implement the proposed mitigation measures that require real-time monitoring, and to satisfy the anticipated monitoring requirements of the IHA.

SIO's proposed Monitoring Plan is described below. SIO understands that this Monitoring Plan will be subject to review by NMFS, and that refinements may be required.

The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same regions. SIO is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

Vessel-based Visual Monitoring

PSO observations will take place during daytime GI airgun operations and nighttime start ups of the airguns. GI airgun operations will be suspended when marine mammals or turtles are observed within, or about to enter, designated EZ [see § XI above] where there is concern about potential effects on hearing or other physical effects. PSOs will also watch for marine mammals and turtles near the seismic vessel for at least 30 min prior to the planned start of airgun operations. When feasible, PSOs will also

make observations during daytime periods when the seismic system is not operating for comparison of animal abundance and behavior.

Three PSOs will be appointed by SIO, with NMFS Office of Protected Resources concurrence. At least one PSO will monitor the EZ during seismic operations. PSOs will normally work in shifts of 4-hour duration or less. The vessel crew will also be instructed to assist in detecting marine mammals and turtles.

The *Revelle* is a suitable platform from which PSOs will watch for marine mammals and turtles. The *Revelle* has been used for that purpose during the routine CalCOFI (California Cooperative Oceanic Fisheries Investigations). Observing stations are located at the 02 level, with the observer eye level at ~10.4 m above the waterline. At a forward-centered position on the 02 deck, the view is ~240º; an aft-centered view includes the 100-m radius area around the GI airguns. The observer eye level on the bridge is ~15 m above sea level. Standard equipment for marine mammal observers will be 7 x 50 reticule binoculars and optical range finders. At night, night-vision equipment will be available. The observers will 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 shut down.

PSO Data and Documentation

PSOs will record data to estimate the numbers of marine mammals and turtles exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data will be used to estimate numbers of animals potentially 'taken' by harassment (as defined in the MMPA). They will also provide information needed to order a power down or shut down of the airguns when a marine mammal or sea turtle is within or near the EZ.

When a sighting is made, the following information about the sighting will 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.
2. Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare.

The data listed under (2) will 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.

All observations and shut downs will be recorded in a standardized format. Data will be entered into an electronic database. The accuracy of the data entry will be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations will provide

1. The basis for real-time mitigation (GI airgun shut down).
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 and turtles in the area where the seismic study is conducted.

4. Information to compare the distance and distribution of marine mammals and turtles relative to the source vessel at times with and without seismic activity.
5. Data on the behavior and movement patterns of marine mammals and turtles seen at times with and without seismic activity.

A report will be submitted to NMFS and NSF within 90 days after the end of the cruise. The report will describe the operations that were conducted and sightings of marine mammals and turtles near the operations. The report will provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report will summarize the dates and locations of seismic operations, and all marine mammal and turtle sightings (dates, times, locations, activities, associated seismic survey activities). The report will also include estimates of the number and nature of exposures that could result in "takes" of marine mammals by harassment or in other ways.

XIV. Coordinating Research to Reduce and Evaluate Incidental Take

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

SIO and NSF will coordinate the planned marine mammal monitoring program associated with the seismic survey with other parties that may have interest in this area. SIO and NSF will coordinate with applicable U.S. agencies (e.g., NMFS), and will comply with their requirements.

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