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 in the Southwest Pacific Ocean East of New Zealand, May–June 2015

submitted by

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to

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SUMMARY

The Scripps Institution of Oceanography (SIO) plans to support a research activity that would involve low-energy seismic surveys, coring, and heat-flow measurements at three sites off the east coast of New Zealand in May–June 2015. The research activity would be funded by the U.S National Science Foundation (NSF). 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 200–3000 m within the Exclusive Economic Zone (EEZ) and outside of the territorial waters of New Zealand. On behalf of SIO, the U.S. State Department will seek authorization from New Zealand for clearance to work within the EEZ. 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 waters of New Zealand. Several of these species are listed as ***endangered*** under the U.S. Endangered Species Act (ESA): the southern right, 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 surveys, heat-flow measurements, and sediment coring at three sites off the southeast coast of North Island and northeast coast of South Island, New Zealand in May–June 2015. The proposed survey areas are located between ~38.5°–42.5°S and ~174–180°E off the east coast of New Zealand (Fig. 1). Water depths in the survey area are ~200–3000 m. The seismic surveys would be conducted in the EEZ of New Zealand, outside of territorial waters. Seismic surveys would be collected in a total of nine grids of intersecting lines of two sizes (see Fig. 1) at exact locations to be determined in the field during 18 May–18 June 2015. Some minor deviation from these dates would be possible, depending on logistics and weather.

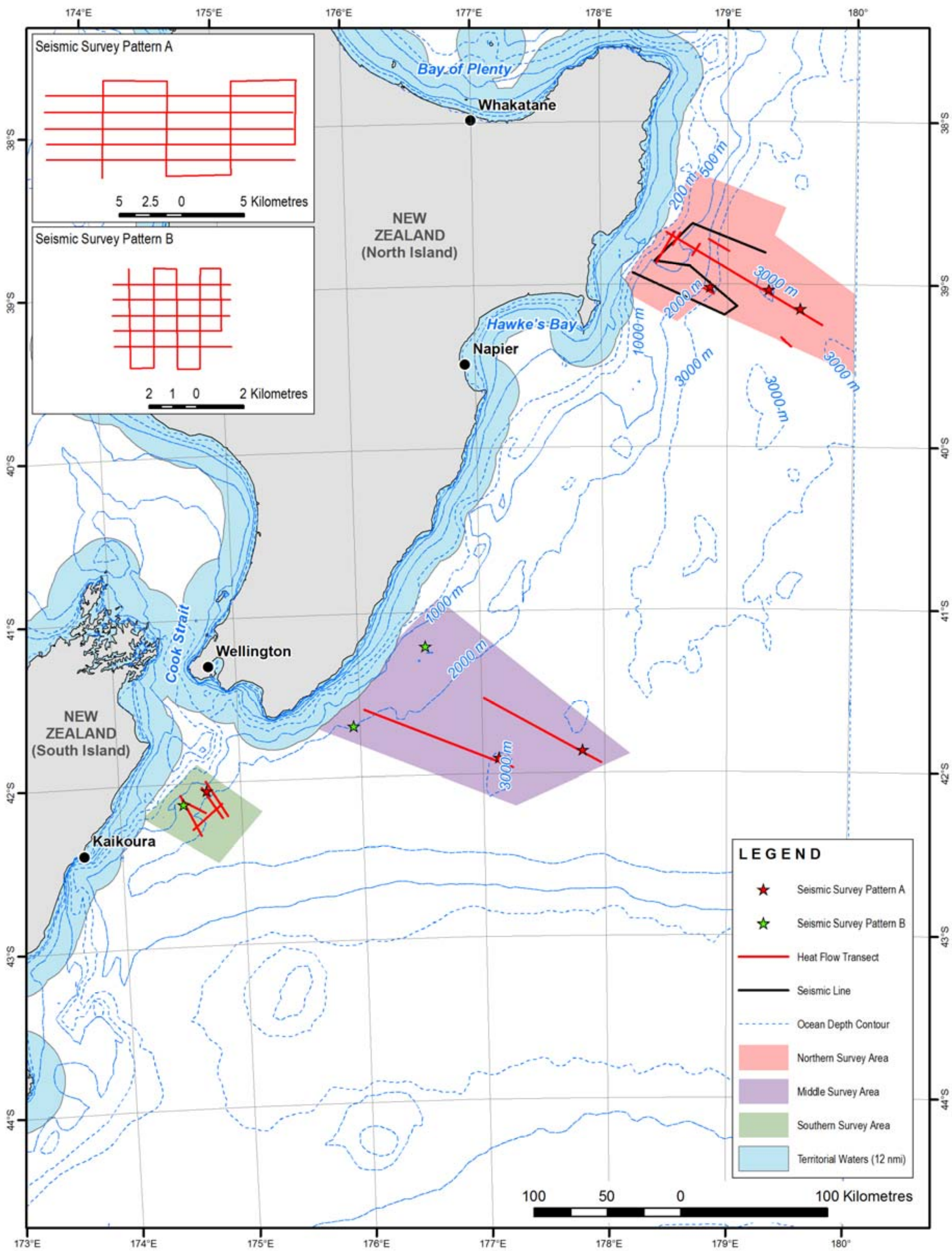

FIGURE 1. Locations of the proposed low-energy seismic survey and heat-flow measurement sites east of New Zealand, May–June 2015.

The proposed surveys would allow the development of a process-based understanding of the thermal structure of the Hikurangi subduction zone, and the expansion of this understanding by using regional observations of gas hydrate-related bottom-simulating reflections. To achieve the project's goals, the Principal Investigators (PIs), Drs. R.N. Harris and A. Tréhu (Oregon State University), propose to collect low-energy, high-resolution MCS profiles, heat-flow measurements, and sediment cores along transects seaward and landward of the Hikurangi deformation front. As noted previously, heat-flow measurements would be made in well-characterized sites, increasing the number of publicly available heat-flow and thermal conductivity measurements from this continental margin by two orders of magnitude. Seismic survey data would be used to produce sediment structural maps and seismic velocities to achieve the project objectives. Data from sediment cores would detect and estimate the nature and sources of fluid flow through high permeability pathways in the overriding plate and along the subduction thrust; characterize the hydrocarbon and gas hydrate system to assist with estimates of heat flow from BSRs, their role in slope stability, and fluid source; and elucidate the response of microbes involved in carbon cycling to changes in methane flux.

The procedures to be used for the seismic 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. Seismic surveys would be conducted while the heat-flow probe (see below) is being recharged.

Seismic surveys would be collected in a total of nine grids of intersecting lines of two sizes (see Fig. 1) at exact locations to be determined in the field. The water depths would be very similar to those at the nominal survey locations shown in Figure 1. The northern and middle sites off North Island are the primary study areas, and the southern site off South Island is a contingency area that would only be surveyed if time permits. Our calculations assume that seven grids at the primary areas and two grids at the southern site would be surveyed. The total track distance of the surveys would be ~1250 km, almost all (95%) in water depths >1000 m.

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 § IV(3)], 25% has been added for those additional operations.

Heat-flow measurements would be made using a "violin-bow" probe, 3.5 m long with 11 thermistors, that provides real time (analog) telemetry of the thermal gradient and in-situ thermal conductivity. Internal power allows 20–24 measurements during a single lowering of the tool, with profiles lasting as long as 48 h. Heat-flow measurements would have a nominal spacing of 0.5–1 km, which would be decreased in areas of significant basement relief or of large changes in gradient. Heat-flow transect locations are shown in Figure 1, and details of the probe and its deployment are given below. In total, ~200 heat-flow measurements would be made.

Details of the coring devices and their deployment are given below. Sediment cores would be collected at ~20 locations, mostly in the northern survey area.

In addition to the operations of the airgun array, heat-flow measurements, and coring, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) would also be operated from the *Revelle* continuously throughout the cruise. 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.

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 3000-hp Propulsion General Electric motors and an 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 μPa_{p-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.

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

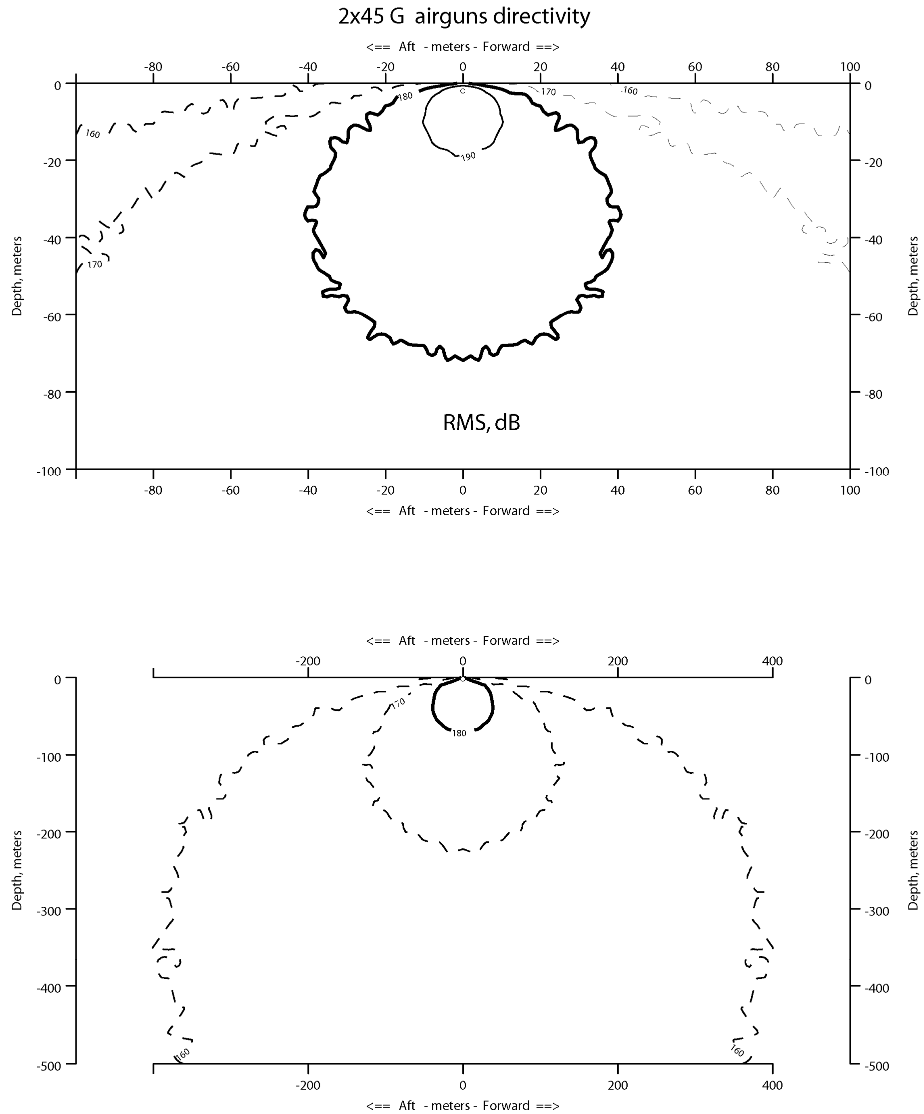

FIGURE 2. Modeled received sound levels from two 45-in^3 G. Guns, similar to the two 45-in^3 GI airguns that would be used during the SIO surveys off New Zealand during May–June 2015. Model results were provided by L-DEO.

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.

Table 1 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 190-dB EZ and 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. If marine mammals or sea turtles are detected in or about to enter the appropriate EZ, the airguns would be shut down immediately.

TABLE 1. Predicted distances to which 190 and 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 guns that would be used during the seismic surveys off New Zealand during May–June 2015 (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		
	190 dB	180 dB	160 dB
>1000 m	10	100 m	400 m
100–1000 m	15	100 m	600 m

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In December 2013, NOAA published draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013), although at the time of preparation of this Draft IHAA, the date of release of the final guidelines and how they will be implemented are unknown. As such, this IHAA has been prepared in accordance with the current NOAA acoustic practices, and the procedures are based on best practices noted by Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

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. 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. Seismic surveys would be conducted while the heat-flow probe (see below) is being recharged.

Seismic surveys would be collected in nine grids of intersecting lines of two sizes (see Fig. 1) at exact locations to be determined in the field. The water depths would be very similar to those at the nominal survey locations shown in Figure 1. The northern and middle sites off North Island are the primary study areas, and the southern site off South Island is a contingency area that would only be surveyed if time permits. Our calculations assume that seven grids at the primary areas and two grids at the southern site would be surveyed. The total track distance of the surveys would be ~1250 km, almost all (95%) in water depths >1000 m.

Heat-flow Probe Description and Deployment

The heat-flow probe to be used on the *Revelle* consists of a lance 6 cm in diameter and 3.5 m long, a sensor tube housing thermistors and heater wires, and a 560-kg weight stand. The probe is lowered to the bottom, and a 12-kHz pinger attached to the wire ~50 m above the instrument monitors the distance between the probe and bottom. The probe is driven into the sediment by gravity, and temperatures within the sediment are measured with equally spaced thermistors. On completion of a measurement, the instrument is hoisted 100–500 m above the sediment, the ship is maneuvered to a new position, and the process is repeated. Heat-flow measurements can generally be made at a rate of 1–2 h per measurement, ~15 min for the actual measurement and 45–90 min to reposition the ship and probe.

Heat-flow transect locations are shown in Figure 1, and details of the probe and its deployment are given in Section (f) below. In total, ~200 heat-flow measurements would be made.

Piston Core and Gravity Core Description and Deployment

The piston corer to be used on the R/V *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.

Sediment cores would be collected at ~20 locations, mostly in the northern survey area.

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 ~38.5°–42.5°S and ~174–180°E off the east coast of New Zealand, in the EEZ of New Zealand, outside of territorial waters (Fig. 1). Water depths in the survey area are ~200–3000 m. The exact dates of the activities depend on logistics and weather conditions. The *Revelle* would depart from Auckland, New Zealand, on 18 May 2015 and return to Napier, New Zealand, on 18 June 2015. Seismic operations would take ~135 h in total, and the remainder of the time would be spent in transit and collecting heat-flow measurements and cores.

III. SPECIES AND NUMBERS OF MARINE MAMMALS IN AREA

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

New Zealand is considered a hotspot for marine mammal species richness (Kaschner et al. 2011). Thirty-two marine mammal species, including 21 odontocetes, nine mysticetes, and two pinnipeds could occur in the proposed seismic survey areas (Table 2). 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.

Six of the 32 species are listed under the U.S. Endangered Species Act (ESA) as ***endangered***: the sperm whale, humpback whale, blue whale, fin whale, sei whale, and southern right whale. Two other species are ranked as *nationally critical* (Baker et al. 2010) but are not included in Table 3: Maui's dolphin (*Cephalorhynchu hectori maui*) is only found along the west coast of the North Island, and the northern range of the New Zealand sea lion (*Phocarctos hookeri*) is not expected to extend to the proposed survey area based on New Zealand's National Aquatic Biodiversity Information System (NABIS 2014).

TABLE 2. The habitat, occurrence, regional population sizes, and conservation status of marine mammals that could occur near the proposed seismic survey area off New Zealand, in the southwest Pacific Ocean.

Species	Habitat	Occurrence in study area during May-June	Regional population size[1]	U.S. ESA[2]	IUCN[3]	NZ[4]
Mysticetes						
Southern right whale	Coastal, shelf	Common	12,000[5]	EN	LC	NE
Pygmy right whale	Coastal, oceanic	Rare	N.A.	NL	DD	DD
Humpback whale	Coastal, oceanic	Common	42,000[5]	EN	LC	M
Bryde's whale	Coastal, oceanic	Very rare	48,109[6]	NL	DD	NC
Dwarf minke whale	Coastal, shelf	Uncommon	750,000[7,8]	NL	LC	NT
Antarctic minke whale	Coastal, oceanic	Uncommon	750,000[7,8]	NL	DD	NT
Sei whale	Mostly offshore, pelagic	Uncommon	10,000[7]	EN	EN	M
Fin whale	Oceanic	Uncommon	15,000[7]	EN	EN	M
Blue whale	Coastal, shelf, offshore	Uncommon	2300 true[5]; 1500 pygmy[7]	EN	EN	M
Odontocetes						
Sperm whale	Slope, oceanic; canyons	Common	30,000[7]	EN	VU	NT
Pygmy sperm whale	Outer shelf, oceanic	Uncommon	N.A.	NL	DD	DD
Cuvier's beaked whale	Mostly over slope	Uncommon	600,000[7,9]	NL	LC	DD
Shepherd's beaked whale	Oceanic	Rare	600,000[7,9]	NL	DD	DD
Southern bottlenose whale	Oceanic	Rare	600,000[7,9]	NL	LC	DD
Hector's beaked whale	Oceanic	Rare	600,000[7,9]	NL	DD	DD
Gray's beaked whale	Oceanic	~Common	600,000[7,9]	NL	DD	DD
Andrew's beaked whale	Oceanic	Rare	600,000[7,9]	NL	DD	DD
Strap-toothed whale	Oceanic	Uncommon	600,000[7,9]	NL	DD	DD
Blainville's beaked whale	Slope	Very rare	600,000[7,9]	NL	DD	DD
Spade-toothed whale	Presumed oceanic	Very rare	600,000[7,9]	NL	DD	DD
Common bottlenose dolphin	Coastal, shelf, offshore	Common	N.A.	NL[10]	LC	NE
Short-beaked common dolphin	Oceanic	Abundant	N.A.	NL	LC	NT
Dusky dolphin	Shelf, slope	Common	12,000-20,000 NZ[11]	NL	DD	NT
Hourglass dolphin	Oceanic	Uncommon	150,000[7]	NL	LC	DD
Southern right whale dolphin	Oceanic	Uncommon	N.A.	NL	DD	NT
Hector's dolphin	Nearshore	Rare	7,400[12]	NL[13]	EN	NE
False killer whale	Oceanic, occ. shelf	Uncommon	N.A.	NL	DD	NT
Killer whale	Coastal, occ. offshore	Common	80,000[7]	NL	DD	N[14]
Long-finned pilot whale	Mostly pelagic	Common	200,000[7]	NL	DD	NT
Short-finned pilot whale	Oceanic	Uncommon	N.A.	NL	DD	M
Pinnipeds						
New Zealand fur seal		Common	50,000-100,000 NZ[12]	NL	LC	NT
Southern elephant seal		Rare	607,000[11]	NL	LC	NC

NZ = New Zealand; N.A. = Not Available; ETP = Eastern Tropical Pacific; occ. = occasionally
[1] Abundance for the Southern Hemisphere or Antarctic unless otherwise noted
[2] U.S. Endangered Species Act (ESA) (NMFS 2014); EN = Endangered; NL = Not Listed
[3] Codes for classifications from IUCN Red List of Threatened Species (IUCN 2014): EN = Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient
[4] New Zealand Threat Classification System (Baker et al. 2010); NC = Nationally Critical; NE = Nationally Endangered; DD = Data Deficient; NT = Not Threatened; M = Migrant
[5] IWC (2014)
[6] IWC (1981)
[7] Boyd (2002)

[8] Dwarf and Antarctic minke whales combined
[9] All Antarctic beaked whales combined
[10] The Fiordland population in New Zealand is a candidate species for ESA listing
[11] NZDOC (2014)
[12] Suisted and Neale (2004)
[13] Candidate species for ESA listing
[14] Only Type A is considered nationally critical.

An additional 18 species are categorized as *vagrant* under the New Zealand Threat Classification System (Baker et al. 2010) and were not included in Table 3; these include Arnoux's beaked whale (*Berardius arnouxi*), Ginkgo-toothed whale (*Mesoplodon ginkgodens*), pygmy beaked whale (*M. peruvianus*), dwarf sperm whale (*Kogia sima*), spectacled porpoise (*Phocoena dioptrica*), Type B, C, D killer whale (*Orcinus orca*), melon-headed whale (*Peponocephala electra*), Risso's dolphin (*Grampus griseus*), Fraser's dolphin (*Lagenodelphis hosei*), pantropical spotted dolphin (*Stenella attenuata*), striped dolphin (*S. coeruleoalba*), rough-toothed dolphin (*Steno bredanensis*), Antarctic fur seal (*Arctocephalus gazelle*), Subantarctic fur seal (*A. tropicalis*), leopard seal (*Hydrurga leptonyx*), Weddell seal (*Leptonychotes weddellii*), crabeater seal (*Lobodon carcinophagus*), and Ross seal (*Ommatophoca rossi*).

According to Jefferson et al. (2008), the distributional range of two more species may include New Zealand: Hubb's beaked whale (*Mesoplodon carlhubbsi*) and True's beaked whale (*M. mirus*). However, these two species are not discussed further, as there are no records of Hubb's beaked whale in New Zealand, and only a single record of True's beaked whale, which stranded on the west coast of South Island in November 2011 (Constantine et al. 2014).

General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of marine mammals are given in § 3.6.1, § 3.7.1, and § 3.8.1 of the PEIS. One of the qualitative analysis areas (QAAs) defined in the PEIS, the Sub-Antarctic, is located to the east of New Zealand and the proposed survey area, at 42ºS, 145ºW. The general distribution of mysticetes, odontocetes, and pinnipeds in the western South Pacific Ocean is discussed in § 3.6.3.8, § 3.7.3.8, and § 3.8.3.4 of the PEIS, respectively. The rest of this section deals specifically with species distribution in the proposed survey areas off the coast of New Zealand.

Few systematic surveys have been conducted in the waters of New Zealand, and these mainly consist of single-species surveys in shallow coastal waters (e.g., Dawson et al. 2004; Slooten et al. 2004, 2006); large-scale, multi-species surveys are lacking. Below we use various sources to describe the occurrence of marine mammals in the waters of New Zealand, such as opportunistic sighting records presented in previous reports, including the New Zealand Department of Conservation marine mammal sightings database.

Mysticetes

Southern Right Whale (*Eubalaena australis*)

The southern right whale occurs throughout the Southern Hemisphere between ~20°S and 60°S (Kenney 2009). Right whales used to be widely distributed throughout New Zealand waters (Stewart and Todd 2001), but they were decimated by commercial whaling operations (Carroll et al. 2014). Their populations have been slow to recover (Patenaude and Baker 2001). However, numbers of right whales using the waters near the sub-Antarctic Auckland Islands have been increasing, and these islands appear to be primary wintering/calving areas for this species in New Zealand (Patenaude and Baker 2001), particularly Port Ross (Carroll et al. 2011a). Southern right whales are also known to winter at sub-Antarctic Campbell Island (Stewart and Todd 2001), as well as mainland New Zealand (Patenaude 2003). Movement of whales between the islands, as well as between the islands and the mainland (e.g., Patenaude et al. 2001; Childerhouse et al. 2010; Carroll et al. 2011b), suggests that right whales in New Zealand comprise a single stock (Carroll et al. 2011b). The population size in New Zealand was estimated at 2,169 individuals (Carroll et al. 2013).

Southern right whales calve in nearshore coastal waters during the winter and typically migrate to offshore feeding grounds during summer (Patenaude 2003). The Chatham Rise area is thought to be an important feeding area for right whales (Torres et al. 2013a). Based on a re-analysis of historical and other documents, Richards (2002) suggested that right whales arrived at South Island from sub-Antarctic waters during May and occurred in nearshore waters along the coast of New Zealand to calve. By October, whales had moved northward into offshore waters east of the Kermadec Islands, between 173 and 165°W, and 30 and 37°S, or over the northern half of the Louisville Ridge. During November, there was a marked shift southward and eastward, reaching 50°S around January. Clement (2010) noted that southern right whales likely use East Cape to navigate along the east coast of New Zealand during the northern and southern migrations.

Patenaude (2003) reported 110 sightings and 23 photo-identifications that were made between 1976 and 2002 around New Zealand. All of these records were for nearshore waters (generally within 200 m) along the three main islands of New Zealand. Patenaude (2003) noted that the majority of sightings were made during the winter (59%) and spring (23%), with fewer sightings during summer (7%) and fall (6%). Thirty percent of all sightings were made along the east coast of North Island, some of which occurred near the proposed northern survey area. The majority of sightings along the east coast of North Island were made within coastal waters of the East Coast/Hawke's Bay conservancy (Patenaude 2003). The area from Hawke's Bay to Bay of Plenty appears to be a primary calving area for right whales during August–November (Patenaude 2003). At least another 30 sightings have been reported for the region between Bay of Plenty and Hawke's Bay since 2008, mainly along the East Cape headland (Clement 2010). A right whale record for spring also exists for deep waters just to the south of the proposed southern survey area (Torres et al. 2013b). Patenaude (2003) reported a total of seven fall sightings off New Zealand; one sighting was made off North Island (Hauraki Gulf), there were two sighting records for eastern Cook Strait, one off Stewart Island, and three off South Island—one on the southwest and two on the southeast coast. Berkenbusch et al. (2013) reported 42 sightings during May–June 1970–2013.

During 2005, two right whales were reported on the west coast of New Zealand, two sightings were made at 35°15'S near Bay of Islands, and one sighting occurred north off Cape Reinga at 33°25'S (Richards 2009). In 2006, 64 sightings were reported off the North and South Islands, including one near Whangarei at 35°37'S (Richards 2009). During 2007, more than 60 sightings were made off the main islands of New Zealand, and in 2008, 43 sightings of at least 64 whales were made. In 2009, up to 1 August, more than 50 sightings had been made off North and South Islands (Richards 2009). In addition, there have been at least two strandings of southern right whales in New Zealand (Berkenbusch et al. 2013).

Habitat use modeling for New Zealand by Torres et al. (2013c) showed that the proposed survey areas have low habitat suitability for the southern right whale; sheltered coastal areas had the highest habitat suitability, at least during winter. Torres et al. (2013a,d) reported that southern right whale presence increases in water temperatures 7–13°C, with closer proximity to the subtropical front, and a mixed layer depth of <100 m.

The available information suggests that it is possible that southern right whales could be migrating through the proposed survey area at the time the survey is scheduled (May–June). However, the low population numbers indicate that few, if any, would be encountered. Thus, southern right whale sightings are likely to be uncommon in the project area during the austral fall.

Pygmy right whale (*Caperea marginata*)

The pygmy right whale's distribution is circumpolar in the Southern Hemisphere between 30°S and 55°S in oceanic and coastal environments (Jefferson et al. 2008; Kemper 2009). Pygmy right whales appear to be non-migratory, although there may be some movement inshore in spring and summer (Kemper 2002; Jefferson et al. 2008). Sightings of pygmy right whales in the southwestern Pacific Ocean are rare (Jefferson et al. 2008). Matsuoka et al. (2005) reported a sighting of 14 pygmy right whales at 46°26'S, 177°18'E in January 2001 that had been feeding in the area; this suggests that the Subtropical Convergence may be an important feeding area for this species during the austral summer (Matsuoka et al. 2005). In addition, Kemper et al. (2013) reported a sighting in very shallow water of Cook Strait during October 2002, and Berkenbusch et al. (2013) noted a sighting off the east coast of Northland. Other records include one whale that was captured at Stewart Island in 1874, and a skull that was trawled up by a fishing vessel at Chatham Rise (Kemper et al. 2013).

There have been at least 56 strandings in New Zealand, including at least eight live strandings (Kemper et al. 2013). Berkenbusch et al. (2013) reported 11 live strandings. Most strandings were concentrated at Stewart Island, Cook Strait, and the Auckland area; one stranding was also reported for Hawke's Bay (Kemper 2002). Strandings appear to be associated with favorable feeding areas in New Zealand, including upwelling regions, along the Subtropical Convergence, and the Southland Current (Kemper 2002; Kemper et al. 2013). Kemper et al. (2013) reported live strandings for the west coast of North Island (n = 4), Cook Strait (2), east coast of South Island (1), and Stewart Island (1). Records have been made throughout the year, but appear to be more frequent during austral spring and summer (Kemper et al. 2013).

Although Kemper (2009) noted that the number of strandings indicate that the pygmy right whale may be relatively common in Australia and New Zealand, it seems unlikely that this species would be encountered in the survey areas because of the scarcity of sightings.

Humpback Whale (*Megaptera novaeangliae*)

The humpback whale is found throughout all of the World's oceans (Jefferson et al. 2008). Although considered to be mainly a coastal species, humpback whales often traverse oceanic areas while migrating (Jefferson et al. 2008). Humpbacks migrate from winter breeding areas in the tropics to temperate or polar feeding areas in the summer (Jefferson et al. 2008). In the South Pacific Ocean, there are several distinct winter breeding grounds, including eastern Australia and Oceania (Anderson et al. 2010; Garrigue et al. 2011). Whales from Oceania migrate past New Zealand to Antarctic summer feeding areas (Constantine et al. 2007; Garrigue et al. 2000, 2010). The northern migration along the New Zealand coast occurs between May and August, with a peak in late June to mid July; the southern migration occurs from September to December, with a peak in late October to late November (Dawbin 1956). Dawbin (1956) suggested that northern migrating humpback whales travel along the east coast of South Island and then move along the east coast of North Island or through Cook Strait and up the west coast of North Island; smaller numbers migrate around southwestern South Island. Most southern migrating whales travel along the west coast of New Zealand, whereas some migrate along the east coast of North Island south to East Cape before moving to offshore waters (Dawbin 1956). Clement (2010) also noted that humpback whales likely use East Cape to navigate along the east coast of New Zealand during the northern and southern migrations. Humpback whales that migrate past New Zealand are likely part of the International Whaling Commission (IWC) Area V Antarctic management zone (Dawbin 1956; Constantine et al. 2007), and also part of IWC breeding stock E (Constantine et al. 2007).

Large numbers of humpback whales were taken around New Zealand during the commercial whaling era, and the recovery of humpbacks in those waters has been slow (Gibbs and Childerhouse 2000; Constantine et al. 2007). Gibbs and Childerhouse (2000) reported 157 sightings consisting of 437 live individuals for the east coast of New Zealand during 1970 to 1999; approximately half were from Kaikoura, on the east coast of South Island, and Cook Strait. Over half of the total sightings were made during May–August; most sightings were made off the eastern coast of South Island (Gibbs and Childerhouse 2000), although none were reported in the proposed southern survey area. Torres et al. (2013b) reported one summer humpback whale sighting in the proposed southern survey area near the 2000-m isobath, and several other humpback sightings just south of the southern survey area during spring, summer, and autumn. Gibbs and Childerhouse (2000) did not report any humpback records for the study areas off North Island, although numerous sightings were made in the Bay of Plenty to the northwest.

Since 1999, at least 30 additional sightings have been made between Hawke's Bay and Bay of Plenty (Clement 2010). Most sightings in the Bay of Plenty were made between August and January; sightings in the coastal waters of Gisborne District were made in June and July (Clement 2010). Several sightings of humpbacks have been reported for shelf waters adjacent to the northern survey area (Clement 2010). Clement (2010) noted that humpbacks regularly occur off eastern North Island during their migration, although they appear to be more prevalent in Hawke's Bay and coastal waters of the Gisborne District during fall migration. Clement (2010) also reported that humpbacks have been observed feeding in the Bay of Plenty before migrating south for the summer. In addition, there have been at least 20 humpback whale strandings in New Zealand (Berkenbusch et al. 2013).

A total of 34 whales were photo-identified off New Zealand during 1994–2004 (Constantine et al. 2007); most were sighted during a 2004 survey in Cook Strait (Gibbs and Childerhouse 2004 *in* Constantine et al. 2007). In addition, humpback whale vocalizations were detected off Great Barrier Island, northern New Zealand, from February through September 1997, with peak calling activity from May through September (McDonald 2006).

It is likely that some humpback whales will be encountered in the survey area during May–June as they migrate from summer feeding grounds in the Antarctic to winter breeding areas in the tropics.

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

The distribution of Bryde's whale is circumglobal, but it generally occurs in tropical and subtropical areas (Jefferson et al. 2008). In New Zealand, Bryde's whale distribution is largely restricted to warmer waters north of East Cape off North Island (Baker 1999), within ~18 km from shore (NABIS 2014). The west and southeast coast of North Island, including the proposed survey areas, are not included in the species range description by NABIS (2014). Baker (1999) noted that Bryde's whales migrate along the northeast coast of North Island on a seasonal basis. Bryde's whales are found in the Bay of Plenty, Hauraki Gulf, and the eastern coast of Northland throughout the year (O'Callaghan and Baker 2002; Clement 2010; NZDOC 2009; Baker and Madon 2007; Wiseman 2008; Baker et al. 2010; Wiseman et al. 2011; Berkenbusch et al. 2013). Bryde's whale vocalizations were also detected year-round off Great Barrier Island, northern New Zealand, during 1997 (McDonald 2006). Berkenbusch et al. (2013) noted that there were 33 strandings for New Zealand during 1970–2013, and Baker et al. (2010) reported 38 mortalities from 1989 to 2008, including vessel strikes.

Although there have been strandings along the coast adjacent to the northern survey area (Clement 2010), a sighting in offshore waters southeast of New Zealand (Berkenbusch et al. 2013), and three sightings within the South Taranaki Bight region (Torres 2012), Bryde's whale is unlikely to occur in the proposed survey areas.

Dwarf minke (*Balaenoptera acutorostrata*) and Antarctic minke whale (*B. bonaerensi*)

The common minke whale has a cosmopolitan distribution ranging from the tropics and sub-tropics to the ice edge in both hemispheres (Jefferson et al. 2008). Its distribution in the South Pacific is not well known (Jefferson et al. 2008). 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 during summer (Perrin and Brownell 2009). The range of the dwarf minke whale is thought to extend as far south as 65°S (Jefferson et al. 2008) and as far north as 11°S off Australia, where it can be found year-round (Perrin and Brownell 2009). The Antarctic minke whale has a circumpolar distribution in coastal and offshore areas of the Southern Hemisphere from ~7°S to the ice edge (Jefferson et al. 2008). Antarctic minke whales are found between 60°S and the ice edge during the austral summer; in the austral winter, they are mainly found at breeding grounds at mid latitudes, including 10°S–30°S and 170°E–100°W in the Pacific, off eastern Australia, western South Africa, and northeastern Brazil (Perrin and Brownell 2009).

Populations of minke whales around New Zealand are migratory (Baker 1983). Clement (2010) noted that minke whales likely use East Cape to navigate along the east coast of New Zealand during the northern and southern migrations. Small groups of minke whales have been sighted off New Zealand (Baker 1999; Clement 2010; Berkenbusch et al. 2013; Torres et al. 2013b). Clement (2010) noted that at least one to two common minke whales are seen annually in the Bay of Plenty from mid winter through early summer; however, according to Berkenbusch et al. (2013), minke whales have also occurred there during austral fall (May–June). Minke whale sightings have also been made during fall in Hawke's Bay and in eastern Cook Strait during summer (Berkenbusch et al. 2013). Offshore sightings east of North Island and South Island, including at Chatham Rise southeast of the proposed survey areas, have primarily been made during spring and summer, although sightings have also been reported for fall and winter (Berkenbusch et al. 2013; Torres et al. 2013b).

Between 1970 and 2013, there were 85 strandings of dwarf minke whales in New Zealand, including 34 live strandings (Berkenbusch et al. 2013). Strandings occurred along North and South Island, including Hawke's Bay, Cook Strait, and Bay of Plenty (Brabyn 1991). In addition, 17 Antarctic minke whales stranded in New Zealand between 1970 and 2013, including 10 live strandings (Berkenbusch et al. 2013).

Although minke whales are considered to be one of the most frequently sighted rorquals in the area, both species are likely to be uncommon in the proposed survey areas during May–June.

Sei Whale (*Balaenoptera borealis*)

The sei whale occurs in all ocean basins (Horwood 2009). It undertakes seasonal migrations to feed in sub-polar latitudes during summer, returning to lower latitudes during winter to calve (Horwood 2009). In the South Pacific, sei whale typically concentrate between the sub-tropical and Antarctic convergences during the summer (Horwood 2009).

Numerous sightings of sei whales have been made in New Zealand waters (Baker 1999; Clement 2010; Berkenbusch et al. 2013; Torres et al. 2013b). Although most sightings have been made during October–April (Clement 2010), there are records of this species throughout the year, including May and June (Berkenbusch et al. 2013). The majority of sightings are for the east coast of North Island in shelf waters, including the Hauraki Gulf, Bay of Plenty, and East Cape (Clement 2010; Berkenbusch et al. 2013); nonetheless, sightings have also been recorded for the east coast of South Island, Cook Strait, Stewart Island, the west coast of New Zealand, and the Chatham Islands (Berkenbusch et al. 2013). Large groups (>100 whales) and single sei whales have been reported for Bay of Plenty and the Hawke's

Bay area (Clement 2010). Some of the sightings have occurred in and near the proposed survey areas off North and South Island (see Clement 2010; Berkenbusch et al. 2013). Fall sightings have been reported for East Cape and eastern Cook Strait, as well as other areas around New Zealand (Berkenbusch et al. 2013). In addition, at least eight strandings have been reported for New Zealand, including strandings in the Bay of Plenty and Cook Strait (Brabyn 1991)

The sei whale is likely to be uncommon in the proposed survey area, especially during May–June.

Fin Whale (*Balaenoptera physalus*)

The fin whale occurs in all major oceans; however, its overall range and distribution is not well known (Jefferson et al. 2008). Northern and southern fin whale populations are distinct and are sometimes recognized as different subspecies (Aguilar 2009). In the Southern Hemisphere, fin whales are usually distributed south of 50ºS in the austral summer, and they migrate northward to breed in the winter (Gambell 1985).

Numerous sightings of fin whales have been made in New Zealand waters, mostly during spring and summer, although records exist throughout the year (Baker 1999; Clement 2010; Berkenbusch et al. 2013). The majority of sightings are for the east coast of North Island in shelf waters, including the Hauraki Gulf, Bay of Plenty, and East Cape (Clement 2010; Berkenbusch et al. 2013), although sightings have also been recorded for the east coast of South Island, Cook Strait, and the west coast of New Zealand (Berkenbusch et al. 2013). Some of the sightings have occurred in and near the proposed survey areas off North and South Island (see Clement 2010; Berkenbusch et al. 2013). Fall sightings have been reported for East Cape and Banks Peninsula, as well as other areas around New Zealand (Berkenbusch et al. 2013). Distant fin whale vocalizations were detected off Great Barrier Island, northern New Zealand, during June–September 1997 (McDonald 2006). At least 13 fin whale strandings have been reported for New Zealand, including strandings in Hawke's Bay, Bay of Plenty, and Cook Strait (Brabyn 1991).

Fin whales could be encountered during the proposed survey, as they migrate to winter breeding areas at the time of the survey.

Blue Whale (*Balaenoptera musculus*)

The blue whale has a cosmopolitan distribution, but tends to be mostly pelagic, only occurring nearshore to feed and possibly breed (Jefferson et al. 2008). Three subspecies of blue whale are recognized: *B. m. musculus* in the Northern Hemisphere; *B. m. intermedia* (the true blue whale) in the Antarctic, and *B. m. brevicauda* (the pygmy blue whale) in the sub-Antarctic zone of the southern Indian Ocean and the southwestern Pacific Ocean (Sears and Perrin 2009). The pygmy and Antarctic blue whales occur in New Zealand (Branch et al. 2007). The blue whale is considered rare in the Southern Ocean (Sears and Perrin 2009). Most pygmy blue whales do not migrate south during summer; however, Antarctic blue whales are typically found south of 55°S during summer, although some are known not to migrate (Branch et al. 2007).

Blue whales have been sighted throughout New Zealand waters year-round, with most sightings reported for the South Taranaki Bight and the east coast of Northland (Berkenbusch et al. 2013; Torres 2013). Most sightings off the east coast, including at East Cape and Bay of Plenty, occurred during spring and summer (Clement 2010; Berkenbusch et al. 2013). Fall sightings were made in Cook Strait, South Taranaki Bight, and offshore from Banks Peninsula (Berkenbusch et al. 2013; Olson et al. 2013; Torres 2013). Sightings have been made near the proposed northern and middle survey areas off North Island, as well as near the southern area off South Island during summer (Berkenbusch et al. 2013; Torres 2013; Torres et al. 2013b). One blue whale was sighted on the Chatham Rise south of the survey area during fall (Torres et al. 2013b).

Blue whale vocalizations specific to New Zealand waters were detected within 2 km from Great Barrier Island, northern New Zealand, from June to December 1997; Southern Ocean blue whale songs were detected further offshore during May–July (McDonald 2006). Blue whale vocalizations were also detected within the southern survey area off the northeastern South Island during March 2013 (Miller et al. 2013).

The South Taranaki Bight, between North and South Island, appears to be a foraging area for blue whales, as the upwelling in this area likely concentrates their euphausiid prey (Torres 2013). There are likely other feeding areas in New Zealand for blue whales (Olson et al. 2013). There have been 20 strandings of blue whales on the New Zealand coast (Torres 2013), including at least three strandings of pygmy blue whales (Berkenbusch et al. 2013). One blue whale stranding was reported for Hawke's Bay, several were reported in the South Taranaki Bight/Cook Strait area, and the remainder were spread out along the rest of the coastline (Torres 2013).

Based on the available information, it is possible that pygmy or true blue whales could be encountered in the proposed survey areas during May–June.

Odontocetes

Sperm Whale (Physeter macrocephalus)

Sperm whales have an extensive worldwide distribution which is linked to social structure: mixed groups of adult females and juveniles of both sexes generally occur in tropical and subtropical waters, whereas adult males are commonly found alone or in same-sex aggregations, often occurring in higher latitudes outside the breeding season (Best 1979; Rice 1989). Females typically inhabit waters >1000 m deep and latitudes <40° (Rice 1989). Torres et al. (2013a) found that sperm whale distribution is associated with proximity to geomorphologic features, as well as surface temperature.

Sperm whales are widely distributed throughout New Zealand waters, occurring in offshore and nearshore regions, with decreasing abundance away from New Zealand toward the central South Pacific Ocean (Gaskin 1973). Year-round sightings of sperm whales have been made throughout New Zealand waters, both close to shore and offshore (Berkenbusch et al. 2013; Torres et al. 2013b). Clement (2010) noted that male and female sperm whales likely migrate through the Hawke's Bay area during summer and fall. An aggregation of sperm whales is known to occur off Kaikoura Peninsula, on the northeastern coast of South Island; this area is almost exclusively used by males on a year-round basis (Lettevall et al. 2002; Richter et al. 2003). Letteval et al. (2002) reported that 192 sperm whales used the area off Kaikoura Peninsula over the course of 1990–2001. Some individuals spend several weeks or months in the area at a time, revisiting the location over several seasons; some other individuals are only seen once, and are considered transients (Jaquet et al. 2000; Letteval et al. 2002). The mean residency times of sperm whales in the area was 42 days, and the mean number of whales in the area at any one time was 13.8 (Lettevall et al. 2002). More recently, Sagnol et al. (2014) reported a mean of four sperm whales were present in the area at any one time.

Childerhouse et al. (1995) noted that 60 to 108 whales may be present off Kaikoura in any season. Whales in that area are seen closer to shore in the winter than in summer, possible because of changes in the distribution of their prey (Jaquet et al. 2000; Richter et al. 2003). During summer, almost all sightings are made in waters deeper than 1000 m, whereas during winter, sperm whale distribution is more diffuse, with more whales seen south of Kaikoura, over the Conway Trench and in waters 500–1000 m deep (Jaquet et al. 2000; Richter et al. 2003).

Sperm whale sightings have been reported throughout the year in and near the proposed northern and middle survey areas, as well as the southern survey area (Clement 2010; Berkenbusch et al. 2013;

Torres et al. 2013b). There have been at least 211 strandings reported for New Zealand (Berkenbusch et al. 2013), including along the coast of East Cape, and in Hawke's Bay and Cook Strait (Brabyn 1991).

Sperm whales, particularly adult males, are likely to be seen in the proposed survey areas during May–June.

Pygmy Sperm Whale (*Kogia breviceps*)

The pygmy sperm whale is distributed widely throughout tropical and temperate seas, but its precise distribution is unknown because much of what we know of the species comes from strandings (McAlpine 2009). Although there are few useful estimates of abundance for pygmy 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 South Pacific Ocean.

There have been very few sightings of pygmy sperm whales in New Zealand. The lack of sightings is likely because of their subtle surface behavior and long dive times (Clement 2010). Berkenbusch et al. (2013) reported one sighting off Banks Peninsula and one in the Bay of Plenty, and Clement (2010) mapped a sighting off the north coast of East Cape. The pygmy sperm whale is one of the most regularly stranded cetacean species in New Zealand, suggesting that this species is not uncommon in those waters (Clement 2010). A total of 355 strandings were reported between 1970 and 2013; nearly half of those (154) were live strandings (Berkenbusch et al. 2013). The East Cape/Hawke's Bay area seems to be a key area for this species, as stranding events are common there (Suisted and Neale 2004; Clement 2010; Berkenbusch et al. 2013). Half of all female strandings at Hawke's Bay involved calves, suggesting that this area is an important breeding ground (Brabyn 1991; Clement 2010; Berkenbusch et al. 2013). Based on stranding data, the pygmy sperm whale calving season in New Zealand is during summer months (Baker 1999).

Pygmy sperm whales are likely to occur near the survey areas.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

Cuvier's beaked whale is probably the most widespread of the beaked whales, although it is not found in polar waters (Heyning 1989). New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of Cuvier's beaked whales in the area (MacLeod et al. 2006). Beaked whale sightings in New Zealand primarily consist of *Mesoplodon* spp. and Cuvier's beaked whales (MacLeoad and Mitchell 2006), with sightings of Cuvier's beaked whale reported for the Bay of Plenty (Clement 2010). Cuvier's beaked whales also strand relatively frequently in New Zealand; at least 82 strandings have been reported (Berkenbusch et al. 2013). Strandings have been reported for East Cape, Mahia Peninsula, Hawke's Bay, Cook Strait, the southeast coast of North Island, and northeastern coast of South Island (Brabyn 1991; Clement 2010).

Cuvier's beaked whale could be encountered during the proposed surveys.

Shepherd's Beaked Whale (*Tasmacetus shepherdi*)

Based on known records, it is likely that Shepherd's beaked whale has a circumpolar distribution in the cold temperate waters of the Southern Hemisphere (Mead 1989a). This species is primarily known from strandings, most of which have been recorded in New Zealand (Mead 2009). Thus, MacLeod and Mitchell (2006) suggested that New Zealand may be a globally important area for Shepherd's beaked whale. One possible sighting was made near Christchurch (Watkins 1976). At least 20 specimens have stranded on the coast of New Zealand (Baker 1999), including in southern Taranaki Bight and Banks Peninsula (Brabyn 1991).

Shepherd's beaked whale could be encountered during the proposed surveys.

Southern Bottlenose Whale (*Hyperoodon planifrons*)

The southern bottlenose whale can be found throughout the Southern Hemisphere from 30°S to the ice edge, with most sightings occurring from ~57°S to 70°S (Jefferson et al. 2008). It is apparently migratory and is found in Antarctic waters during the summer (Jefferson et al. 2008). New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of southern bottlenose whales in the area (MacLeod et al. 2006). At least four sightings have been reported for waters around New Zealand, including one in Hauraki Gulf, one on the southwest coast of South Island, and two sightings south of New Zealand within the EEZ (Berkenbusch et al. 2013). In addition, 24 strandings were reported for New Zealand between 1970 and 2013 (Berkenbusch et al. 2013). Strandings have been reported for East Cape, Hawke's Bay, southern North Island, northeastern South Island, and Cook Strait (Brabyn 1991; Clement 2010).

The southern bottlenose whale could be encountered during the proposed surveys.

Hector's beaked whale (*Mesoplodon hectori*)

Hector's beaked whale is thought to have a circumpolar distribution in deep oceanic temperate waters of the Southern Hemisphere (Pitman 2002). Based on the number of stranding records for the species, it appears to be relatively rare. One individual was observed swimming close to shore off southwestern Australia for periods of weeks before disappearing (Gales et al. 2002). This was the first live sighting in which species identity was confirmed.

MacLeod and Mitchell (2006) suggested that New Zealand may be a globally important area for this species. There are sighting and stranding records of Hector's beaked whales for New Zealand (MacLeod et al. 2006; Clement 2010). One sighting has been reported for the Bay of Plenty on the North Island (Clement 2010). At least 12 strandings have been reported for New Zealand (Berkenbusch et al. 2013), including records for the Bay of Plenty, East Cape, Mahia Peninsula, Hawke's Bay, and Cook Strait (Brabyn 1991; Clement 2010).

Hector's beaked whale could be encountered during the proposed surveys.

Gray's beaked whale (*Mesoplodon grayi*)

Gray's beaked whale is thought to have a circumpolar distribution in temperate waters of the Southern Hemisphere (Pitman 2002). Gray's beaked whale primarily occurs in deep waters beyond the edge of the continental shelf (Jefferson et al. 2008). Some sightings have been made in very shallow water, usually of sick animals coming in to strand (Gales et al. 2002; Dalebout et al. 2004). One Gray's beaked whale was observed within 200 m of the shore off southwestern Australia off and on for periods of weeks before disappearing (Gales et al. 2002). There are many sighting records from Antarctic and sub-Antarctic waters, and in summer months they appear near the Antarctic Peninsula and along the shores of the continent (sometimes in the sea ice).

New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of Gray's beaked whales in the area (MacLeod et al. 2006). In particular, the area between the South Island of New Zealand and the Chatham Islands has been suggested to be a hotspot for sightings of this species (Dalebout et al. 2004). In addition, a mother and calf Grays' beaked whale was observed in Mahurangi Harbor on the North Island over five consecutive days in June 2001 (Dalebout et al. 2004). Gray's beaked whale is the most common beaked whale to strand in New Zealand with at least 252 records (Berkenbusch et al. 2013). Stranding records exist along the east coasts of North and South Islands, including Bay of Plenty, Mahia Peninsula, Hawke's Bay, and Cook Strait (Brabyn 1991; Clement 2010).

Gray's beaked whale could be encountered during the proposed surveys.

Andrew's beaked whale (*Mesoplodon bowdoini*)

Andrew's beaked whale has a circumpolar distribution in temperate waters of the Southern Hemisphere (Baker 2001). This species is known only from stranding records between 32°S and 55°S, with more than half of the strandings occurring in New Zealand (Jefferson et al. 2008). Thus, New Zealand may be a globally important area for Andrew's beaked whale (MacLeod and Mitchell 2006). In particular, Clement (2010) suggested that the East Cape/Hawke's Bay waters may be an important habitat for Andrew's beaked whale.

There have been at least 19 strandings in New Zealand (Berkenbusch et al. 2013), at least 10 of which have been reported in the spring and summer (Baker 1999). Strandings have occurred from the North Island to the sub-Antarctic Islands (Baker 1999), including East Cape, Hawke's Bay, and Cook Strait (Brabyn 1991; Clement 2010).

Andrew's beaked whale could be encountered during the proposed surveys.

Strap-toothed beaked whale (*Mesoplodon layardii*)

The strap-toothed beaked whale is thought to have a circumpolar distribution in temperate and sub-Antarctic waters of the Southern Hemisphere, mostly between 35° and 60°S (Jefferson et al. 2008). Based on the number of stranding records, it appears to be fairly common. Strap-toothed whales are thought to migrate northward from Antarctic and sub-Antarctic latitudes during April–September (Sekiguchi et al. 1996).

New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of strap-toothed beaked whales in the area (MacLeod et al. 2006; Clement 2010). Strap-toothed whales commonly strand in New Zealand, with at least 78 strandings reported (Berkenbusch et al. 2013). Most strandings occur between January and April, suggesting some seasonal austral summer inshore migration (Baker 1999). Strap-toothed whale strandings have been reported for the east coast of North Island and South Island, including the Bay of Plenty, East Cape, Hawke's Bay, and Cook Strait (Brabyn 1991; Clement 2010).

The strap-toothed beaked whale could be encountered during the proposed surveys.

Blainville's Beaked Whale (*Mesoplodon densirostris*)

Blainville's beaked whale is found in tropical and temperate waters of all oceans (Jefferson et al. 2008). It has the widest distribution throughout the world of all *Mesoplodon* species (Mead 1989b). According to Berkenbusch et al. (2013), there have been at least three strandings of Blainville's beaked whale in New Zealand. One stranding has been reported for the west coast of Northland and another for Hawke's Bay (Baker and van Helden 1999).

Blainville's beaked whale could be encountered during the proposed surveys.

Spade-toothed beaked whale (*Mesoplodon traversii*)

The spade-toothed beaked whale is the name proposed for the species formerly known as Bahamonde's beaked whale (*M. bahamondi*). Recent genetic evidence has shown that they belong to the species first identified by Gray in 1874 (van Helden et al. 2002). The species is considered relatively rare and is known from only four records, three of which are from New Zealand (Thompson et al. 2012). One mandible was found at the Chatham Islands in 1872; two skulls were found at White Island, Bay of Plenty, in the 1950s; a skull was collected at Robinson Crusoe Island, Chile, in 1986; and most recently, two live whales, a female and a male, stranded at Opape, in the Bay of Plenty, and subsequently died

(Thompson et al. 2012). MacLeod and Mitchell (2006) suggested that New Zealand may be a globally important area for the spade-toothed beaked whale.

The spade-toothed beaked whale could be encountered during the proposed surveys.

Common Bottlenose Dolphin (*Tursiops truncatus*)

The bottlenose dolphin is distributed worldwide in coastal and shelf waters of tropical and temperate oceans (Jefferson et al. 2008). There are two distinct bottlenose dolphin types: a shallow water type, mainly found in coastal waters, and a deep water type, mainly found in oceanic waters (Duffield et al. 1983; Hoelzel et al. 1998; Walker et al. 1999). In New Zealand, the inshore form appears to be more common than the offshore ecotype, and is restricted to waters north of 47°S in water <500 m deep (NABIS 2014). The offshore form occurs more widely (Baker et al. 2010), and is seen off eastern Northland during the summer and autumn (NABIS 2014). Baker et al. (2010) noted that there are 900–1000 bottlenose dolphins in inshore waters.

Although the bottlenose dolphin can occur along the entire coast of New Zealand, there are three hotspots (NABIS 2014) or main areas of distribution in New Zealand, including Northland, Marlborough Sounds, and Fiordland (Tezanos-Pinto et al. 2009). These three areas are treated as containing distinct populations that are mostly isolated from one another (Tezanos-Pinto et al. 2009). Even though the three populations occur in coastal waters, they are more similar to other offshore ecotypes than coastal ecotypes (Tezanos-Pinto et al. 2009).

Sightings of bottlenose dolphins have been made in shelf and deeper waters (>200 m) off the east coasts of North and South Islands throughout the year, including East Cape, Mahia Peninsula, Cape Palliser, and Cook Strait (Clement 2010; Berkenbusch et al. 2013). One sighting was made along the 2000-m isobath in the southern survey area, along with several other sightings on the Chatham Rise (see Torres et al. 2013b). Clement (2010) noted that in general, bottlenose dolphins in New Zealand occur closer to shore during summer and autumn, and farther offshore during winter. A total of 157 strandings were reported between 1970 and 2013 for New Zealand (Berkenbusch et al. 2013), including East Cape, Mahia Peninsula, and Cook Strait (Brabyn 1991; Clement 2010).

As sightings have been made near the proposed study areas during the austral autumn, it is likely that bottlenose dolphins would be encountered during the survey during May–June.

Short-beaked Common Dolphin (*Delphinus delphis*)

The common dolphin is found in tropical and warm temperate oceans around the world (Jefferson et al. 2008). It ranges as far south as 40°S in the Pacific Ocean, is common in coastal waters 200–300 m deep and is also associated with prominent underwater topography, such as seamounts (Evans 1994). Neumann (2001) noted that this species can be found in coastal and oceanic habitats.

Short-beaked common dolphins are found in shelf waters of New Zealand, generally north of Stewart Island; they are more commonly seen in waters along the northeastern coast of North Island (Stockin and Orams 2009; NABIS 2014) and may occur closer to shore during the summer (Neumann 2001; Stockin et al. 2008). They can be found all around New Zealand (Baker 1999) with abundance hotspots on the east coast occurring along Northland, Hauraki Gulf, Mahia Peninsula, Cape Palliser, Cook Strait, and Marlborough Sounds (NABIS 2014).

The short-beaked common dolphin is likely the most common cetacean species in New Zealand waters, occurring there year-round (Clement 2010; Hutching 2013). Numerous sightings have been made in shelf waters of the east coast of North and South Islands, as well as farther offshore, throughout the year, including near and within the proposed northern, middle, and southern survey areas (Clement 2010;

Berkenbusch et al. 2013). Clement (2010) reported that dense areas of sightings occur in offshore waters off East Cape and just to the south of Mahia Peninsula, especially during fall and summer. Feeding has also been observed in the shelf waters off East Cape, and calves are sighted regularly there (Clement 2010). Short-beaked common dolphins are generally seen at a mean distance of <10 km from shore in the summer, and move farther offshore in winter (Neumann 2001). In addition, 749 strandings were reported between 1950 and 2008, including records for East Cape, Hawke's Bay, and Cook Strait (Stockin and Orams 2009).

As sightings have been made near and within the survey areas during austral fall, this species could be encountered during the proposed surveys in May–June.

Dusky dolphin (*Lagenorhyncus obscurus*)

The dusky dolphin is widespread in the Southern Hemisphere, occurring in disjunct subpopulations in the waters off southern Australia, New Zealand (including some sub-Antarctic islands), central and southern South America (including the Falkland Islands), and southwestern Africa (Jefferson et al. 2008). The species occurs in coastal and continental slope waters and is uncommon in waters >2000 m deep (Würsig et al 2007). The dusky dolphin is common in New Zealand (Hutching 2013) and occurs there year-round. Dusky dolphins migrate northward to warmer waters in winter and south during the summer (Gaskin 1968).

The dusky dolphin occurs along the entire coast of South Island and the southern part of North Island, up to Hawke's Bay (Würsig et al. 2007; NABIS 2014); they are rarely seen north of East Cape (Baker 1999). Concentration hotspots include Marlborough Sounds and the northeastern coast of South Island, particularly around Kaikoura (NABIS 2014). The shallow waters around Kaikoura serve as a nursery for mother-calf pairs (Weir et al. 2008), with calving occurring between November and January (Würsig et al. 2007). Gaskin (1968) noted that they are the most common dolphin species in the Cook Strait/Banks Peninsula region. They are more often sighted around northern South Island and southern North Island waters during winter (Würsig et al. 1997).

Sightings of dusky dolphins exist for shelf as well as deep, offshore waters (Berkenbusch et al. 2013). Würsig et al. (2007) noted that dusky dolphin typically moves into deeper waters during the winter. Sightings have been made in the northern survey area, and adjacent to the middle and southern survey areas (see Clement 2010; Berkenbusch et al. 2013). Sightings in the austral fall have been made off East Cape, southeastern North Island, and northeastern South Island and Cook Strait (Berkenbusch et al. 2013). Several sightings have been made along the 500-m isobath on the Chatham Rise, south of the survey areas (Torres et al. 2013b). In addition, at least 107 strandings have been reported for New Zealand (Berkenbusch et al. 2013), including records for East Cape, Hawke's Bay, Cape Palliser, and Cook Strait (Brabyn 1991; Clement 2010).

The dusky dolphin could be encountered during the proposed surveys.

Hourglass Dolphin (*Lagenorhynchus cruciger*)

The hourglass dolphin occurs in all parts of the Southern Ocean south of ~45°S, with most sightings between 45°S and 60°S (Goodall 2009). Although it is pelagic, it is also sighted near banks and islands (Goodall 2009). Baker (1999) reported that the hourglass dolphin is considered a rare coastal visitor to New Zealand. Berkenbusch et al. (2013) reported five sightings of hourglass dolphins in New Zealand waters, including one off Banks Peninsula, one off the southeast coast of South Island, and three south of New Zealand; all sightings were made during November–February. In addition, there have been at least five strandings in New Zealand (Berkenbusch et al. 2013), including records for the South Island (Baker 1999).

The hourglass dolphin likely would be rare in the proposed survey area.

Southern Right Whale Dolphin (*Lissodelphis peronii*)

The southern right whale dolphin is distributed between the Subtropical and Antarctic Convergences in the Southern Hemisphere, generally between ~30ºS and 65ºS (Jefferson et al. 2008). It is sighted most often in cool, offshore waters, although it is sometimes seen near shore where coastal waters are deep (Jefferson et al. 2008).

The species has rarely been seen at sea in New Zealand (Baker 1999). Berkenbusch et al. (2013) reported five sightings for the EEZ of New Zealand, including one each off the southeast coast and southwest coast of South Island, and three to the southeast of Stewart Island; sightings were made during February and September. During August 1999, a group 500+ southern right whale dolphins including a calf were sighted southeast of Kaikoura in water >1500 m deep (Visser et al. 2004). There were five additional sightings in the OBIS database, including one sighting in the South Taranaki Bight, two sightings southeast of Kaikoura during 1985–1986, and two sightings off the southwest coast of South Island (OBIS 2014).

At least 16 strandings have been reported for New Zealand (Berkenbusch et al. 2013). Most strandings have occurred along the north coast of South Island (Brabyn 1991), but one stranding was also reported for Hawke's Bay (Clement 2010).

The southern right whale dolphin could be encountered during the proposed surveys.

Hector's dolphin (*Cephalorhynchus hectori*)

Hector's dolphin is endemic to New Zealand and has one of the most restricted distributions of any cetacean (Dawson and Slooten 1988); it occurs in New Zealand waters year-round (Berkenbusch et al. 2013). Hector's dolphin (*C. h. hectori*) occurs around South Island, and Maui's dolphin (*C. h. maui*) is restricted to the northern west coast of North Island (Baker et al. 2002). Occasional sightings are made off the eastern coast of North Island (Berkenbusch et al. 2013), but it is unknown whether these individuals are from the South Island or the North island populations (Clement 2010).

There are at least three genetically separate populations off South Island: off the east coast (particularly around Banks Peninsula); off the west coast; and off the Southland coast (Baker et al. 2002). Hector's dolphins occur in coastal waters (Slooten et al. 2006). During summer on the east coast around Banks Peninsula, Hector's dolphins tend to aggregate in shallow waters close to shore. During winter, the distribution extends farther offshore, up to 33 km on shallow shelf areas (Rayment et al. 2006; Slooten et al. 2005). In general, Hector's dolphins prefer waters <90 m deep (Bräger et al. 2003; Rayment et al. 2006; Slooten et al. 2006) within 10 km from shore (Hutching 2013). However, several offshore sightings have also been made, including off Mahia and Banks Peninsula (Berkenbusch et al. 2013), with the farthest sighting at 60 km from shore (Hutching 2013). Sightings have been made in shallow (<100 m) water adjacent to the northern, middle, and southern survey areas (Berkenbusch et al. 2013). In addition, there have been at least 249 strandings of Hector's dolphin in New Zealand (Berkenbusch et al. 2013).

Habitat use modeling by Torres et al. (2013c) showed that nearshore waters adjacent to the southern survey area on the northeast coast of South Island have moderate to high habitat suitability for Hector's dolphin, at least during the winter. The highest habitat suitability occurred in shallow, coastal waters around South Island; suspended particulate matter, dissolved organic matter, wave height, and sea surface temperature were important predictors of suitable habitat (Torres et al. 2013c).

The occurrence of Hector's dolphins in the project area during May–June likely would be rare because of their nearshore distribution.

False Killer Whale (*Pseudorca crassidens*)

The false killer whale is found in all tropical and warmer temperate oceans, especially in deep, offshore waters (Odell and McClune 1999), but is also known to occur over the continental shelf and in nearshore shallow waters on occasion (Jefferson et al. 2008). In the western Pacific, the false killer whale is distributed from Japan south to Australia and New Zealand.

There have been at least 27 sightings of false killer whales in New Zealand during summer and fall, primarily along the coast of North Island, but also off South Island and in South Taranaki Bight (Berkenbusch et al. 2013). Several sightings have been reported for the Bay of Plenty, East Cape, and off northeastern South Island (Clement 2010; Berkenbusch et al. 2013). During 20 and 25 January 2011, two groups of false killer whales, consisting of 150 and 30 individuals, respectively, were seen cooperatively feeding with common bottlenose dolphins in Hauraki Gulf (Zaeschmar et al. 2013). On 25 March 2010, a group of eight killer whales was observed in the Bay of Islands attacking a group of 50–60 false killer whales that included ~15 calves (Visser et al. 2010). In addition, there have been at least 16 strandings in New Zealand (Berkenbusch et al. 2013), including East Cape, Hawke's Bay, and Cape Palliser (Brabyn 1991; Clement 2010). These strandings include a mass stranding on North Island (~37°S) of 231 whales in March 1978 (Baker 1999).

The false killer whale could be encountered during the proposed surveys.

Killer Whale (*Orcinus orca*)

The killer whale is cosmopolitan and globally fairly abundant; it has been observed in all oceans of the world (Ford 2009). It is very common in temperate waters and also frequents tropical waters (Heyning and Dahlheim 1988). The killer whale has been reported to be common in New Zealand waters (Baker 1999), with a population of ~200 individuals (Suisted and Neale 2004).

Killer whales have been sighted in all months around North and South Islands (Berkenbusch et al. 2013; NABIS 2014; Torres 2012). Calves and juveniles also occur there throughout the year (Visser 2000). Only the Type A killer whale is considered resident in New Zealand, while Types B, C, and D are vagrant and most common in the Southern Ocean (Visser 2000, 2007; Baker et al. 2010). Visser (2000, 2007) suggested that there might be three killer whale subpopulations in New Zealand, including off North Island, South Island, and one population that moves between the two regions. Visser (2000) noted that the east coast of North Island appears to be an important region for North Island and North-South populations. Killer whale sightings occur within 37 km of New Zealand throughout the year, but appear to occur more frequently off the southern part of North Island and the northernmost part of South Island from November through February (Visser 2007).

Killer whales sightings have been made in nearshore and offshore waters of New Zealand year-round, including sightings in and near the northern, middle, and southern study areas (Berkenbusch et al. 2013). Sightings have also been made in the northern study area, and off East Cape and Hawke's Bay (Clement 2010; Torres et al. 2013b). Pods of killer whales are known to frequent Wellington Harbour during the spring and summer (NZDOC 2014). In addition, there have been at least 45 strandings of Type A killer whales in New Zealand (Berkenbusch et al. 2013).

During winter, killer whales are usually found farther offshore, up to 150 km (Clement 2010). Habitat use modeling by Torres et al. (2013c) showed that the proposed survey areas likely have average to above average habitat suitability for killer whales. Sea surface temperature was the most important habitat predictor (Torres et al. 2013c).

As sighting of killer whales have been made near and within the survey areas during the austral fall, killer whale sightings may occur in small numbers near the project area during May–June.

Short-finned (*Globicephala macrorhynchus*) and Long-finned Pilot Whales (*G. melas*)

The short-finned pilot whale is found in tropical and warm temperate waters, and the long-finned pilot whale is distributed antitropically in cold temperate waters (Olson 2009). The ranges of the two species show little overlap, but both species are known to occur off North Island, New Zealand (Olson 2009). Short-finned pilot whale distribution does not generally range south of 40°S (Jefferson et al. 2008).

Pilot whales (*Globicephala* sp.) have been sighted in the coastal and offshore waters of New Zealand year-round, including in and near the northern, middle, and southern survey areas (Berkenbusch et al. 2013). Pilot whales also commonly strand en masse in New Zealand (Baker 1999; O'Callaghan et al. 2001). There have been at least 280 strandings of long-finned pilot whales and at least 12 short-finned pilot whale strandings in New Zealand (Berkenbusch et al. 2013). Short-finned and long-finned pilot whale stranding records exist for East Cape and Hawke's Bay (Clement 2010), and strandings for long-finned pilot whales have also been reported for Cook Strait (Brabyn 1991).

Most pilot whales sighted south of ~40°S likely would be the long-finned variety; however, short-finned pilot whales could also be encountered during the survey, particularly in the northern survey area.

Pinnipeds

New Zealand Fur Seal (*Arctocephalus forsteri*)

The New Zealand fur seal occurs throughout New Zealand waters and is the most common seal in the area (NZDOC 2014). It can be found on rocky shores of the mainland, the Chatham Islands, and sub-Antarctic islands (NABIS 2014; NZDOC 2014). The New Zealand fur seal population is expanding, with migrating seals colonizing new locations and haul-out sites becoming new breeding colonies (Bradshaw et al. 2000).

Large breeding colonies occur on the west and southern coast and islands around South Island; smaller colonies occur on North Island, including the east coast of Cape Palliser, and on the northeast coast of South Island (NABIS 2014). Marlborough Sounds, the Cook Strait area, and northeastern South Island are hotspots for New Zealand fur seal distribution (NABIS 2014). There are at least 15 haul-out sites and three breeding areas between Cape Palliser and Bay of Plenty, including haul out sites along Hawke's Bay (Clement 2010). There are also two haul-out sites adjacent to the southern survey area on (Taylor et al. 1995).

Pupping occurs from November to January; during this time, females stay close to breeding locations and foraging trips do not extend past the continental shelf (Harcourt et al. 1995). During autumn and winter, foraging occurs farther from the breeding sites, with trips extending more than 150 km from breeding sites, and into water depths >1000 m (Harcourt and Davis 1997; Harcourt et al. 2002).

It is likely that New Zealand fur seals would be encountered during the proposed survey, especially during May–June, when they tend to occur farther offshore.

Southern Elephant Seal (*Mirounga leonina*)

The southern elephant seal has a near circumpolar distribution in the Southern Hemisphere (Jefferson et al. 2008). However, the distribution of southern elephant seals does not typically extend to the proposed survey area (NABIS 2014). Breeding colonies occur on some New Zealand sub-Antarctic islands, including Antipodes and Campbell Islands (Suisted and Neale 2004); these are part of the

Macquarie Island stock of southern elephant seals (Taylor and Taylor 1989). Pups are occasionally born during September–October on east coast beaches of the mainland, including the southern coast of South Island (between Oamaru and Nugget Point), Kaikoura Peninsula, and on the southeast coast of North Island (Taylor and Taylor 1989; Harcourt 2001).

Even though mainland New Zealand is not part of their regular distribution, juvenile southern elephant seals are sometimes seen over the shelf of South Island (van den Hoff et al. 2002; Field et al. 2004), including the area of the southern survey. Most sightings occur during the haul-out period in July and August and between November and January during the molt (van den Hoff 2001). Sightings have been made on the central coast of South Island and Kaikoura Peninsula (van den Hoff 2001). Individuals have also occurred in the Bay of Plenty, Christchurch, and Gisborne (Harcourt 2001); others have been seen in Wellington and other North Island beaches (Daniel 1971).

Although possible, it is unlikely that southern elephant seals would be encountered during the proposed survey, especially during May–June.

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 southwestern Pacific Ocean off New Zealand during May–June 2015.

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, and refer to recent literature that has become available since the PEIS was released in 2011. 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 off New Zealand during May–June 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

As noted in the PEIS (§ 3.4.4.3, § 3.6.4.3, and § 3.7.4.3), 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; Le Prell 2012). Rather, the onset of TTS has been considered an indicator that, if the animal is exposed to higher levels of that sound, physical damage is ultimately a possibility. Recent research has shown that sound exposure can cause cochlear neural degeneration, even when threshold shifts and hair cell damage are reversible (Liberman 2013). These findings have raised some doubts as to whether TTS should continue to be considered a non-injurious effect.

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 surveys while they are 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 (e.g., Nieukirk et al. 2012). 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. Situations with prolonged strong reverberation are infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between airgun pulses (e.g., Gedamke 2011; Guerra et al. 2011, 2013), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree. Guerra et al. (2013) reported that ambient noise levels between seismic pulses were elevated because of reverberation at ranges of 50 km from the seismic source. Based on measurements in deep water of the Southern Ocean, Gedamke (2011) estimated that the slight elevation of background levels during intervals between pulses reduced blue and fin whale communication space by as much as 36–51% when a seismic survey was operating 450–2800 km away. Based on preliminary modeling, Wittekind et al. (2013) reported that airgun sounds could reduce the communication range of blue and fin whales 2000 km from the seismic source. Klinck et al. (2012) also found reverberation effects between airgun pulses. Nieukirk et al. (2012) and Blackwell et al. (2013) noted the potential for masking effects from seismic surveys on large whales.

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 (e.g., Nieukirk et al. 2012). Cerchio et al. (2014) suggested that the breeding display of humpback whales off Angola could have been disrupted by seismic sounds, as singing activity declined with increasing received levels. In addition, some cetaceans are known to change their calling rates, shift their peak frequencies, or otherwise modify their vocal behavior in response to airgun sounds (e.g., Di Iorio and Clark 2010; Castellote et al. 2012; Blackwell et al. 2013). The hearing systems of baleen whales are undoubtedly more sensitive to low-frequency sounds than are the ears of the small odontocetes that have been studied directly (e.g., MacGillivray et al. 2014). 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; Ellison et al. 2012). 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 (e.g., New et al. 2013). 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 (Malme et al. 1984; Malme and Miles 1985; Richardson et al. 1995).

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 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 (McCauley et al. 1998, 2000). However, some individual humpback whales, especially males, approached within distances of 100–400 m. Studies examining the behavioral responses of humpback whales to airguns are currently underway off eastern Australia (Cato et al. 2011, 2012, 2013).

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 (Moulton and Holst 2010). 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 (Malme et al. 1985). It has been suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel et al. 2004), but data from subsequent years indicated that there was no observable direct correlation between strandings and seismic surveys (IWC 2007).

There are no data on reactions of *right whales* to seismic surveys. However, Rolland et al. (2012) suggested that ship noise causes increased stress in right whales; they showed that baseline levels of stress-related fecal hormone metabolites decreased in North Atlantic right whales with a 6-dB decrease in underwater noise from vessels. Wright et al. (2011) also reported that sound could be a potential source of stress for marine mammals.

Results from *bowhead whales* 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 (Miller et al. 1999; Richardson et al. 1999). However, more recent research on bowhead whales corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources (e.g., Miller et al. 2005). Nonetheless, Robertson et al. (2013) showed that bowheads on their summer feeding grounds showed subtle but statistically significant changes in surfacing–respiration–dive cycles during exposure to seismic sounds, including shorter surfacing intervals, shorter dives, and decreased number of blows per surface interval.

Bowhead whale calls detected in the presence and absence of airgun sounds have been studied extensively in the Beaufort Sea. Bowheads continue to produce calls of the usual types when exposed to airgun sounds on their summering grounds, although numbers of calls detected are significantly lower in the presence than in the absence of airgun pulses; Blackwell et al. (2013) reported that calling rates in 2007 declined significantly where received SPLs from airgun sounds were 116–129 dB re 1 μPa. Thus, bowhead whales in the Beaufort Sea apparently decrease their calling rates in response to seismic operations, although movement out of the area could also contribute to the lower call detection rate (Blackwell et al. 2013).

A multivariate analysis of factors affecting the distribution of calling bowhead whales during their fall migration in 2009 noted that the southern edge of the distribution of calling whales was significantly closer to shore with increasing levels of airgun sound from a seismic survey a few hundred kilometers to the east of the study area (i.e., behind the westward-migrating whales; McDonald et al. 2010, 2011). It was not known whether this statistical effect represented a stronger tendency for quieting of the whales farther offshore in deeper water upon exposure to airgun sound, or an actual inshore displacement of whales.

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} (Malme et al. 1986, 1988). Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast (Malme et al. 1984; Malme and Miles 1985), and western Pacific gray whales feeding off Sakhalin Island, Russia (e.g., Gailey et al. 2007; Johnson et al. 2007; Yazvenko et al. 2007a,b).

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 U.K. 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 operating vs. silent, although there was localized avoidance (Stone and Tasker 2006). Singing fin whales in the Mediterranean moved away from an operating airgun array, and their song notes had lower bandwidths during periods with versus without airgun sounds (Castellote et al. 2012).

During seismic surveys in the Northwest Atlantic, baleen whales as a group showed localized avoidance of the operating array (Moulton and Holst 2010). Sighting rates were significantly lower during seismic operations compared with non-seismic periods. Baleen whales were seen on average 200 m farther from the vessel during airgun activities vs. non-seismic periods, and these whales more often swam away from the vessel when seismic operations were underway compared with periods when no airguns were operating (Moulton and Holst 2010). Blue whales were seen significantly farther from the vessel during single airgun operations, ramp up, and all other airgun operations compared with non-seismic periods (Moulton and Holst 2010). Similarly, fin whales were seen at significantly farther distances during ramp up than during periods without airgun operations; there was also a trend for fin whales to be sighted farther from the vessel during other airgun operations, but the difference was not significant (Moulton and Holst 2010). Minke whales were seen significantly farther from the vessel during periods with than without seismic operations (Moulton and Holst 2010). Minke whales were also more likely to swim away and less likely to approach during seismic operations compared to periods when airguns were not operating (Moulton and Holst 2010).

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 on reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales, and there is an increasing amount of information on 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 (e.g., Stone and Tasker 2006; Moulton and Holst 2010; Barry et al. 2012). 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.

During seismic surveys in the Northwest Atlantic, delphinids as a group showed some localized avoidance of the operating array (Moulton and Holst 2010). The mean initial detection distance was significantly farther (by ~200 m) during seismic operations compared with periods when the seismic source was not active; however, there was no significant difference between sighting rates (Moulton and Holst 2010). The same results were evident when only long-finned pilot whales were considered.

Preliminary findings of a monitoring study of *narwhals* (*Monodon monoceros*) in Melville Bay, Greenland (summer and fall 2012) showed no short-term effects of seismic survey activity on narwhal distribution, abundance, migration timing, and feeding habits (Heide-Jørgensen et al. 2013a). In addition, there were no reported effects on narwhal hunting. These findings do not seemingly support a suggestion by Heide-Jørgensen et al. (2013b) that seismic surveys in Baffin Bay may have delayed the migration timing of narwhals, thereby increasing the risk of narwhals to ice entrapment.

The beluga, however, is a species that (at least at times) shows long-distance (10s of km) avoidance of seismic vessels (e.g., Miller et al. 2005). 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 (e.g., Finneran et al. 2000, 2002, 2005).

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 (e.g., Stone and Tasker 2006; Moulton and Holst 2010), but foraging behavior can be altered upon exposure to airgun sound (e.g., Miller et al. 2009). There are almost no specific data on the behavioral reactions of *beaked whales* to seismic surveys. Most beaked whales tend to avoid approaching vessels of other types (e.g., Würsig et al. 1998) and/or change their behavior in response to sounds from vessels (e.g., Pirotta et al. 2012). 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 (e.g., Simard et al. 2005). 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.

The limited available data suggest that *harbor porpoises* show stronger avoidance of seismic operations than do Dall's porpoises. Thompson et al. (2013) reported decreased densities and reduced acoustic detections of harbor porpoise in response to a seismic survey in Moray Firth, Scotland, at ranges of 5–10 km (SPLs of 165–172 dB re 1 μPa; sound exposure levels or SELs of 145–151 dB $\mu Pa^2 \cdot s$); however, animals returned to the area within a few hours. The apparent tendency for greater responsiveness in the harbor porpoise is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson et al. 1995; Southall et al. 2007).

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.

Additional data are needed to determine the received sound levels at which small odontocetes would start to incur TTS upon exposure to repeated, low-frequency pulses of airgun sound with variable received levels. To determine how close an airgun array would need to approach in order to elicit TTS, one would (as a minimum) need to allow for the sequence of distances at which airgun pulses would occur, and for the dependence of received SEL on distance in the region of the seismic operation (e.g., Breitzke and Bohlen 2010; Laws 2012). At the present state of knowledge, it is also necessary to assume that the effect is directly related to total received energy, although there is recent evidence that auditory effects in a given animal are not a simple function of received acoustic energy. Frequency, duration of the exposure and occurrence of gaps within the exposure can also influence the auditory effect (Finneran and Schlundt 2010, 2011, 2013; Finneran et al. 2010a,b; Finneran 2012; Ketten 2012; Kastelein et al. 2013a).

The assumption that, in marine mammals, the occurrence and magnitude of TTS is a function of cumulative acoustic energy (SEL) is probably an oversimplification (Finneran 2012). Popov et al. (2011) examined the effects of fatiguing noise on the hearing threshold of Yangtze finless porpoises when exposed to frequencies of 32–128 kHz at 140–160 dB re 1 µPa for 1–30 min. They found that an exposure of higher level and shorter duration produced a higher TTS than an exposure of equal SEL but of lower level and longer duration. Kastelein et al. (2012a,b; 2013b) also reported that the equal-energy model is not valid for predicting TTS in harbor porpoises or harbor seals.

Recent data have shown that the SEL required for TTS onset to occur increases with intermittent exposures, with some auditory recovery during silent periods between signals (Finneran et al. 2010b; Finneran and Schlundt 2011). Schlundt et al. (2013) reported that the potential for seismic surveys using airguns to cause auditory effects on dolphins could be lower than previously thought. Based on behavioral tests, Finneran et al. (2011) and Schlundt et al. (2013) reported no measurable TTS in bottlenose dolphins after exposure to 10 impulses from a seismic airgun with a cumulative SEL of ~195 dB re 1 $\mu Pa^2 \cdot s$; results from auditory evoked potential measurements were more variable (Schlundt et al. 2013).

Recent studies have also shown that the SEL necessary to elicit TTS can depend substantially on frequency, with susceptibility to TTS increasing with increasing frequency above 3 kHz (Finneran and Schlundt 2010, 2011; Finneran 2012). When beluga whales were exposed to fatiguing noise with sound levels of 165 dB re 1 µPa for durations of 1–30 min at frequencies of 11.2–90 kHz, the highest TTS with the longest recovery time was produced by the lower frequencies (11.2 and 22.5 kHz); TTS effects also gradually increased with prolonged exposure time (Popov et al. 2013a). Popov et al. (2013b) also reported that TTS produced by exposure to a fatiguing noise was larger during the first session (or naïve subject state) with a beluga whale than TTS that resulted from the same sound in subsequent sessions (experienced subject state). Therefore, Supin et al. (2013) reported that SEL may not be a valid metric for examining fatiguing sounds on beluga whales. Similarly, Nachtigall and Supin (2013) reported that false killer whales are able to change their hearing sensation levels when exposed to loud sounds, such as warning signals or echolocation sounds.

It is inappropriate to assume that onset of TTS occurs at similar received levels in all cetaceans (*cf.* Southall et al. 2007). Some cetaceans could incur TTS at lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin. Based on the best available information, Southall et al. (2007) recommended a TTS threshold for exposure to single or multiple pulses of 183 dB re 1 $\mu Pa^2 \cdot s$. Tougaard et al. (2013) proposed a TTS criterion of 165 dB re 1 $\mu Pa^2 \cdot s$ for porpoises based on data from two recent studies. Gedamke et al. (2011), based on preliminary simulation modeling that attempted to allow for various uncertainties in assumptions and variability around population means, suggested that some baleen whales whose closest point of approach to a seismic vessel is 1 km or more could experience TTS.

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the likelihood that some mammals close to an airgun array might incur at least mild TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson et al. 1995, p. 372*ff*; Gedamke et al. 2011). In terrestrial animals, exposure to sounds sufficiently strong to elicit a large TTS induces physiological and structural changes in the inner ear, and at some high level of sound exposure, these phenomena become non-recoverable (Le Prell 2012). At this level of sound exposure, TTS grades into PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS (e.g., Kastak and Reichmuth 2007; Kastak et al. 2008).

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). The proposed exclusion (shut-down) zones planned for the proposed seismic surveys are considered to be more conservative than distances based on these criteria. 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. In December 2013, NOAA made available for public comment new draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013), taking at least some of the Southall et al. recommendations into account. The new acoustic guidance and procedures could account for the now-available scientific data on marine mammal 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. At the time of preparation of this Draft IHAA, the date of release of the final guidelines and how they would be implemented are unknown.

Nowacek et al. (2013) concluded that current scientific data indicate that seismic airguns have a low probability of directly harming marine life, except at close range. 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. 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.

There is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns. However, Gray and Van Waerebeek (2011) have suggested a cause-effect relationship between a seismic survey off Liberia in 2009 and the erratic movement, postural instability, and akinesia in a pantropical spotted dolphin based on spatially and temporally close association with the airgun array. Additionally, a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings (e.g., Castellote and Llorens 2013).

Non-auditory 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 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 Kongsberg EM 122 MBES, Knudsen Chirp 3260 SBP, and pinger would be operated from the source vessel during the proposed survey, but not during transits. Information about this equipment was provided in § 2.2.3.1 of the PEIS. A review of the anticipated potential effects (or lack thereof) of MBESs, SBPs, and pingers on marine mammals and sea turtles appears in § 3.4.4.3, § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.

There has been some recent attention given to the effects of MBES on marine mammals, as a result of a report issued in September 2013 by an IWC independent scientific review panel (ISRP) linking the operation of a MBES to a mass stranding of melon-headed whales (*Peponocephala electra*; Southall et al. 2013) off Madagascar. During May–June 2008, ~100 melon-headed whales entered and stranded in the Loza Lagoon system in northwest Madagascar at the same time that a 12-kHz MBES survey was being conducted ~65 km away off the coast. In conducting a retrospective review of available information on the event, an independent scientific review panel concluded that the Kongsberg EM 120 MBES was the most plausible behavioral trigger for the animals initially entering the lagoon system and eventually stranding. The independent scientific review panel, however, identified that an unequivocal conclusion on causality of the event was not possible because of the lack of information about the event and a number of potentially contributing factors. Additionally, the independent review panel report indicated that this incident was likely the result of a complicated confluence of environmental, social, and other factors that have a very low probability of occurring again in the future, but recommended that the potential be considered in environmental planning. The proposed survey design and environmental context of the proposed survey are quite different from the mass melon-headed whale stranding described by the ISRP. It should be noted that this event is the first known marine mammal mass stranding closely associated with the operation of a MBES. It is noted that leading scientific experts knowledgeable about MBES have expressed concerns about the independent scientific review panel analyses and findings (Bernstein 2013).

There is no available information on marine mammal behavioral response to MBES sounds (Southall et al. 2013) or sea turtle responses to MBES systems. Much of the literature on marine mammal response to sonars relates to the types of sonars used in naval operations, including Low-Frequency Active (LFA) sonars (e.g., Miller et al. 2012; Sivle et al. 2012) and Mid-Frequency Active (MFA) sonars (e.g., Tyack et al. 2011; Melcón et al. 2012; Miller et al. 2012; DeRuiter et al. 2013a,b; Goldbogen et al. 2013). However, the MBES sounds are quite different from naval sonars. Ping duration of the MBES is very short relative to naval sonars. Also, at any given location, an individual marine mammal would be in the beam of the MBES for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; naval sonars often use near-horizontally-directed sound. In addition, naval sonars have higher duty cycles. These factors would all reduce the sound energy received from the MBES relative to that from naval sonars.

Risch et al. (2012) found a reduction in humpback whale song in the Stellwagen Bank National Marine Sanctuary during Ocean Acoustic Waveguide Remote Sensing (OAWRS) activities that were carried out ~200 km away. The OAWRS used three frequency-modulated (FM) pulses centered at frequencies of 415, 734, and 949 Hz with received levels in the sanctuary of 88–110 dB re 1 μPa. Deng et al (2014) measured the spectral properties of pulses transmitted by three 200-kHz echo sounders, and found that they generated weaker sounds at frequencies below the center frequency (90–130 kHz). These sounds are within the hearing range of some marine mammals, and the authors suggested that they could be strong enough to elicit behavioral responses within close proximity to the sources, although they would be well below potentially harmful levels.

Despite the aforementioned information that has recently become available, this Draft IHAA is in agreement with the assessment presented in § 3.4.7, 3.6.7, and 3.7.7 of the PEIS that operation of MBESs, SBPs, and pingers is not likely to impact mysticetes or odontocetes, and is not expected to affect sea turtles, (1) given the lower acoustic exposures relative to airguns and (2) because the intermittent and/or narrow downward-directed nature of these sounds would result in no more than one or two brief ping exposures of any individual marine mammal or sea turtle given the movement and speed of the vessel. Also, for sea turtles, the associated frequency ranges are above their known hearing range.

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 ~1250 km of seismic surveys east of New Zealand. 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 airgun array where the received levels (RLs) of sound >160 dB re 1 μPa_{rms} are predicted to occur (see Table 1). 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 an operating airgun array, 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.

To our knowledge, no systematic aircraft- or ship-based surveys have been conducted for marine mammals in offshore waters of the South Pacific Ocean east of New Zealand. For most cetacean species, we used densities from extensive NMFS SWFSC cruises (Ferguson and Barlow 2001, 2003; Barlow 2003, 2010; Forney 2007) in one province of Longhurst's (2006) pelagic biogeography, the California Current Province (CALC). That province is similar to the South Subtropical Convergence Province (SSTC) in which the proposed surveys are located, in that productivity is high and large pelagic fish such as tuna occur. Specifically, we used the 1986–1996 data from blocks 35, 36, 47, 48, 59, and 60 of Ferguson and Barlow (2001, 2003), the 2001 data from Barlow (2003) for the OR/WA and CA strata, and the 2005 and 2008 data from Forney (2007) and Barlow (2010), respectively, for the two strata combined. The densities used were effort-weighted means for the 10 locations (blocks or States). The surveys off CA, OR, and WA were conducted up to ~556 km offshore, and most of those data were from offshore areas that overlap with the above blocks selected from Ferguson and Barlow (2001, 2003).

For pinnipeds, we used the densities in Bonnell et al. (1992) of northern fur seals and northern elephant seals in offshore areas of western U.S. (the only species regularly present in offshore areas there) to estimate the numbers of pinnipeds that might be present off New Zealand.

The species that would be encountered during the proposed survey would be different from those sighted during the surveys off the western U.S. and in the ETP. However, the overall abundances of species groups with generally similar habitat requirements are expected to be roughly similar. Thus, we used the data described above to estimate the group densities of beaked whales, delphinids, small whales, and mysticetes in the proposed survey area. We then estimated the relative abundance of individual southern species within the species groups using various surveys and other information from areas near the study area, and general information on species' distributions such as latitudinal ranges and group sizes. Group densities from northern species were multiplied by their estimated relative abundance off New Zealand divided by the relative abundance for all species in the species group to derive estimated for the southern species (Table 3).

TABLE 3. Densities of marine mammal species groups sighted during surveys off the west coast of the US during 1986–2008, densities of cetaceans in the Southern Ocean between 30°S and 50°S, and estimated densities of species expected to occur during the SIO seismic surveys off eastern New Zealand during May–June 2015. Densities are derived as described in the text. Species listed as endangered are in italics.

Species	Observed density off US west coast (#/1000 km^2)	Relative abundance off New Zealand	Estimated density off New Zealand (#/1000 km^2)	Density in the Southern Ocean, 30-50°S, 1978/79–1987/88 (#/1000 km^2)
Mysticetes				
Southern right whale		*5*	*0.98*	
Pygmy right whale		2	0.39	
Humpback whale		*5*	*0.98*	*0.01*
Antarctic minke whale		3	0.59	
Dwarf minke whale		3	0.59	
Bryde's whale		1	0.20	
Sei whale		*3*	*0.59*	*0.07*
Fin whale		*3*	*0.59*	*0.10*
Blue whale		*3*	*0.59*	*0.02*
All mysticetes	**5.47**			
Odontocetes				
Physeteridae				
Sperm whale		*5*	*1.62*	*1.74*
Pygmy sperm whale		3	*0.97*	
All sperm whales	**2.58**			
Ziphiidae				
Southern bottlenose whale		2	0.46	
Cuvier's beaked whale		3	0.69	
Shepard's beaked whale		2	0.46	
Andrew's beaked whale		2	0.46	
Blainville's beaked whale		1	0.23	
Gray's beaked whale		4	0.92	
Hector's beaked whale		2	0.46	
Spade-toothed whale		1	0.23	
Strap-toothed whale		3	0.69	
All Beaked whales	**4.59**			
Delphinidae				
Bottlenose dolphin		5	81.55	
Short-beaked common dolphin		10	163.10	
Hourglass dolphin		3	48.93	
Dusky dolphin		5	81.55	
Southern right-whale dolphin		3	48.93	
Hector's dolphin		2	32.62	
All Dolphins	**456.69**			
False killer whale		3	0.27	
Killer whale		5	0.45	
Short-finned pilot whale		3	0.27	
Long-finned pilot whale		5	0.45	
All small whales	**1.46**			
Pinnipeds				
Southern elephant seal		*2*	5.11	
New Zealand fur seal		*5*	12.79	
All Pinnipeds	**17.90**			

Densities for several cetacean species are available for the Southern Ocean (Butterworth et al. 1994), as follows: (1) for humpback, sei, fin, blue, sperm, killer, and pilot whales in Antarctic Management areas I–VI south of 60°S, based on the 1978/79–1984/84 and 1985/86–1990/91 IWC/IDCR circumpolar sighting survey cruises, and (2) for humpback, sei, fin, blue, and sperm whales extrapolated to latitudes 30–40°S, 40–50°S, 50–60°S based on Japanese scouting vessel data from 1965/66–1977/78 and 1978/79–1987/88. We calculated densities based on abundances and surface areas given in Butterworth et al. (1994) and used the mean density for the more recent surveys and the 30–40°S and 40–50°S strata because the survey areas are between ~38°S and 43°S.

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 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 surveys if no animals moved away from the survey vessel. The *Requested Take Authorization* is given in the far right column of Table 4.

It should be noted that the following estimates of exposures to various sound levels assume that the proposed surveys 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 EZ 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 surveys, the transect lines are widely spaced relative to the 160-dB distance. Thus, the area including overlap is 1.13 x the area excluding overlap, so a marine mammal that stayed in the survey area during

TABLE 4. Densities and estimates of the possible numbers of individuals that could be exposed to $\geq$160 dB re 1 µPa$_{rms}$ during SIO's proposed seismic surveys east of New Zealand during May–June 2015. The proposed sound source consists of two 45-in^3 GI guns. Species in italics are listed under the ESA as endangered. The column of numbers in boldface shows the numbers of Level B "takes" for which authorization is requested.

Species	Estimated Density (#/1000 km^2) based on US west coast	Reported Density (#/1000 km^2) in Southern Ocean	Estimated Density (#/1000 km^2)	Ensonified Area (km^2)	Calculated Take[1]	% of Regional Pop'n[2]	Requested Level B Take Authorization
Mysticetes							
Southern right whale	*0.98*		*0.98*	1154	*1*	*0.01*	*1*
Pygmy right whale	0.39		0.39	1154	0	N/A	0
Humpback whale	*0.98*	*0.01*	*0.01*	1154	*1*	*<0.01*	*1*
Bryde's whale	0.20		0.20	1154	0	<0.01	0
Antarctic minke whale	0.59		0.59	1154	1	<0.01	1
Dwarf minke whale	0.59		0.59	1154	1	<0.01	1
Sei whale	*0.59*	*0.07*	*0.07*	1154	*0*	*<0.01*	*0*
Fin whale	*0.59*	*0.10*	*0.10*	1154	*0*	*<0.01*	*0*
Blue whale	*0.59*	*0.02*	*0.02*	1154	*0*	*<0.01*	*0*
Odontocetes							
Sperm whale	*1.62*	*1.74*	*1.74*	1154	*2*	*0.01*	*2*
Pygmy sperm whale	*0.97*		*0.97*	1154	1	N/A	1
Cuvier's beaked whale	0.69		0.69	1154	1	<0.01	1
Shepard's beaked whale	0.46		0.46	1154	1	<0.01	1
Southern bottlenose whale	0.46		0.46	1154	1	<0.01	1
Hector's beaked whale	0.46		0.46	1154	1	<0.01	1
Gray's beaked whale	0.92		0.92	1154	1	<0.01	1
Andrew's beaked whale	0.46		0.46	1154	1	<0.01	1
Strap-toothed whale	0.69		0.69	1154	1	<0.01	1
Blainville's beaked whale	0.23		0.23	1154	0	<0.01	0
Spade-toothed whale	0.23		0.23	1154	0	<0.01	0
Bottlenose dolphin	81.55		81.55	1154	94	N/A	94
Short-beaked common dolphin	163.10		163.10	1154	188	N/A	188
Dusky dolphin	81.55		81.55	1154	94	N/A	94
Hourglass dolphin	48.93		48.93	1154	56	<0.01	56
Southern right-whale dolphin	48.93		48.93	1154	56	N/A	56
Hector's dolphin	32.62		32.62	1154	38	<0.01	38
False killer whale	0.27		0.27	1154	0	N/A	0
Killer whale	0.45		0.45	1154	1	N/A	1
Long-finned pilot whale	0.27		0.27	1154	0	<0.01	0
Short-finned pilot whale	0.45		0.45	1154	1	N/A	1
Pinnipeds							
Southern elephant seal	5.11		5.11	1154	6	0.01	6
New Zealand fur seal	12.79		12.79	1154	15	<0.01	15

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

[2] Requested takes expressed as percentages of the regional populations in New Zealand, the Southern Hemisphere, or Antarctic (Table 2); N/A means not available

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.

Applying the approach described above, ~923 km^2 (~1153.6 km^2 including the 25% contingency) would be within the 160-dB isopleth on one or more occasions during the proposed surveys. Because this approach does not allow for turnover in the mammal populations in the area during the course of the surveys, 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 estimates of the numbers of individual cetaceans and pinnipeds that could be exposed to seismic sounds with received levels ≥160 dB re 1 μPa_{rms} during the proposed surveys are 545 and 21, respectively (Table 4). That total includes seven cetaceans listed as ***Endangered*** under the ESA: the southern right, humpback, sei, fin, and blue whales (1 each or 0.01% or less of the regional populations) and the sperm whale (2 or 0.01% of the regional population).

In addition, seven beaked whales could be exposed during the surveys (Table 5). Most (96.9%) of the cetaceans potentially exposed are delphinids; the common dolphin, bottlenose dolphin, and dusky dolphin are estimated to be the most common delphinid species in the area, with estimates of 188 (estimate of regional population size not available), 94 (estimate of regional population size not available), and 94 (0.59% of regional population) exposed to ≥160 dB re 1 μPa_{rms}, respectively.

Two pinnipeds species could be exposed during the surveys: the New Zealand fur seal and the southern elephant seal, with estimates of 15 (<0.01% of the regional population) and 6 (0.01%), 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, 3.7.7, and 3.8.7, the PEIS concluded that airgun operations with implementation of the proposed monitoring and mitigation measures could result in a small number of Level B behavioral effects in some mysticete and odontocete species in the Sub-Antarctic QAA, and that Level B behavioral effects were possible but unlikely for pinnipeds; 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 no subsistence hunting for whales in New Zealand.

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 areas. 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 EEZ of New Zealand.

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 1 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 190-dB EZ and 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. 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. In December 2013, NOAA published draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013), although at the time of preparation of this Draft IHAA, the date of release of the final guidelines and how they will be implemented are unknown. As such, this IHAA has been prepared in accordance with the current NOAA acoustic practices, and the procedures are based on best practices noted by Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

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 southwestern Pacific Ocean off New Zealand, 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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