Protected Species Mitigation and Monitoring Report

Marine Geophysical (Seismic) Surveys
North Pacific Ocean

Main Hawaiian Islands Survey
11 September 2018 – 21 October 2018

Emperor Seamount Chain Survey
23 April 2019 – 01 June 2019

R/V *Marcus G. Langseth*

Prepared for:

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES:

Appendix	Description
Appendix A	**Incidental Harassment Authorization**
Appendix B	**Basic Data Summary Form**
Appendix C	**Passive Acoustic Monitoring System Specifications on R/V *Langseth***
Appendix D	**PAM Hydrophone Deployment on R/V *Langseth***
Appendix E	**Survey Lines Acquired**
Appendix F	**Changes in Acoustic Source Volume During Survey Operations**
Appendix G	**Acoustic Monitoring Downtime**
Appendix H	**Summary of Visual Detections of Protected Species**
Appendix I	**Photographs of Positively Identified Protected Species**
Appendix J	**Birds and Other Wildlife Observed**

1. EXECUTIVE SUMMARY

The U.S. National Science Foundation (NSF) owned research vessel (R/V) *Marcus G. Langseth* (*Langseth*), operating under an existing cooperative agreement by Columbia University's Lamont-Doherty Earth Observatory (L-DEO), conducted two 2-D (two-dimensional) surveys in the North Pacific Ocean along the Hawaiian-Emperor Seamount Chain. The operational activities were conducted for research surveys proposed by Principal Investigators (PIs) Drs. D. Shillington (L-DEO), T. Watts (Oxford University, L-DEO), and R. Dunn, G. Ito, and P. Wessel (University of Hawaii). In addition, although not funded by NSF, Dr. I. Grevenmeyer (GEOMAR) provided assistance with logistical support and data acquisition and exchange, and Drs. U. Brink and N. Miller (USGS) participated in planning, acquiring and analyzing data, and using the results to inform hazards for Hawaii.

The first survey of the program was conducted around the Main Hawaiian Islands from 11 September 2018 to 21 October 2018. The second survey was conducted over the Emperor Seamount Chain from 01 to 26 May 2019.

The purpose of the surveys was to collect seismic reflection and refraction data to gain fundamental insight into the formation of the Hawaiian-Emperor Seamount chain, and to contribute to a more comprehensive assessment of geohazards for the Hawaiian Islands region that could be used to evaluate earthquake, tsunami and submarine landslides hazards.

This report serves to comply with the reporting obligations for the survey required pursuant to the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA). On 15 March 2018, L-DEO submitted an application to the National Marine Fisheries Service (NMFS) for an Incidental Harassment Authorization (IHA) that would allow for the potential harassment of small numbers of marine mammals incidental to the seismic surveys. On 24 August 2018, NMFS issued an IHA, an Incidental Take Statement (ITS), and a Biological Opinion (BO). An Environmental Assessment (EA) and a Finding of No Significant Impact (FONSI) were also issued for the project. In addition, the U.S. Fish and Wildlife Service (USFWS) issued a Letter of concurrence (LOC) on 13 July 2018 that the proposed seismic surveys "may affect", but were not likely to "adversely affect", the endangered short-tailed albatross (*Phoebastria albatrus*), Hawaiian petrel (*Pterodroma sandwichensis*), band-rumped storm petrel – Hawaiian Distinct Population Segment (DPS) (*Oceanodroma castro*), and the threatened Newell's shearwater (*Puffinus auricularis newelli*). Mitigation measures were implemented to minimize potential impacts to marine mammals and endangered or threatened sea turtles and sea birds during the survey program. These measures included, but were not limited to, the use of NMFS approved Protected Species Observers (PSOs) for both visual and acoustic monitoring, the establishment of a 1,000 meter buffer zone from any source element (where operators would be alerted to the presence of the animal(s)), a 500 meter exclusion zone from any source element (where the source would be powered-down or shut-down depending on the species present), a 100 meter exclusion zone from a single operating source element (where the source would be shut-down), and the implementation of ramp-up procedures.

Continuous protected species observation coverage during the survey was provided by RPS, the environmental consulting company contracted by L-DEO for the project. Pursuant to the contract, PSOs monitored and reported on the presence and behavior of protected species and directed the implementation of the mitigation measures as described in the NSF Environmental Analysis (EA) and FONSI (prepared pursuant to the National Environmental Policy Act (NEPA) and Executive Order 12114, Environmental Effects Abroad of Major Federal Actions (E.O. 12114)), and the IHA and ITS issued by NMFS. Additionally, PSO activities were consistent with the PSO standards identified in the Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the NSF or Conducted by the U.S. Geological Survey and Record of Decision (referred to herein as the PEIS), to which the NSF EA tiered. Five PSOs, one of which was designated as the Lead PSO and one of which was designated as the Lead Passive Acoustic Monitoring (PAM) operator, were present on board the R/V *Langseth* throughout each of the two surveys of the program.

Over the course of the entire survey program, PSOs conducted visual monitoring for a total of 921 hours 10 minutes and acoustic monitoring for a total of 796 hours 54 minutes. Visual and acoustic monitoring was conducted simultaneously for a total of 465 hours nine minutes.

The acoustic source was active for a total of 771 hours 20 minutes throughout the entire survey program, which occurred during 49% (454 hours 16 minutes) of the total visual monitoring and during 96% (768 hours 49 minutes) of the total acoustic monitoring.

There were a total of 13 visual detections and no acoustic detections of protected species detections throughout the survey program. Visual detections included: eight detections of whales, four detections of dolphins, and one detection of pinnipeds. Visual detections of positively identified whales included: two detections of fin whales (*Balaenoptera physalus*) and one detection of sperm whales (*Physeter macrocephalus*). There were also three detections of unidentified baleen whales and two detections of unidentified whales. Visual detections of positively identified dolphins included: one detection of killer whales (*Orcinus orca*), one detection of short-finned pilot whales (*Globicephala macrohynchus*), and one detection of spinner dolphins (*Stenella longirostris*). There was also one detection of unidentified dolphins. Visual detections of positively identified pinnipeds included: one detection of a northern fur seal (*Callorhinus ursinus*).

Protected species detections did not result in the implementation of any mitigation actions throughout the survey program.

NMFS issued an IHA and ITS authorizing takes for marine mammals for each of the two surveys. For the first Main Hawaiian Island survey, a total of 11,066 individual marine mammals from 28 species (including five whale species and one dolphin species listed as endangered species) were authorized for takes in the IHA and ITS. Of this total, 11,043 individuals from all 28 species were authorized for Level B takes, and 23 individuals from two species were authorized for Level A takes. Takes for endangered species totaled 205 individuals, all Level B, including five blue whales (*Balaenoptera musculus*), four fin whales (*Balaenoptera physalus*), two humpback whales (*Megaptera novaengliae*), 11 sei whales (*Balaenoptera borealis*), 123 sperm whales (*Physeter macrocephalus*), and 60 false killer whales (*Pseudorca crassidens*) from the Hawaiian Main Islands Insular population. Takes for endangered sea turtles totaled 166 individuals, including seven green (*Chelonia mydas*), one hawksbill (*Eretmochelys imbricate*), 65 leatherback (*Dermochyls coriacea*), 61 loggerhead (*Caretta caretta*), and 32 olive ridley (*Lepidochelys olivacea*). For the second Emperor Seamount Chain survey, a total of 11,090 individual marine mammals from 26 species (including seven whale species listed as endangered species) were authorized for takes in the IHA and ITS. Of this total, 11,024 individuals from all 26 species were authorized for Level B takes, and 66 individuals from four species were authorized for Level A takes. Takes for endangered species totaled 139 individuals, including two Level A takes for humpback whales and three Level A takes for sei whales. The remaining Level B takes for endangered species included five blue whales, eight fin whales, two gray whales (*Eschrichtius robustus*), 16 humpback whales, two North Pacific right whales (*Eubalaena japonica*), 11 sei whales, and 90 sperm whales. No takes were issued for sea turtles for the Emperor Seamount Chain survey.

During acoustic source operations, no protected marine mammals were observed within the predicted radius at which there is a potential for auditory injury (based upon each species hearing range and how that overlaps with the frequencies produced by the sound source), constituting potential Level A takes. A total of four protected marine mammals were observed within the predicted 160 decibel radius (where there is a potential for a behavioral response), constituting potential Level B takes. This total included three fin whales and one unidentified baleen whale.

There were no sea turtles observed within the predicted 175 decibel radius (where there is a potential for a behavioral response), constituting a potential Level B take, and no sea turtles observed within the predicted 195 decibel radius (where there is a potential for auditory injury based on the species hearing range), constituting potential Level A takes. Mitigation measures for sea turtles included shutting down the acoustic source if the individual was observed approaching, entering or within the predicted 100 meter exclusion zone.

In addition to marine mammal protected species detections, there was one sighting of protected seabirds throughout the survey program. This total included one sighting of a juvenile short-tailed albatross. While the sighting occurred during active acoustic source operations, no mitigation actions were required. Mitigation measures for protected sea birds were only implemented if the birds were observed diving or foraging within the exclusion zones while the acoustic source was active. This included powering down the source within the 500 meter exclusion zone and shutting down the source within the 100 meter exclusion zone.

A summary sheet of observation, detection, and operational totals for the survey program can be found in Appendix B.

2. INTRODUCTION

The following report details protected species monitoring and mitigation as well as seismic survey operations undertaken for two marine geophysical surveys on board the *R/V Langseth* in the North Pacific Ocean around the Hawaiian-Emperor Seamount Chain from 11 September 2018 to 21 October 2018 (Main Hawaiian Islands survey) and from 01 to 26 May 2019 (Emperor Seamount Chain survey).

This document serves to meet the reporting requirements dictated in the IHA and ITS issued to L-DEO by NMFS on 24 August 2018. The IHA and ITS authorized "takes" of Level A and Level B harassment of specific marine mammals, incidental to the marine seismic survey. NMFS has stated that seismic source received sound levels equal to or greater than 160 dB re 1 µPa (root mean square (rms)) could potentially disturb marine mammals, temporarily disrupting behavior, such that they could be considered non-lethal 'takes' (Level B harassment). In July 2016, NMFS released new technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing, which established new thresholds for potential permanent threshold shift (PTS) onset or Level A harassment (auditory injury) for marine mammal species. Predicted distances to Level A harassment vary based on marine mammal hearing groups – low frequency cetaceans, mid frequency cetaceans, high frequency cetaceans, phocid pinnipeds and otariid pinnipeds – and how each group's hearing range overlaps with the frequencies produced by the sound source. For sea turtles, per the ESA, NMFS has stated that received sound levels equal to or greater than 175 dB re 1 µPa (root mean square (rms)) represents the current best understanding of the threshold at which they could exhibit behavioral responses, and that received sound levels equal to or greater than 195 dB re 1 µPa (root mean square (rms)) represents the current best understanding of the threshold at which they could experience PTS.

NMFS requires that provisions such as exclusion zones (EZ), delayed operations, ramp-ups, power-downs and shut-downs be implemented to mitigate for potentially adverse effects of the acoustic source sounds on protected species. A 1,000 meter buffer zone, a 500 meter exclusion zone, and a 100 meter exclusion zone were established from any single element on the acoustic source array as areas where the presence of a marine mammal would trigger the implementation of a mitigation action. This included delayed operations for all three zones, a power-down or a shut-down of the acoustic source for the 500 meter EZ (depending on the species – see section 3.1) and a shut-down of the acoustic source for the 100 meter EZ. The 500 meter EZ is intended to be precautionary as it encompasses the zones for most species within which auditory injury (Level A harassment) could occur on the basis of instantaneous exposure. It also provides additional protection from the potential for more severe behavioral reactions for marine mammals at relatively close range to the acoustic source, provides a consistent area for PSOs to conduct effective observational effort, and is a distance within which detection probabilities are reasonably high for most species under typical conditions. For sea turtles, the occurrence of an individual detected approaching, entering, or within the 100 meter EZ would trigger the implementation of a shut-down of the acoustic source. For protected sea birds, the detection of one foraging or diving within the 500 meter and 100 meter EZs would trigger a power-down and shut-down respectively.

2.1. PROJECT OVERVIEW AND LOCATION

The survey program was comprised of two separate seismic surveys conducted in the North Pacific Ocean. The first survey was conducted around the Main Hawaiian Islands and the second survey was conducted over the Emperor Seamount Chain. The Hawaii-Emperor Seamount Chain is the most well-known example of hotspot magmatism, where volcanoes form far from the boundaries between tectonic plates above hot regions in the underlying mantle. The data from the two seismic surveys was collected to address many remaining questions about the fundamental earth processes that create the volcanoes of the Hawaii-Emperor Seamount Chain and similar seamount chains around the world, and how the enormous mass of these volcanoes is supported by the rock material below them. The images of the magmatic crust created by the hotspot will give critical information about the crust's volume, its composition, how it varies along the island chain, and how the tectonic plate deforms in response to the weight of the volcanoes. Seismic data will also image faults within the volcanic edifice and in the surrounding oceanic crust that can be used to evaluate earthquake, tsunami, and submarine landslide hazards.

The Main Hawaii Island survey occurred within the U.S. Exclusive Economic Zone between approximately 18 to 24 degrees North and approximately 153 to 160 degrees West, in waters depths ranging from approximately 700 meters to more than 5,000 meters. The survey consisted of ten survey lines, including two acquired with seismic refraction data utilizing ocean bottom seismometers (OBS), and eight acquired with seismic reflection data utilizing a high resolution multi-channel seismic (MCS) streamer (Figure 1). Two of the MCS lines were the same length and bearing of the two OBS lines but offset by 500 meters.

The Emperor Seamount Chain Survey occurred within International Waters between approximately 43 to 48 degrees North and approximately 166 to 173 degrees East, in water depths approximately 1,200 to more than 7,000 meters. The survey consisted of six survey lines, two of which were acquired with OBS seismic refraction data and four of which were acquired with MCS seismic reflection data (Figure 2). Two of the MCS lines were located at the same position as the two OBS lines.

Throughout the survey program, a total of 5,474 kilometers of transect lines were surveyed, including 3,397 kilometers during the Main Hawaiian Islands Survey and 2,077 kilometers during the Emperor Seamount Chain Survey.

All seismic survey operations, including deployment and retrieval of the OBSs, were conducted solely by the *R/V Marcus G. Langseth*. The vessel is 72 meters (235 feet) in length and utilizes a particularly quiet propulsion system to avoid interference with the seismic signals. The *Langseth*'s cruising speed was approximately 10 to 11 knots during transits and varied between three to five knots during the seismic surveys. Seismic acquisition was conducted between 20 September to 09 October 2018 and 19 to 20 October 2018 for the Main Hawaiian Islands survey, and between 5 May to 23 May 2019 for the Emperor Seamount survey.

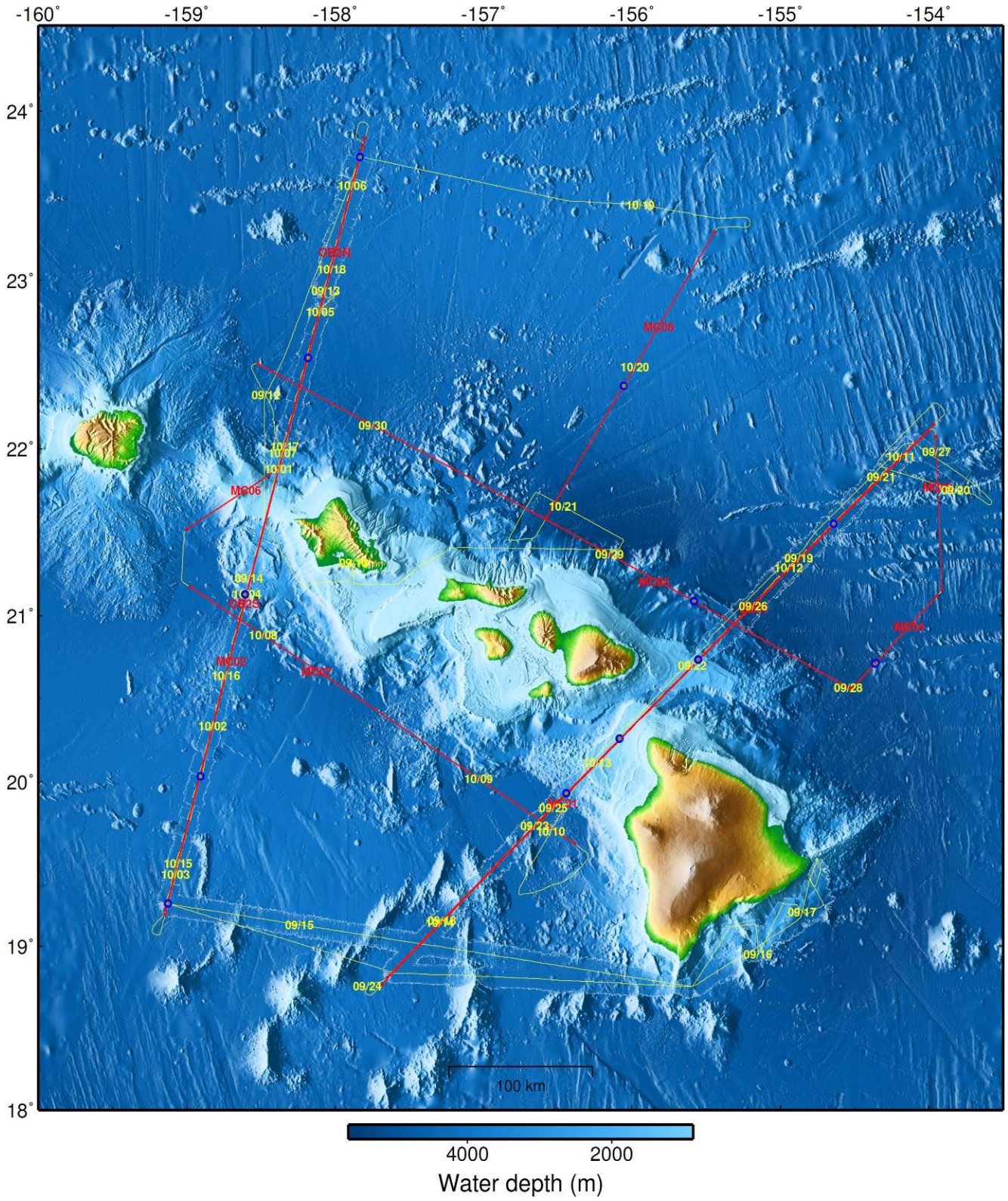

Figure 1. Location and survey lines of the Main Hawaiian Islands Marine Geophysical Survey.

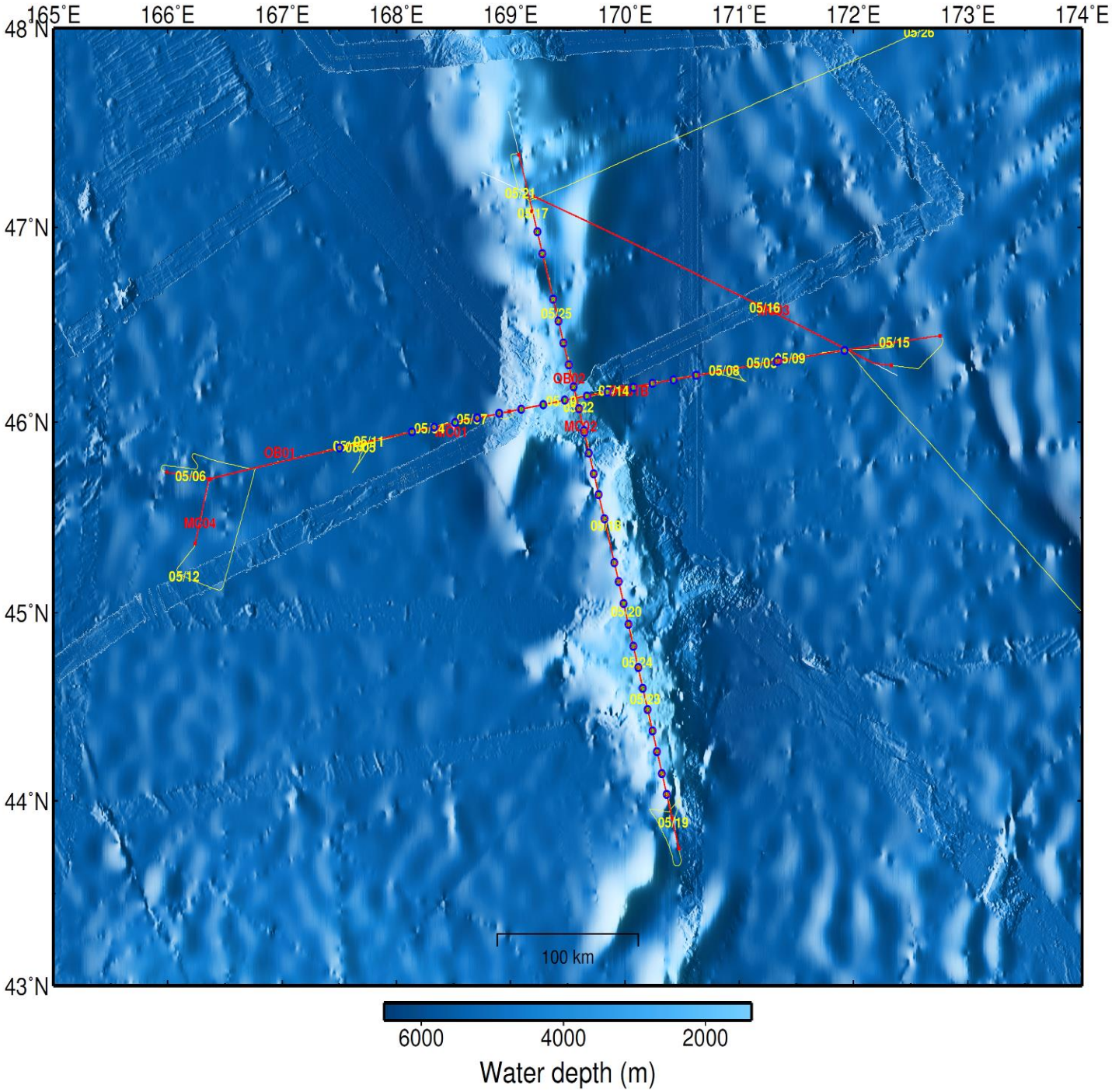

Figure 2: Location and survey lines of the Emperor Seamount Chain Marine Geophysical Survey.

2.1.1. Energy Source and Receiving Systems

The energy source utilized during the surveys consisted of four towed acoustic source sub-arrays, each with ten source elements (for a total of 40 source elements), deployed astern of the vessel. During survey production operations, a maximum of 36 elements were active at any time, with the additional elements considered spares in the event that one of the main elements could not be utilized. The source elements were towed at a depth of 12 meters for both surveys. For the Main Hawaiian Islands Survey, the center of the source was situated 220 meters from the Navigational Reference Point (NRP), which was located on the PSO observation tower. This location positioned the first elements on the arrays approximately 183 meters from the stern of the vessel. For the Emperor Seamount Chain Survey, the center of the source was situated 230 meters from the NRP, which positioned the first elements on the arrays approximately 193 meters from the stern of the vessel.

The source array utilized a mixture of Bolt 1500LL and Bolt 1900LLX elements ranging in size from 40 to 360 cubic inches (in^3), with an operating pressure of 1,950 pounds per square inch. The dominant frequency components ranged from two to 188 Hertz (Hz) and nominal source levels ranged from 259 to 265 dB re: 1 µPa (peak-to-peak). The total volume of the seismic source array with all main 36 source elements active was 6600 in^3. During times when acoustic source arrays were brought on board for maintenance or repair, the total source volume was reduced from 6600 in^3 to varying lower volumes depended on how many of the elements and arrays were disabled. The overall source volume would also be reduced if a main element was switched with a spare element of a smaller volume.

The shot point interval for the Main Hawaiian Islands Survey was 50 meters for the MCS lines and 390 meters for the OBS survey lines. The shot point interval for the Emperor Seamount Chain Survey was 62.5 meters for the MCS lines and 300 meters for the OBS survey lines. During acquisition the source elements would emit a brief (approximately 0.1 second) pulse of sound. During the intervening periods of operations, the source elements would be silent.

The receiving system for the survey program consisted of a hydrophone streamer and OBSs. For the Main Hawaiian Islands Survey, a single streamer of 15 kilometers in length was utilized for all survey lines except the final MCS survey line, for which only a six kilometer streamer was utilized. For the Emperor Seamount Chain Survey, a 15 kilometer streamer was used for all MCS acquisition operations. As the acoustic source array was towed along the track lines, the hydrophone streamer received the returning acoustic signals and transferred the data to the on-board processing system. The long streamer allowed for accurate measurements of seismic velocities and provided a large amount of data redundancy for enhancing seismic images during data processing.

The OBSs for the first Main Hawaiian Islands Survey consisted of 70 OBSs from the US Ocean Bottom Seismograph Instrument Pool (OBSIP), which included OBSs from Scripps Institution of Oceanography (SIO) and Woods Hole Oceanographic Institute (WHOI). The OBSs for the second Emperor Seamount Chain survey consisted of 32 OBSs, which included seven from the OBSIP and 25 from GEOMAR. The SIO OBSs had a height of approximately one meter and a maximum diameter of approximately one meter and utilized a 36 kilogram iron grate anchor with dimensions of 7x91x91.5 centimeters. The WHOI OBSs had a height of approximately one meter and a maximum diameter of 50 centimeters and utilized a 23 kilogram hot-rolled steel anchor with dimensions of 2.5x30.5x38.1 centimeters. The GEOMAR OBSs were 165 centimeters long, 130 centimeters wide, and 72 centimeters high. They had a titanium frame that weighed approximately 335 kilograms and utilized a steel anchor. To retrieve the OBSs from the sea floor, an acoustic release transponder transmits a signal to the instrument at a frequency of eight to 11 kilohertz, and a response is received at the frequency of 11.5 to 13 kilohertz to activate and release the instrument. The transponder will trigger the burn-wire assembly that releases the instrument from the anchor on the sea floor, and the device floats to the surface where it can be retrieved by the vessel. The anchor for the OBS is scuttled and left on the sea floor. The OBSs receive and store the returning acoustic signals internally for later analysis.

Additional sound sources included a Kongsberg EM 122 multi-beam echosounder (MBES), Knudsen Chirp 3260 sub-bottom profiler (SBP), and a Teledyne RDI 75 kHz Ocean Surveyor acoustic Doppler

current profiler (ADCP). The hull-mounted MBES operated at frequencies between 10.5 and 13 (usually 12) kilohertz. Each ping consists of eight (in water greater than 1,000 meters) or four (in water less than 1,000 meters) successive fan-shaped transmissions. The transmitting beam width is one or two degrees fore-aft and 150 degrees perpendicular to the ship's line of travel. The maximum source level is 242 dB re: 1 µPa (root mean square [rms]). The hull-mounted SBP beam is transmitted as a 27 degree cone, which is directed downward by a 3.5 kilohertz transducer. The nominal power output is 10 kilowatts; however, the actual maximum radiated power is three kilowatts or 222 dB re: 1 µPa m (rms). The ping duration is 64 seconds and the interval is one second. The hull-mounted ADCP operates at a frequency of 75 kilohertz and a maximum source level of 224 dB re: 1 µPa m (rms) over a conically-shaped 30 degree beam. The MBES and SBP operated simultaneously to provide information about near sea floor sedimentary features and to map the topography of the ocean floor. The ADCP was used to measure water current velocities. The *Langseth* also towed a Geometrics G822 Cesium magnetometer approximately 113 meters off the starboard stern of the vessel, which was also utilized in the process of mapping the sea floor.

3. MITIGATION AND MONITORING METHODS

The PSO monitoring program on the R/V *Langseth* was established to meet the standards set forth in the PEIS, NSF EA, IHA and ITS requirements. Survey mitigation measures were designed to minimize potential impacts of the *Langseth*'s seismic activities on marine mammals, sea turtles, and other protected species of interest. The following monitoring protocols were implemented to meet these objectives.

- Visual observations were conducted to provide real-time sighting data, allowing for the implementation of mitigation procedures as necessary.
- A Passive Acoustic Monitoring system was operated continuously day and night to augment visual observations and provide additional marine mammal detection data.
- Effects of marine mammals and sea turtles exposed to sound levels constituting a take were observed and documented. The nature of the probable consequences was discussed when possible.

In addition to the mitigation objectives outlined in the PEIS, EA, USFS LOC, IHA and ITS, PSOs collected and analyzed necessary data mandated by the IHA (see Appendix A).

3.1. MITIGATION METHODOLOGY

Mitigation actions were implemented for visual and acoustic detections of protected species, including marine mammals, sea turtles, and protected sea birds, as outlined in the IHA, ITS, BO and USFWS LOC. These actions included the establishment of a 1,000 meter buffer zone (BZ), 500 meter and 100 meter exclusion zones (EZ), and the implementation of delayed operations, power-downs (during which the source volume was reduced to a single active 40 in^3 element), and shut-downs (during which the source was fully silenced) for protected species detected approaching, entering, or within the designated EZ.

Before the acoustic source could be activated after a period of silence, during daylight hours or during hours of darkness, two PSOs and one PAM operator conducted a 30 minute clearance survey of the buffer and exclusion zones. In the event of a detection of protected species, a delay of source operations would be implemented if: (1) a marine mammal was detected approaching, entering, or within the 1,000 meter BZ; (2) if a protected seabird was detected foraging or diving within the 500 meter EZ; or (3) if a sea turtle was detected approaching, entering or within the 100 meter EZ. Source operations would not be cleared to begin until the protected species were observed exiting their designated zones. If the animals were not observed leaving their designated zones (i.e. if they dove within the zone and were not re-sighted), operations would not be cleared to begin until a specific time following the final detection of the animals. For detections of small odontocetes, pinnipeds, sea turtles, or sea birds, this time was 15 minutes following last sighting. For detections of mysticetes, large odontocetes, and false killer whales, this time was 30 minutes following last sighting.

Once the acoustic source was active, the 1,000 meter buffer zone from any element on the acoustic source arrays was established as an area in which the presence of a protected species would initiate an alert to the seismic operators that the animal was detected and that the implementation of a mitigation action may soon be required. PSOs and the PAM operator would keep in frequent contact with each other and the seismic team, relaying information on the location and movement of the animal(s), and the implementation of any needed mitigation actions.

The 500 meter exclusion zone from any element on the acoustic source array was established as the area in which the presence of a marine mammal (with the exception of several delphinid species) observed approaching, entering, or within the zone would initiate a shut-down of the acoustic source. A shut-down was also required for an acoustic only (without visual sighting) detection of marine mammals (other than delphinids) that were confirmed to be within the 500 meter EZ. The 100 meter EZ from any element on the source array was established as the area in which the presence of a sea turtle observed approaching, entering, or within the zone would initiate a shut-down of the source. The 500 meter and

100 meter EZ were also utilized for protected sea birds. If a protected sea bird was visibly observed foraging or diving within these EZs, the acoustic source would be powered-down (500 meter EZ) or shut-down (100 meter EZ).

The shut-down requirement was waived for small dolphins of the genera *Tursiops*, *Delphinus*, *Lagenodelphis*, *Lagenorhynchus*, *Lissodelphis*, *Stenella*, and *Steno*. If PSOs could positively identify the dolphins sighted as one of these species, the acoustic source would be powered-down instead of shut-down if they were observed approaching, entering, or within the 500 meter exclusion zone. However, if there was any doubt on the species identification, the source would instead be shut-down. If the acoustic source was powered-down due to the presence of one of the dolphin species for which the shut-down requirement was waived, the EZ was reduced to 100 meters around the single active element. If any other protected species were then observed approaching, entering or within the smaller 100 meter EZ, the acoustic source would then be shut-down. Visual PSOs could also elect to waive the power-down requirement for these specific dolphins if the individuals appeared to be voluntarily approaching the vessel for the purpose of interacting with the vessel or towed gear. However, if the PSOs observed the delphinids exhibiting any adverse reactions, then a power-down was required.

Once the acoustic source had been powered-down for a detection of delphinids for which the shut-down requirement was waived, the source had to remain powered-down until the dolphins were no longer observed within the 500 meter EZ or the 30 minute time limit on power-downs had been reached. If the dolphins were no longer visually observed within the 500-meter EZ less than 30 minutes after the power-down was initiated, source operations could be resumed at the previous operating volume without a ramp-up. However, if the dolphins were still observed within the 500 meter EZ 30 minutes after the power-down was initiated, the source would then be shut-down. Once shut-down for a protected species mitigation action, the acoustic source would remain silent until the animal(s) were confirmed exiting their designated EZs, or until a specific time had passed following the last detection. As with delayed operations, this time was 15 minutes for small odontocetes, pinnipeds, sea turtles and seabirds, and 30 minutes for mysticetes, large odontocetes, and false killer whales. A ramp-up of the acoustic source was required after the implementation of a shut-down for protected species in order for full volume operations to resume.

The IHA and ITS also outlined three extra mitigation actions required for specific detections of marine mammals: (1) a shut-down was required when a large whale with a calf or an aggregation of large whales (six individuals or more) were observed at any distance from the vessel; (2) within waters of 2,500 meters or less near the Kohala Peninsula and west coast of Hawaii Island, a shut-down was required for detections of melon-headed whales at any distance from the vessel; and (3) if the authorized takes for spinner or bottlenose dolphins was met, a shut-down was then required when any individual or group of this species was observed approaching or within the Level B harassment zone (6.7 kilometers) within the 1,000 meter isobaths of Oahu and Hawaii Islands. Upon the implementation of a shut-down for one of these extra mitigation requirements, the source would not be cleared for ramp-up until the animal(s) were observed exiting the applicable EZ or following a clearance period of 15 minutes from the last sighting for dolphins or a period of 30 minutes from the last sighting for large whales.

Table 1 describes the predicted 160 decibel radius (Level B harassment zone for marine mammals), the predicted 175 decibel radius (Level B harassment zone for sea turtles), and the predicted 195 decibel radius (Level A harassment zone for sea turtles).

Table 2 describes the predicted Level A harassment zones for each marine mammal hearing group per the NMFS new guidelines, and the species that could occur in the survey areas assigned to each group.

Table 1: Predicted 160/175/195 Decibel Zones* implemented during the seismic survey program.

Source	Volume (in^3)	Water Depth (m)	160 dB radius – Level B harassment zone for marine mammals	175 dB radius – Level B harassment zone for sea turtles	195 dB radius – Level A harassment zone for sea turtles
1 element	40	100 to 1,000	647	116	11
1 element	40	> 1,000	431	77	8
36 elements	6600	100 to 1,000	10,100	2,796	272
36 elements	6600	> 1,000	6,733	1,864	181
*Distances are from any single element on the array					

Table 2: Predicted Level A Harassment Zones* for each marine mammal hearing group implemented during the seismic survey program.

Source	Volume (in^3)	Low Frequency Cetaceans (m)	Mid Frequency Cetaceans (m)	High Frequency Cetaceans (m)	Phocid Pinnipeds (m)	Otariid Pinnipeds (m)
1 element	40	1.76	0	12.5	1.98	0
36 elements	6600	320.2	13.6	268.3	43.7	10.6
Species anticipated that could occur in the survey area: **Distances are from any single element on the acoustic source arrays*		• Humpback Whale • Minke whale • Bryde's Whale • Sei Whale • Fin Whale • Blue whale • Gray Whale • North Pacific Right Whale	• Sperm Whale • Cuvier's Beaked Whale • Blainville's Beaked Whale • Ginko-toothed Beaked Whale • Deraniygala's Beaked Whale • Hubbs Beaked Whale • Longmans Beaked Whale • Stenjeger's Beaked Whale • Rough-toothed Dolphin • Bottlenose Dolphin • Short-beaked Common Dolphin • Pantropical Spotted Dolphin • Pacific White-sided Dolphin • Northern Right-whale Dolphin • Spinner Dolphin • Striped Dolphin • Fraser's Dolphin • Risso's Dolphin • Melon-headed Whale • Killer Whale • Pygmy Killer Whale • False Killer Whale • Short-finned Pilot Whale	• Pygmy Sperm Whale • Dwarf Sperm Whale • Dall's Porpoise	• Hawaiian Monk Seal • Northern Fur Seal	• Northern Elephant Seal • Ribbon Seal

3.2. VISUAL MONITORING SURVEY METHODOLOGY

There were five trained and experienced PSOs on board the *Langseth* for each survey during the program to conduct monitoring for protected species, record and report detections, and request mitigation actions in accordance with the PEIS, EA, IHA and ITS. The PSOs on board were NMFS approved and held certifications from a recognized Bureau of Ocean Energy Management (BOEM) course, and/or an approved Joint Nature Conservation Committee (JNCC) course. Visual monitoring was primarily carried out from an observation tower (Figure 3) located 18.9 meters above the surface of the water, which allowed a 360 degree viewpoint around the vessel and acoustic source.

Figure 3. Protected Species Observer observation tower with mounted big-eye binoculars, as seen from the stern of the vessel.

The PSO tower was equipped with Fujinon 7x50 and Steiner Marine 7x50 binoculars, as well as two mounted 25x150 Big-eye binoculars, and a D-300-2MS Night Optics USA, Inc. monocular (for visual clearance and monitoring of night time ramp-ups). In addition, a Butler Creek PVS-7 night vision binocular was secured in the bridge and could be requested for use by the PSOs when needed. Inside the tarpaulin tent located in the middle of the platform was a laptop for data collection, and a telephone for communication with the PAM station, bridge, and main lab. Also inside the tent was a monitor that displayed current information about the vessel (e.g. position, speed, heading, etc.), sea conditions (e.g. water depth, sea temperature, etc.), weather (e.g. wind speed and direction, air temperature, etc.), and source activity (e.g. survey line number, total number of active elements, volume, etc.). Environmental conditions along with vessel and acoustic source activity were recorded at least once an hour, or every time there was a change of one or more of the variables. Most observations were held from the tower; however, during severe weather or when the ships exhaust was blowing on the tower, observations would be conducted from the bridge (approximately 12.8 meters above sea level) or the catwalk (approximately 12.3 meters above sea level) around the bridge.

Visual monitoring methods were implemented in accordance with the survey requirements outlined in the IHA and ITS. Two PSOs visually monitored for protected species at all times during daylight hours throughout each survey, regardless of acoustic source activity. Visual monitoring during periods of acoustic source silence were conducted to gather baseline data on the presence and abundance of protected species in the areas. When the acoustic source was activated from silence at dawn or dusk, two PSOs would begin or end visual monitoring earlier or later to ensure that the entire 30 minute pre-clearance and ramp-up were monitored. When the acoustic source was activated from silence during hours of darkness, two PSOs would be woken up to visually monitor the 30 minute pre-clearance and ramp-up until the source reached full volume. Visual monitoring during dawn, dusk and night hours was conducted using the two night-vision monocular/binoculars.

Monitoring was conducted each day from 30 minutes before sunrise until 30 minutes after sunset as required by the IHA and ITS. For the Main Hawaiian Islands survey, observation times ranged between approximately 15:40 to 05:15 Coordinated Universal Time (UTC) (approximately 05:50 to 19:15 local time). For the Emperor Seamount Chain survey, observation times ranged between approximately 16:30 to 08:50 UTC (approximately 06:30 to 22:50 local time). A visual monitoring schedule was established by the PSOs where each person completed visual watches of varying lengths throughout the day. Scheduled watches of the maximum four hours in duration were followed by at least one hour of required break time.

Visual observations were conducted around the entire area of the vessel and acoustic source, with each PSO on watch focused on a specific half of the area. The smaller monitoring area for each observer increased the probability of protected species being sighted. PSOs searched for blows, fins, splashes or disturbances of the sea surface, large flocks of feeding sea birds, and other sighting cues indicating the possible presence of a protected species. Upon the visual detection of a protected species, PSOs would first identify the animals' range to the vessel and acoustic source. Range estimations were made using reticle binoculars, the naked eye, and by relating the animal(s) to an object at a known distance, such as the acoustic source arrays and streamer head floats. PSOs would also identify the animals' species, if possible upon initial detection, to ensure that the proper mitigation measures were implemented, should any be required.

PSOs recorded the following information for each protected species detection:

I. Date, time of first and last sighting, observers on duty during the detection, location of the observers, vessel information (e.g. position, speed, heading), water depth, acoustic source activity (e.g. volume and number of active elements), and environmental conditions (e.g. Beaufort sea state, wind force, swell height, visibility and glare).
II. Species, detection cue, group size (including number of adults and juveniles), visual description (e.g. overall size, shape of the head, position and shape of the dorsal fin, shape of the flukes, height and direction of the blow), observed behaviors (e.g. porpoising, logging, diving, etc.), and the initial and final pace, heading, bearing, and direction of travel in relation to both the vessel and the source (e.g. towards, away, parallel, perpendicular, etc.).
III. Initial and final distance to the vessel and the source, time and distance of the closest distance to the source, time when entering and exiting the exclusion zones, type of mitigation action implemented, total time of the mitigation action and any production loss, description of other vessels in the area, and any avoidance maneuvers conducted.

During or immediately after each sighting event, the PSOs recorded the detection details per the requirements of the IHA and ITS in a provided detection datasheet. Each sighting event was linked to an entry on an effort datasheet where specific environmental conditions and vessel activity were logged.

Species identifications were made whenever the distance of the animal(s), length of the sighting, and visual observation conditions allowed. Whenever possible during detections, photographs were taken with two provided Canon EOS 70D/80D cameras that had a 300 millimeter telephoto lens. Marine mammal identification manuals were consulted, and photos were examined during observation breaks to confirm identifications.

3.3. PASSIVE ACOUSTIC MONITORING SURVEY METHODOLOGY

Passive Acoustic Monitoring (PAM) was used to augment visual monitoring efforts in the detection, identification, and location of marine mammals. PAM was particularly beneficial during periods of darkness or low visibility when visual monitoring was not as effective. Acoustic monitoring was conducted continuously during all seismic operations and to the maximum extent possible during periods of acoustic source silence. When the acoustic source was activated from any period of silence, acoustic monitoring was conducted for at least 30 minutes prior to the activation of the source along with visual monitoring for the pre-survey clearance.

In accordance with the IHA and ITS, in the event of an issue with any of the PAM equipment, acoustic source activity could continue for 30 minutes without acoustic monitoring while the PAM operator diagnosed the issue. If the diagnosis indicated that the PAM system needed maintenance, operations could continue for an additional five hours without acoustic monitoring provided that: (1) no marine mammals (excluding delphinids) were detected solely by PAM within the EZs in the previous two hours, (2) operations without acoustic monitoring did not exceed a total of five hours in any 24 hour period, and (3) NMFS was notified as soon as practicable of the time and location operations without PAM began.

Five Protected Species Observers (PSOs) were on board to provide monitoring for protected species during the survey program. One PSO trained and experienced with the PAM system was designated as the Lead PAM Operator and oversaw all PAM operations during each survey. Other PSOs trained in the use of the PAM system also conducted acoustic monitoring to ensure continuous PAM operations. PAM shifts were no longer than four hours in duration followed by at least a one hour break.

The PAM system was located in the main science lab to provide space for the system, allow for quick communication with the visual PSOs and seismic technicians, and provide access to the vessel's instrumentation screens. Information about the vessel (e.g. position, heading, and speed), water depth, source activity (e.g. line number, total volume, number of active elements), and the PAM system (e.g. cable deployments/retrievals, changes to the system, background noise score) were recorded at least once an hour, or whenever any of the parameters changed.

Acoustic monitoring for marine mammals was conducted aurally, utilizing Sennheiser headphones, and visually with the *Pamguard* software program. Low to mid-frequency delphinid whistles, clicks, and burst pulses, as well as sperm whale clicks and baleen whale vocalizations, could be visualized in *Pamguard's* spectrogram modules. Sperm whale, beaked whale, Kogia species, and delphinid clicks could also be visualized in low and high frequency click detector modules. Settings adjustments to amplitude range, amplitude triggers, and spectral content filters, among others, could be made in *Pamguard*'s spectrogram and click detector modules to maximize the distinction between cetacean vocalizations and ambient signal. The map module within *Pamguard* could be utilized to attempt localizing the position and range of vocalizing marine mammals. Sound recordings could be made using the high and low frequency sound recording modules when potential marine mammal vocalizations were detected, or when the operator noted unknown or unusual sound sources.

PAM operators recorded the following information during acoustic detections of protected species:

I. Date, time of first and last detection, operator on duty, if the detection was linked to a visual sighting, vessel information (e.g. position, speed, heading), water depth, and acoustic source activity (e.g. volume and number of active elements).
II. Species (if determinable), group size, methods/modules on which vocalizations were detected during the event, and vocalization characteristics (e.g. signal type, frequency and amplitude range, inter-click interval, patterns, etc.)
III. Determinable bearings (to the hydrophones, vessel and source), estimated and/or attempted localizations and any ranges determined, type and time of any implemented mitigation actions and any resulting production loss.

3.3.1. Passive Acoustic Monitoring Parameters

A passive acoustic monitoring (PAM) system designed to detect most species of marine mammals was installed on board the *Langseth*. The system was developed by *Seiche Measurements Limited* and consisted of the following main components: a 250 meter hydrophone cable (configured as a separate 230 meter steel-reinforced tow cable and detachable 20 meter hydrophone array); a 100 meter deck cable; a rack-mounted electronic processing unit (EPU) that incorporated a buffer unit, a RME Fireface 800 unit, and a computer; two desktop monitors; acoustic analysis software package; and headphones for aural monitoring. On this project, the PAM operators used two pre-installed, wall-mounted computer monitors supplied by the *Langseth*. A spare hydrophone cable, deck cable, rack-mounted DPU and computer, monitors, and headphones were also present on board in the event the main system components became damaged or inoperable. The diagram in Figure 4 is a simplified depiction of the PAM system installed on the *Langseth*, and further PAM system specifications can be found in Appendix C.

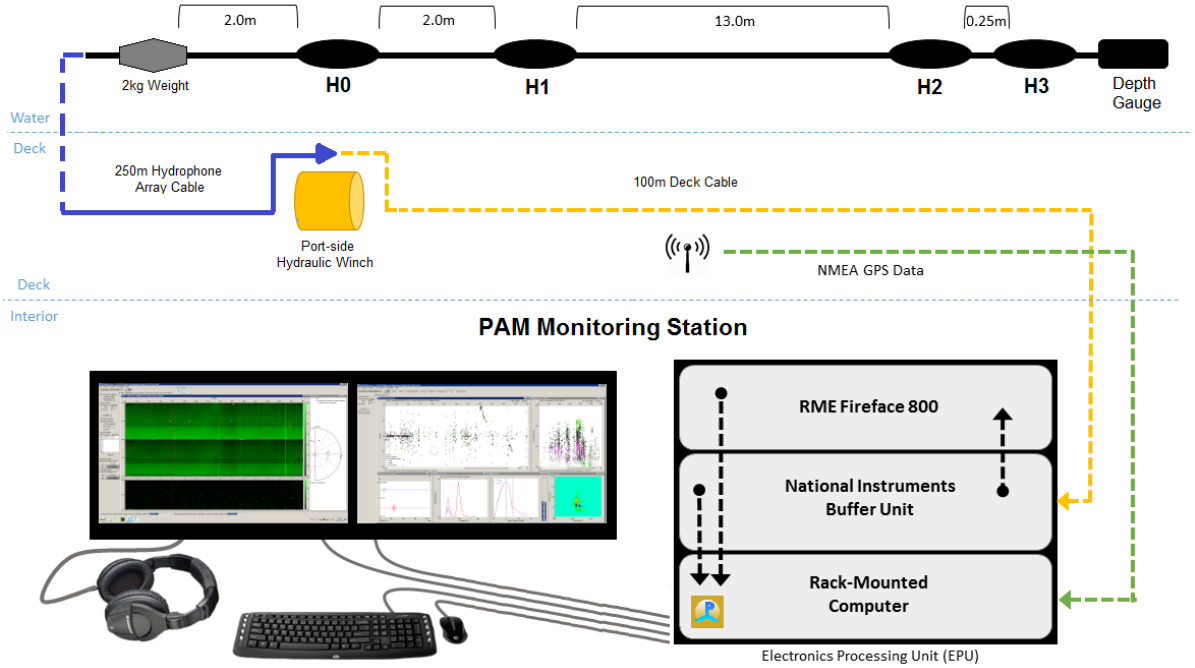

Figure 4: Simplified pathway of data through the PAM system on board the Langseth.

The hydrophone cable contained four hydrophone elements and a depth gauge molded into a 20m section of the cable. The four-element linear hydrophone array allowed the system to sample a large range of marine mammal vocalization frequencies. The first two hydrophones (H0 and H1) were broadband elements, with a frequency response of 200 hertz to 200 kilohertz. The third and fourth hydrophones (H2 and H3) were standard elements, with a frequency response of two kilohertz to 200 kilohertz.

The deck cable interfaced between the hydrophone cable installed on a winch in the main back deck of the vessel and the electronics processing unit (EPU) located in the main science lab. The rack-mounted EPU was set up with the two pre-installed, wall-mounted monitors, a keyboard, a mouse and headphones. The EPU contained a buffer unit with Universal Serial Base (USB) output, an RME Fireface 800 ADC unit with firewire output, and a rack-mounted computer. A Global Positioning System (GPS) feed of GNGGA strings was supplied from the ship's Seapath navigation system and routed to the computer, reading data every 20 seconds. Data from the hydrophone cable's depth transducer was routed through the buffer unit to the computer, via USB connection. *Pamguard Beta* versions 1.15.11 and 1.15.13 were the software versions utilized for the surveys.

Raw feed from the two standard hydrophone elements (H2 and H3) was digitized in the buffer unit using an analogue-digital National Instruments data acquisition (DAQ) soundcard at a sampling rate of 500 kilohertz. The output was filtered for high frequency (HF) content and visualized using the *Pamguard* software. Clicks were measured at sixth order (Butterworth) with a high-pass digital pre-filter of 30 kilohertz and a high-pass trigger filter of 40 kilohertz. *Pamguard* used the difference between the time that a signal arrived at each of the two hydrophones to calculate and display the bearing to the source of the signal. A scrolling bearing/time module displayed the filtered data in real time, allowing for the detection and directional mapping of click trains. Additional components of the HF click detector system in *Pamguard* were an amplitude/time display that registered click intensity data in real time, as well as click waveform, click spectrum, and Wigner plot displays, providing the PAM operator immediate review of individual click characteristics in the identification process. One of the two monitors was designated for displaying *Pamguard* HF click detector and sound recorder modules.

Raw feed from the two broadband hydrophone elements (H0 and H1) was routed from the buffer unit to the RME Fireface 800 unit, where it was digitized at a sampling rate of 48 kilohertz. The relatively low frequency (LF) output was further processed within *Pamguard* by applying Engine Noise Fast Fourier Transform (FFT) filters, including click suppression and spectral noise removal filters (e.g. median filter, average subtraction, Gaussian kernel smoothing and thresholding). Filtered LF content was visualized in two spectrograms, one displaying two channel feeds at frequency ranges of three to 24 kilohertz, and another displaying one channel feed at a frequency range of zero to three kilohertz. LF click detector modules allowed for review of individual click characteristics as well as the detection and tracking of click trains.

A map module on the LF system interfaced with GPS data provided by the vessel to display the vessel location, and could be used to determine range and bearing estimates based on clicks tracked in the click detector module. *Pamguard* contained a function for calculating the range to vocalizing marine mammals based upon the least squares fit test. This method is most effective with animals that are relatively stationary in comparison to the moving vessel, such as sperm whales. The mathematical function estimates the range to vocalizing marine mammals by calculating the most likely crossing of a series of bearing lines generated from tracked clicks or whistles and plotted on a map display. Additionally, the bearings of detected whistles and moans were calculated using a Time-of-Arrival-Distance (TOAD) method (the signal time delay between the arrival of a signal on each hydrophone is compared), and presented on a radar display, along with amplitude information for the detected signal as a proxy for range.

Additional modules displayed on the LF monitor included an LF sound recorder and clip generator. The clip generator module within *Pamguard* could also be used to generate short sound clips in response to either an automatic detection or the operator manually selecting a portion of the spectrogram display. This module was useful in the event that the whistle-and-moan detector falsely triggered and identified a non-biological sound (i.e. echosounder) or if it missed detecting tonal signatures that the operator determined to be vocalizations.

3.3.2. Hydrophone Deployment

The hydrophone cable was deployed from a hydraulic winch on the port stern of the vessel's main back deck where the acoustic source arrays were deployed from. Two deck cables, a main and a spare, were installed along the deck-head running from the winch to the main science lab. The hydrophone cable was deployed off the port stern and attached via tow rope to the port side boom to move the cable further away from the vessel and source arrays (Figure 5). For the Main Hawaiian Islands survey, there were two deployment lengths of the PAM cable. Initially, the trailing end of the hydrophone cable was approximately 80 meters from the port stern of the vessel and 111 meters forward of the center of the source (COS). On 23 September 2018, an additional 30 meters was added to the tow length in attempt to increase the tow depth, which placed the trailing end of the hydrophone cable approximately 110 meters astern and 81 meters forward of the COS. For the Emperor Seamount Chain survey, the hydrophone cable was deployed approximately 100 meters astern of the vessel and 100 meters forward of the COS.

PAM system specifications can be found in Appendix C, and a more detailed description of the hydrophone deployment method, including photos of the installation, can be found in Appendix D.

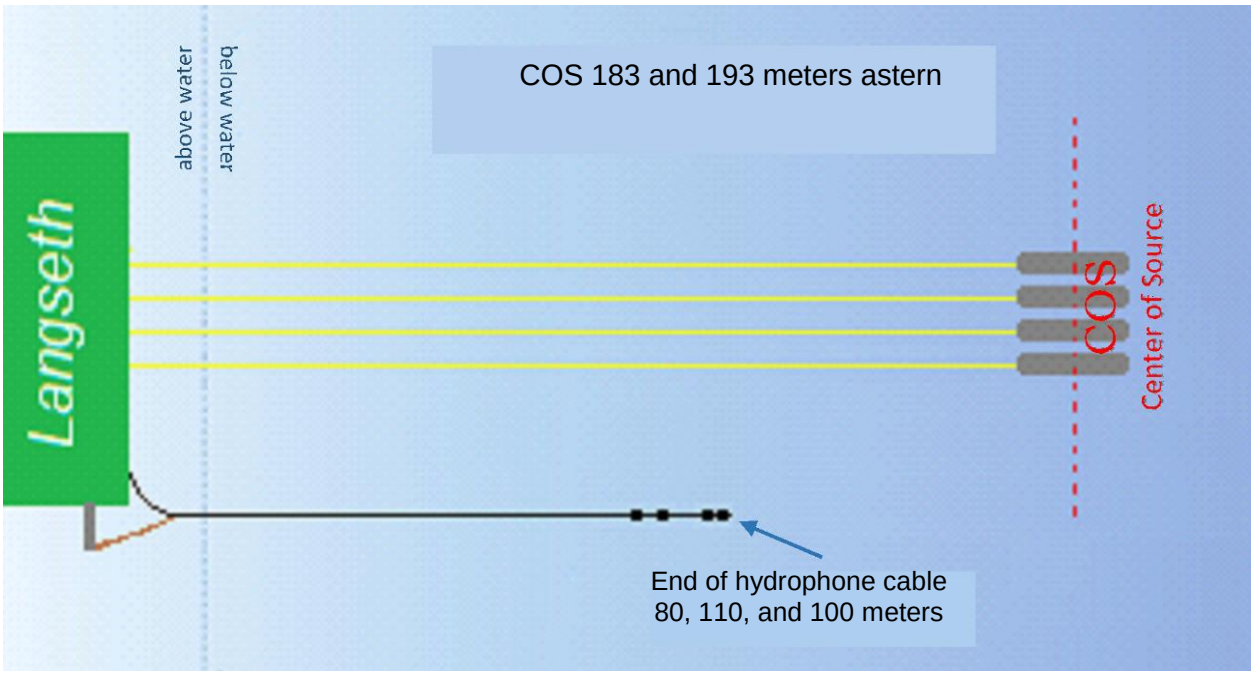

Figure 5. Location of the PAM cable in relation to the seismic gear during the Hawaiian-Emperor Seamount Chain seismic survey program.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

4.1.1. General survey parameters

The North Pacific Ocean Hawaiian-Emperor Seamount Chain seismic survey program was conducted in two separate surveys (**Error! Not a valid bookmark self-reference.**). The dates and times of acquisition for each survey line can be found in Appendix E.

Table 3: Survey parameters of the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	Mobilization Location / Date	First Source Activity	Start of Acquisition	End of Acquisition	Demobilization Location / Date
Main Hawaiian Island	Honolulu, Hawaii/11 Sept 2018/14:00 UTC	12:20 UTC/20 Sept 2018	17:25 UTC/20 Sept 2018	14:15 UTC/ 20 Oct 2018	Honolulu, Hawaii/21 OCT 2018/18:39 UTC
Emperor Seamount Chain	Honolulu, Hawaii/23 April 2019/14:00 UTC	16:34 UTC/5 May 2019	22:01 UTC/5 May 2019	08:53 UTC/23 May 2019	Kodiak, Alaska/01 June 2019/23:15 UTC

Acquisition continued during each program according to the survey plan and survey operations were only suspended when operationally necessary, as outlined in
Table 4. The main reason for interrupted acquisition operations during the survey program was deployment and retrieval of the seismic equipment.

Table 4: Suspension of survey operations during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	Time Source silenced	Time Ramp-up Initiated	Reason for Interruption in Acquisition
Main Hawaiian Islands	21 Sept 2018/13:04 UTC	21 Sept 2018/14:21 UTC	PAM equipment failed and could not resume within the allowed 30 minutes for night-time source operations
Main Hawaiian Islands	23 Sept 2018/21:43	24 Sept 2018/ 02:17 UTC	Issues with retrieving sub-arrays for maintenance during a line change
Main Hawaiian Islands	10:30 UTC/09 Oct 2018	07:46 UTC/19 Oct 2018	OBS retrieval operations
Emperor Seamount Chain	13:41 UTC/08 May 2019	03:21 UTC/12 May 2019	OBS retrieval operations then deployment of the streamer for acquiring MCS survey lines
Emperor Seamount Chain	02:05 UTC/19 May 2019	23:57 UTC/20 May 2019	Retrieval of the streamer, then deployment of the OBSs on the second OBS survey line

4.1.2. MBES, SBP and ADCP operations

The multi-beam echosounder (MBES), sub-bottom profiler (SBP), and the acoustic Doppler current profiler (ADCP) were active throughout the majority of each survey of the program while the vessel was within the permitted survey areas. For the Main Hawaiian Islands survey, the multibeam echosounder was initiated for the first time at 09:12 UTC on 11 September 2018 for a depth check in preparation for an acoustic rosette test at the beginning of the survey. The sonar was disabled at 09:33 UTC for the test, and then all three sonars were initiated at 15:14 UTC on 11 September 2018. The sonars were disabled for the final time at 02:48 UTC on 21 October 2018 when survey operations concluded and before the vessel began transit back to port. For the Emperor Seamount Chain survey, the sonars were initiated on 24 April 2019 from 15:30 to 19:40 UTC for testing during the transit, and then again at 17:25 UTC on 1

May 2019 when the vessel entered the survey area. The sonars were disabled for the final time at 06:28 UTC on 25 May 2019 when survey operations concluded and before the vessel departed the survey area. During both surveys, the sonars were briefly disabled during OBS deployment/retrieval operations while the OBS technicians communicated with the instruments.

4.1.3. Airgun operations

The acoustic source was active for a total of 771 hours 20 minutes throughout both surveys of the program. This total includes ramp-up of the acoustic source, full and reduced volume operations on a survey line, full and reduced volume operations not on a survey line, operation of a single 40 in^3 source element, and testing of the acoustic source elements. The acoustic source was ramped-up seven times totaling two hours 35 minutes over the course of the survey program to commence full volume operations from a period of silence or resume full volume operations from a mitigation shut-down. Table 5 summarize the acoustic source operations over the course of the North Pacific Ocean Hawaiian-Emperor Seamount seismic survey program.

Ramp-ups averaged 20 minutes in duration and were conducted using the automated controller program, DigiShot, which added source elements sequentially to achieve the full source volume over the required period. Ramp-ups were performed by cycling each source element two times at a shot point interval of 17 seconds, adding an additional element after each cycle, resulting in an approximately 20 minute ramp-up when all 36 elements were operating. There were three ramp-ups initiated during daylight hours and four initiated during hours of darkness. All ramp-ups were cleared and monitored by both visual and acoustic monitoring per the survey requirements.

Operations with only a single 40 in^3 source element totaled 16 minutes throughout the survey program. In accordance with the IHA and ITS, operation of a single 40 in^3 source element was mainly to be conducted for mitigation power-downs for protected species, and was limited to 30 minutes in duration, after which the source would be resumed at full volume or silenced depending on if the exclusion zone was clear of protected species at that time or not. All 16 minutes of single 40 in^3 source element operations occurred during the second Emperor Seamount Chain survey and were accumulated during of two events, each unrelated to mitigation power-downs for protected species detections. The first event occurred on 15 May 2019: there were four minutes of operation of the single 40 in^3 source element conducted while the air compressors were re-started after accidentally being shut-down. The mitigation source was enabled instead of being silenced all together because dense fog had resulted in reduced visibility such that the PSOs could not monitor the entire mitigation radii and they would have been unable to clear source operations to resume. The second instance occurred on 16 May 2019: there were 12 minutes of operation of the single 40 in^3 source element operation at the beginning of a line change. The mitigation source was enabled when seismic crew had concerns about entanglement of the port arrays during the upcoming turn but after consulting with the PSOs about the planned length of mitigation source use, the decision was made instead to increase the array back to full volume.

There were three occasions of acoustic source testing during the survey program totaling seven minutes. During the Main Hawaiian Islands survey, there were two source tests conducted on 27 September 2018 totaling five minutes. The first test consisted of a two minute bubble test on a single 40 in^3 element on sub-array two. The second test consisted of a three minute full volume test on the whole array. The testing was done during a brief line change between two full volume MCS survey lines. During the Emperor Seamount Chain survey, there was one source test conducted on 8 May 2019 at the conclusion of source operations for the first OBS survey line, consisting of a two minute test of two elements with a total volume of 580 in^3.

Figure 6 and Figure 7 each show the geospatial data for source operations conducted during each of the three surveys of the program.

Table 5. Total acoustic source operations during the Hawaiian-Emperor Seamount Chain seismic survey program.

Acoustic Source Operation	Number			Duration		
	Total	MHI[1]	ESC[2]	Total	MHI[1]	ESC[2]
Source Tests	3	2	1	00:07	00:05	00:02
Ramp-up	7	4	3	02:35	01:34	01:01
Day-time ramp-ups from source silence	3	1	2	01:01	00:21	00:40
Night-time ramp-ups from source silence	4	3	1	01:34	01:13	00:21
Full 6600 in^3/Reduced Volume on a Survey Line[3]				714:26	440:54	273:32
Full 6600 in^3)/Reduced Volume not on a Survey Line[4]				53:56	36:00	17:56
Single Source Element (40 in^3)				00:16	00:00	00:16
Total Time Acoustic Source Was Active				771:20	478:33	292:47

1. **MHI** = Main Hawaiian Islands Survey
2. **ESC** = Emperor Seamount Chain Survey
3. **Total:** 458:11 (full volume), 256:15 (reduced volume); **MHI:** 404:41 (full volume), 36:13 (reduced volume); **ESC:** 53:30 (full volume), 220:02 (reduced volume)
4. **Total:** 30:24 (full volume), 23:32 (reduced volume); **MHI:** 25:09 (full volume), 10:51 (reduced volume); **ESC:** 05:15 (full volume), 12:41 (reduced volume)

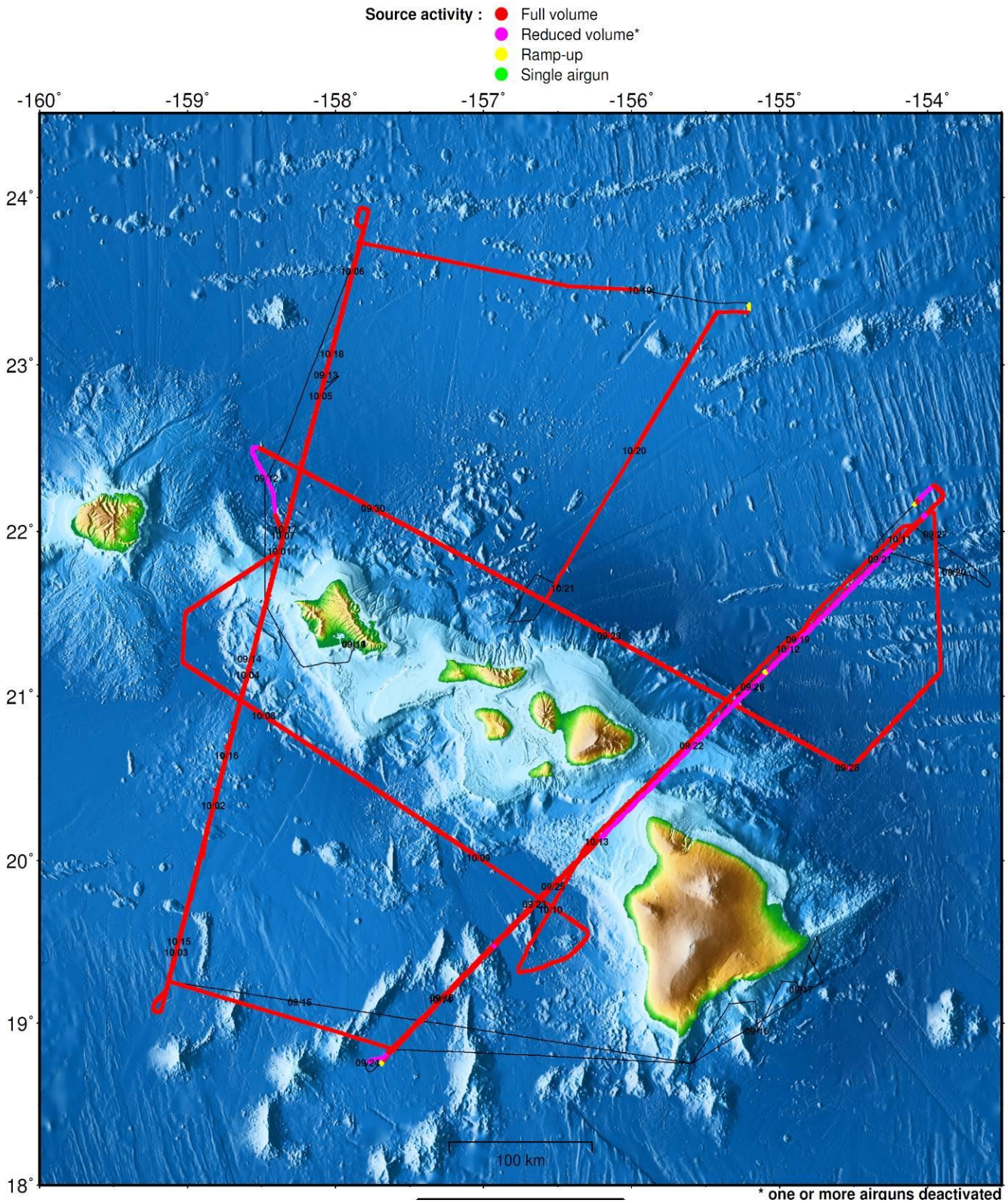

Figure 6: Geospatial data of source operations for the Main Hawaiian Islands survey area.

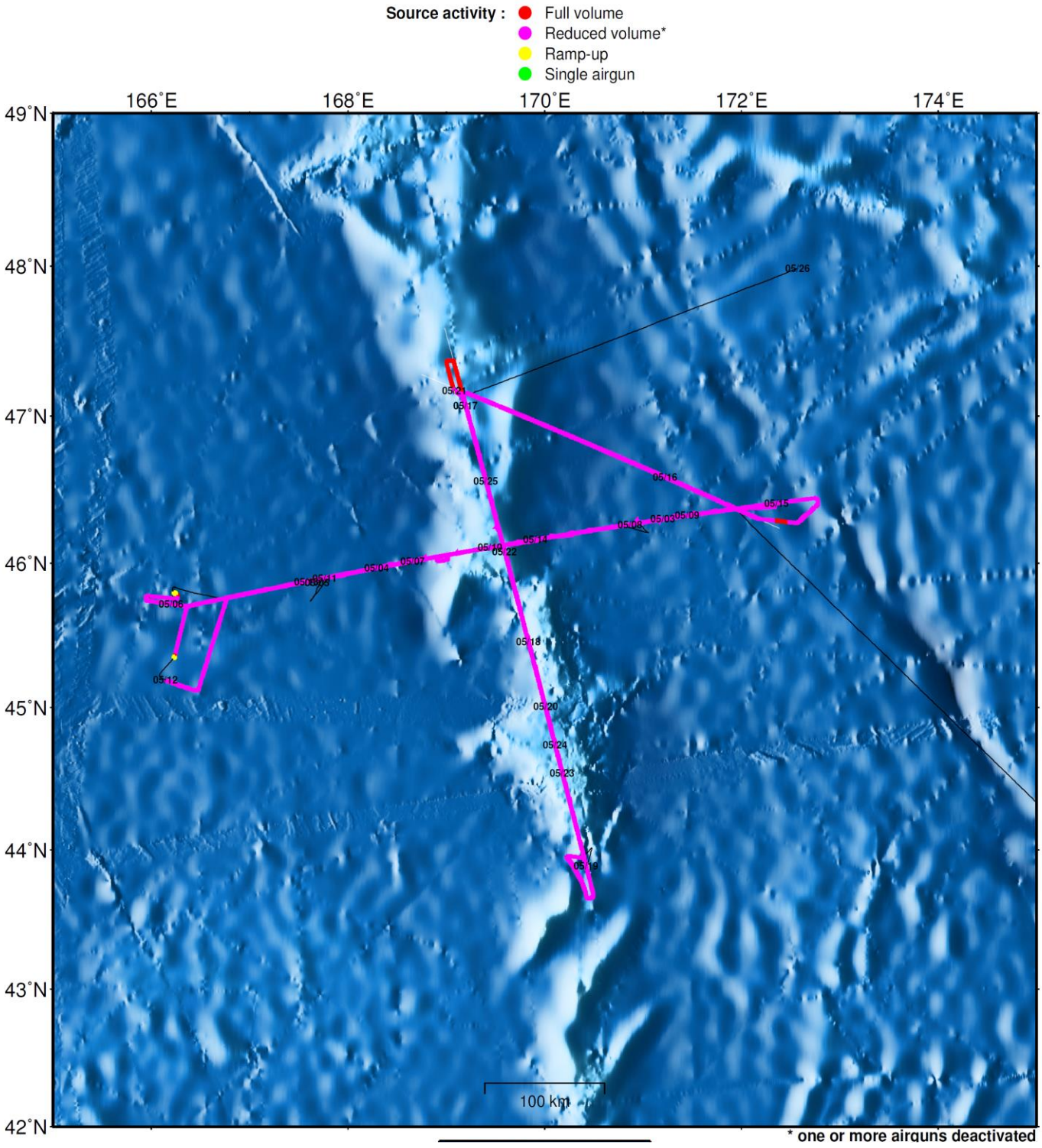

Figure 7: Geospatial data of source operations for the Emperor Seamount Chain survey area.

In addition to the suspensions of operations outlined in

Table 4, the acoustic source was silenced for mechanical/technical reasons on one occasion during the Main Hawaiian Islands survey (**Error! Not a valid bookmark self-reference.**). Per the IHA, brief periods (less than 30 minutes) of operational silence due to mechanical/technical shut-downs did not require a ramp-up to resume full volume source operations provided that: (1) PSOs have maintained constant visual and/or acoustic observation, and (2) no visual or acoustic detections of protected species occurred within the applicable exclusion zone. For any brief mechanical/technical shut-down at night or in periods of poor visibility (e.g. BSS of four or greater), a ramp-up was required, but if the constant observation was maintained, a pre-clearance watch of 30 minutes was not required. For any longer shut-down, both a 30 pre-clearance watch and a ramp-up were required.

Table 6: Mechanical and technical source silence during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	Date	Reason for Source Silence	Time Acoustic Source Silenced (UTC)	Time Acoustic Source Resumed (UTC)
Main Hawaiian Islands	30 September 2018	Technical – adjustment to the Digishot software	16:10	16:15

The volume of the acoustic source was changed (reduced or increased within the planned full source level) on multiple occasions during the Hawaiian-Emperor Seamount Chain survey programs for a variety of reasons including, but not limited to, issues with individual airgun elements and routine source maintenance. Specific information about each instance where acoustic source volume changed can be found in Appendix F.

4.1.4. Interactions with Other Vessels

In addition to visually monitoring for protected species, PSOs also observed and documented interactions with other marine traffic. Over the course of the survey program, 25 other vessels were observed in the vicinity of the R/V *Langseth*, including 10 cargo vessels, two chase vessels, eight fishing vessels, two navy ships, one tanker, one tour group boat, and one tug boat and barge. These vessels had an average closest distance of 9,956 meters to the *Langseth*, ranging between 1,000 and 35,188 meters. Table 7 lists the number of each vessel type observed during the survey program as well as the closest, farthest, and average distances each vessel type was observed to the *Langseth*. The majority of the vessels were observed during the first Main Hawaiian Islands survey, with only seven of the vessels (including six cargo vessels and one tanker) observed during the second Emperor Seamount Chain survey.

Table 7: Other vessels observed during the Hawaiian-Emperor Seamount Chain seismic survey program.

Vessel Type	Total Number Observed	Recorded Distance to the *Langseth* (meters)		
		Average	Closest	Farthest
Cargo	10	16,453	5,000	35,188
Chase	2	8,150	1,300	15,000
Fishing	8	4,425	1,500	7,700
Navy	2	8,750	7,500	10,000
Tanker	1	3,704	3,704	3,704
Tour Group	1	1,000	1,000	1,000
Tug Boat and Barge	1	8,000	8,000	8,000

There was one occasion during the survey program where another vessel was observed having some type of interaction with the *Langseth's* seismic gear (**Error! Not a valid bookmark self-reference.**), when a small fishing/recreational boat travelled over the streamers astern of the *Langseth*, and their fishing gear becoming entangled with the deployed seismic equipment. No seismic gear was damaged during these interactions.

There were no occasions during the survey program where the Langseth had to deviate from planned survey operations (e.g. diverge from the survey line, reduce speed) because of other vessels in the survey area.

In addition to vessel interactions, 08 and 09 October 2018, during the Main Hawaiian Islands survey, two unmanned ocean research drones from the company Saildrone were sighted in the vicinity of the Langseth. The closest distance one of these drones was observed to the vessel was approximately 1,500 meters.

Table 8: Other vessel interaction with Langseth seismic gear during the Hawaiian-Emperor Seamount Chain seismic survey program.

Date	Interaction	Closest Point of Approach (meters)
22 Sept 2018	Fishing vessel crossed over the streamer approximately 1500 meters astern of the Langseth. Bridge was unsuccessful contacting them via radio.	1500

4.2. VISUAL MONITORING SURVEY SUMMARY

Visual monitoring during the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey program was conducted by two PSOs during all daylight hours throughout each survey of the program, beginning 30 minutes before sunrise and ended 30 minutes after sunset each day (

Table 9).

Table 9: Initiation and termination of visual monitoring during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey program	Visual Monitoring Began	Visual Monitoring Ended
Main Hawaiian Islands	16:17 UTC/11 September 2018	18:39 UTC/21 October 2018
Emperor Seamount Chain	16:30 UTC/1 May 2019	08:39 UTC/26 May 2019

Throughout the entire North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey program, visual monitoring was conducted over a period of 67 days for a total of 921 hours 10 minutes. This total includes 523 hours 51 minutes over 41 days during the Main Hawaiian Islands Survey, and 397 hours 19 minutes over 26 days during the Emperor Seamount Chain Survey.

Of the overall total visual monitoring effort, 49% was undertaken while the acoustic source was active, and 51% was undertaken while the acoustic source was silent. Visual monitoring during acoustic source silence occurred during the transits to and from the survey sites, and during deployment, retrieval and maintenance of the seismic equipment, and was conducted to collect baseline data about protected species abundance in the survey areas.

Table 10 detail visuals monitoring with acoustic source operations throughout the North Pacific Ocean

Hawaiian-Emperor Seamount Chain Seismic Survey programs.

Table 10. Total visual monitoring effort during the Hawaiian-Emperor Seamount Chain seismic survey program.

Visual Monitoring Effort	Duration (hh:mm)	% of Overall Visual Monitoring Effort
Main Hawaiian Islands Survey		
Total monitoring while acoustic source active	256:03	48.88%
Total monitoring while acoustic source silent	267:48	51.12%
Total monitoring effort	**523:51**	**56.87%**
Emperor Seamount Chain Survey		
Total monitoring while acoustic source active	198:13	49.89%
Total monitoring while acoustic source silent	199:06	50.11%
Total monitoring effort	**397:19**	**43.13%**
North Pacific Ocean Hawaiian-Emperor Seamount Chain Survey Program		
Total monitoring while acoustic source active	454:16	49.31%
Total monitoring while acoustic source silent	466:54	50.69%
Total monitoring effort	**921:10**	**100%**

Visual observations were preferentially conducted from the PSO tower, which provided a 360-degree view of the water around the vessel and the acoustic source. Visual watches were conducted from other locations including the catwalk, bridge and/or stern if monitoring conditions could not be undertaken from the tower, such as during rough weather and sea conditions which made the tower unsafe, or when the vessel was heading directly into the wind blowing the engine exhaust onto the tower.

During the North Pacific Ocean Hawaiian-Emperor Seamount Chain survey program, PSOs conducted visual monitoring from the tower (30%) and from the bridge (48%) more often than any other location. The majority of the monitoring from the bridge (78%) was conducted during the second Emperor Seamount Chain survey due to several days of high winds and large swells which made monitoring from the tower unsafe, and many days where the wind off the bow of the vessel blew engine exhaust onto the tower. Monitoring was conducted from multiple locations simultaneously when the ships exhaust was blowing on part of the tower but monitoring conditions were otherwise favorable (Table 11).

Table 11: Total visual monitoring effort from observation locations during the Hawaiian-Emperor Seamount Chain seismic survey program.

Observation Location During Visual Effort	Main Hawaiian Islands Survey		Emperor Seamount Chain Survey		Total	
	Duration (hh:mm)	% of Overall Effort	Duration (hh:mm)	% of Overall Effort	Duration (hh:mm)	% of Overall Effort
Tower	248:00	47%	27:03	7%	**275:03**	**30%**
Bridge	98:19	19%	345:34	87%	**443:53**	**48%**
Catwalk	65:24	12%	09:50	2%	**75:14**	**8%**
Stern	00:00	0%	00:00	0%	**00:00**	**0%**
Tower/Bridge	09:39	2%	01:59	1%	**11:38**	**1%**
Tower/Catwalk	25:51	5%	00:25	0%	**26:16**	**3%**
Tower/Stern	00:00	0%	00:00	0%	**00:00**	**0%**
Bridge/Catwalk	76:38	15%	12:28	3%	**89:06**	**10%**

Bridge/Stern	00:00	0%	00:00	0%	**00:00**	**0%**
Catwalk/Stern	00:00	0%	00:00	0%	**00:00**	**0%**

4.3. ACOUSTIC MONITORING SURVEY SUMMARY

Acoustic monitoring during the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program was conducted continuously throughout acoustic source operations and to the maximum extent possible while the acoustic source was silent from the first deployment of the PAM cable to the final retrieval of the cable upon completion of a survey program (Table 12). Brief periods of source activity without acoustic monitoring were infrequently conducted for any needed assessments, adjustments, or maintenance to the PAM system. Periods without source activity or acoustic monitoring occurred when the PAM hydrophone cable was secured on board the vessel during transits, during deployment and recovery of the seismic gear, and during times when operations were suspended due to rough weather and sea conditions.

Table 12: Initiation and termination of acoustic monitoring watches during Hawaiian-Emperor Seamount Chain seismic survey program.

Survey program	Acoustic Monitoring Began	Acoustic Monitoring Ended
Main Hawaiian Islands	08:21 UTC/20 September 2018	15:44 UTC/20 October 2018
Emperor Seamount Chain	09:59 UTC/5 May 2019	09:43 UTC/23 May 2019

Throughout the entire survey program, acoustic monitoring was conducted on 38 days for a total of 796 hours 54 minutes. This total includes 488 hours 15 minutes over 22 days during the Main Hawaiian Islands Survey, and 308 hours 39 minutes over 16 days during the Emperor Seamount Chain Survey.

Of the overall total acoustic monitoring effort, 96% (768 hours 49 minutes) was undertaken while the acoustic source was active, and 4% (28 hours five minutes) was undertaken while the acoustic source was silent. Acoustic monitoring while the acoustic source was silent was mainly conducted during the brief periods of time between recovery/deployment of the seismic gear and recovery/deployment of the PAM cable

Table 13 details acoustic monitoring with acoustic source operations throughout the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program.

Table 13. Total Passive Acoustic Monitoring (PAM) effort during the Hawaiian-Emperor Seamount Chain seismic survey program.

Acoustic Monitoring Effort	Duration (hh:mm)	% of Overall Acoustic Monitoring Effort
Main Hawaiian Islands Survey		
Total night time monitoring	231:25	53%
Total day time monitoring	256:50	47%
Total monitoring while the acoustic source was active	476:02	97%
Total monitoring while the acoustic source was silent	12:13	3%
Total acoustic monitoring	**488:15**	**61%**
Emperor Seamount Chain Survey		
Total night time monitoring	104:15	34%
Total day time monitoring	204:24	66%
Total monitoring while the acoustic source was active	292:47	95%
Total monitoring while the acoustic source was silent	15:52	5%
Total acoustic monitoring	**308:39**	**39%**
North Pacific Ocean Hawaiian-Emperor Seamount Chain Survey Program		
Total night time monitoring	335:40	42%

Total day time monitoring	461:14	58%
Total monitoring while the acoustic source was active	768:49	96%
Total monitoring while the acoustic source was silent	28:05	4%
Total acoustic monitoring	**796:54**	**100%**

Acoustic monitoring was suspended seven times throughout the survey program for a variety of reasons including: debris removal and maintenance of the PAM cable, replacement of damaged PAM equipment, rough seas/risk of entanglement with towed seismic gear, assessment and adjustment of the PAM equipment, seismic gear deployment and retrievals, and transit. Acoustic monitoring downtime was calculated as any time acoustic monitoring was not conducted between the first deployment of the hydrophone cable at the beginning of the survey and the final retrieval of the hydrophone cable at the end of the survey.

During the entire North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program, acoustic monitoring downtime totaled 362 hours 13 minutes. Most of the downtime was due to deployment, retrieval, and maintenance of the seismic equipment (Table 14). Most of the acoustic monitoring downtime occurred during the Main Hawaiian Islands Survey (66%), as the hydrophone cable was on board for extended periods during deployment and retrieval of the OBSs before completion of source operations for the survey. Each instance of acoustic monitoring downtime is recorded in Appendix G.

In accordance with the IHA and ITS, acoustic monitoring downtime occurred during acoustic source activity only when the need was unavoidable. Throughout the entire survey program, only two hours 31 minutes of acoustic monitoring downtime occurred while the acoustic source was still active. These occurrences were attributed to the assessment, adjustment, and maintenance of the PAM equipment, all of which occurred during the first Main Hawaiian Islands survey of the program.

During the Main Hawaiian Islands Survey, acoustic monitoring was suspended on five occasions for a total duration of 239 hours eight minutes, including two hours 52 minutes for replacement of damaged PAM equipment and 42 minutes for assessing and adjusting the PAM equipment. There were 10 days of no acoustic monitoring or source operations while OBS retrieval operations were conducted from 10 to 18 October 2018 before acquisition of the final survey line, which accounted for the remaining 235 hours 34 minutes of the downtime. During the Emperor Seamount Chain Survey, acoustic monitoring was suspended on two occasions for a total of 123 hours five minutes of acoustic monitoring downtime, all of which occurred due to deployment and retrieval of the seismic equipment when operations switched between MCS and OBS survey lines.

Per the IHA requirements for the survey, NMFS was notified of the suspensions of acoustic monitoring during operations.

Table 14. Passive Acoustic Monitoring (PAM) downtime during the Hawaiian-Emperor Seamount Chain seismic survey program.

Cause of Downtime	Main Hawaiian Islands Survey		Emperor Seamount Chain Survey		Total	
	Duration (hh:mm)	% of Overall Downtime	Duration (hh:mm)	% of Overall Downtime	Duration (hh:mm)	% of Overall Downtime
Debris Removal and Maintenance Hydrophone Cable	-	-	-	-	-	-
Replacement of Damaged PAM Equipment	02:52	1.20%	-	-	02:52	0.79%
Rough Seas/Risk of Entanglement	-	-	-	-	-	-
Assessment and Adjustment to PAM Equipment	00:42	0.29%	-	-	00:42	0.19%

Seismic Gear Deployment/Retrieval/Maintenance	235:34	98.51%	123:05	100%	358:39	99.02%
Transit (after initial PAM cable deployment for the survey)	-	-	-	-	-	-
Total Passive Acoustic Monitoring Downtime	**239:08**	**66%**	**123:05**	**34%**	**362:13**	**100%**

4.4. SIMULTANEOUS VISUAL AND ACOUSTIC MONITORING SUMMARY

Acoustic monitoring was conducted during all day and night hours during the survey program to the maximum extent possible for a total of 465 hours nine minutes over both programs (Table 15). Of the overall simultaneous monitoring effort, 97% was conducted while the acoustic source was active. Additional visual monitoring conducted during transit periods was not accompanied by acoustic monitoring as the increased vessel speed caused the hydrophone cable to migrate to the water surface, out of the ideal tow position, where the increased background noise impaired acoustic detection capabilities.

Table 15: Simultaneous visual and acoustic monitoring effort during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey Program	Simultaneous Visual and Acoustic Monitoring				
	Source Active		Source Silent		Overall
	Duration (hh:mm)	Percentage (%)	Duration (hh:mm)	Percentage (%)	Duration (hh:mm)
Main Hawaiian Islands Survey	253:58	98%	05:49	2%	259:47
Emperor-Seamount Chain Survey	198:13	97%	07:09	3%	205:22
Total Survey Program	**452:11**	**97%**	**12:58**	**3%**	**465:09**

4.5. ENVIRONMENTAL CONDITIONS

Environmental conditions can have an impact on the probability of detecting protected species in a survey area. The environmental conditions present during visual observations undertaken during this survey program were generally moderate to good for the Main Hawaiian Islands Survey, and moderate to poor for the Emperor Seamount Chain Survey.

Visibility was classified as ‘excellent’ if it extended to 10 kilometers or greater, good if it was between six to nine kilometers, moderate if it was between two and five kilometers, and poor if it was less than two kilometers. During the North Pacific Ocean Hawaiian-Emperor Seamount Survey Program, only 45% of the overall visual monitoring effort was undertaken during excellent visibility and 24% was undertaken during good visibility (Table 16). There was a large difference in visibility between the two surveys of the program. During the first Main Hawaiian Islands survey, 77% of visual monitoring was undertaken when visibility was 10 kilometers or greater. However, during the second Emperor Seamount Chain survey, only 4% of visual monitoring was undertaken when visibility was 10 kilometers or greater. The majority of visual monitoring during the Emperor Seamount Chain survey was undertaken while visibility was five kilometers or less (54%; 26% for visibility two to five kilometers, and 28% for visibility less than two kilometers).

Table 16. Visibility during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	<2 km	2-5 km	6-9 km	>10 km
Main Hawaiian Islands Survey	**40:28**	**33:56**	**46:53**	**402:34**
Emperor Seamount Chain Survey	**110:33**	**103:33**	**169:09**	**14:15**
Overall Project Totals	**151:01**	**137:18**	**216:02**	**416:49**

Reduced visibility was mainly attributed to periods of rain and fog, and the brief periods of reduced lighting before sunrise and after sunset. Throughout the survey program, precipitation was recorded during 29% of the overall visual monitoring effort, for a total of 272 hours 18 minutes. The majority of the precipitation was fog (20% of the overall visual monitoring effort, 185 hours 22 minutes), the majority of which was recorded during the Emperor Seamount Chain survey (46% of visual monitoring effort during the survey, 183 hours 15 minutes) (Table 17).

Table 17. Precipitation during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	None	Light Rain	Heavy Rain	Squall	Fog
Main Hawaiian Islands Survey	**477:10**	**40:36**	**01:59**	**01:59**	**02:07**
Emperor Seamount Chain Survey	**171:42**	**34:25**	**07:57**	**00:00**	**183:15**
Overall Project Totals	**648:52**	**75:01**	**09:56**	**01:59**	**185:22**

During visual monitoring throughout the survey program, the entire predicted 160 decibel radius was not visible for 329 hours 39 minutes, mainly due to precipitation and reduced lighting during the dawn and dusk hours. The entire 1,000 meter buffer zone was not visible for 100 hours 20 minutes, the entire 500 meter exclusion zone was not visible for 68 hours 14 minutes, and the entire 100 meter exclusion zone was not visible for 46 hours 56 minutes (Table 18). The majority of the time where one of these predicted radii were not full visible occurred during the Emperor Seamount Chain survey due to extended periods of dense fog and light rain.

Table 18. Duration radii were NOT fully visible during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	160 dB	1000 m	500 m	100 m
Main Hawaiian Islands Survey	**87:57**	**24:12**	**14:46**	**05:01**
Emperor Seamount Chain Survey	**241:42**	**76:08**	**53:28**	**41:55**
Overall Project Totals	**329:39**	**100:20**	**68:14**	**46:56**

The Beaufort Sea state recorded during visual monitoring ranged from level one to level six over the course of the survey program. The majority of visual observations (688 hours 21 minutes, 75%) were undertaken in conditions where the Beaufort state was level three or four, which were considered good conditions for the detection of protected species (Table 19). The majority of the level five to level six sea states were recorded during the Emperor Seamount Chain survey (72 hours 16 minutes). The Emperor Seamount Chain survey also had more variability in recorded sea states than the Main Hawaiian Islands survey, mainly due to several storm systems that passed through the survey location.

Table 19. Beaufort Sea State during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Main Hawaiian Islands Survey	**00:00**	**63:53**	**224:43**	**189:16**	**40:22**	**05:37**	**00:00**	**00:00**	**00:00**	**00:00**
Emperor Seamount Chain Survey	**05:43**	**44:49**	**159:26**	**114:56**	**66:04**	**06:12**	**00:00**	**00:00**	**00:00**	**00:00**
Overall Project Totals	**05:43**	**108:42**	**384:09**	**304:12**	**106:26**	**11:49**	**00:00**	**00:00**	**00:00**	**00:00**

The Beaufort wind force recorded during visual monitoring ranged from one (one to three knots) to eight

(34 to 40 knots). The majority of visual monitoring throughout the survey program occurred during a recorded wind force of four (11 to 16 knots) for a total of 291 hours 55 minutes (32% of all visual monitoring effort). The highest wind speeds, between 28 and 40 knots (levels seven and eight), were recorded for a total of 38 hours three minutes (4% of the overall project total), mainly during the Emperor Seamount Chain survey (35 hours 58 minutes) (Table 20).

Table 20. Beaufort Wind Force during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	B1 (1-3 knots)	B2 (4-6 knots)	B3 (7-10 knots)	B4 (11-16 knots)	B5 (17-21 knots)	B6 (22-27 knots)	B7 (28-33 knots)	B8 (34-40 knots)	B9 (41-47 knots)	B10 (48-55 knots)
Main Hawaiian Islands Survey	**21:55**	**49:41**	**121:11**	**176:02**	**115:53**	**37:04**	**01:35**	**00:30**	**00:00**	**00:00**
Emperor Seamount Chain Survey	**15:43**	**16:42**	**47:53**	**115:53**	**92:49**	**72:21**	**32:04**	**03:54**	**00:00**	**00:00**
Overall Project Totals	**37:38**	**66:23**	**169:04**	**291:55**	**208:42**	**109:25**	**33:39**	**04:24**	**00:00**	**00:00**

Swell heights during visual observations were generally low, with swells of less than two meters recorded for the majority of visual observations (780 hours six minutes, 85% of the total visual effort, Table 21). The majority of the two to four meter swells and all of the greater than four meter swells were recorded during the Emperor Seamount Chain survey, totaling 116 hours 11 minutes.

Table 21. Swell height during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	<2m	2-4m	>4m
Main Hawaiian Islands Survey	**498:58**	**24:53**	**00:00**
Emperor Seamount Chain Survey	**281:08**	**92:38**	**23:33**
Overall Project Totals	**780:06**	**117:31**	**23:33**

The majority of visual monitoring effort during the survey program was conducted while no glare was present, for a total of 423 hours six minutes (46%, Table 22). The majority of the moderate and severe glare occurred during the Main Hawaiian Islands survey (346 hours 38 minutes). During times of moderate to severe glare, it is possible that the detection of protected species was hindered.

Table 22. Glare during the Hawaiian-Emperor Seamount Chain seismic survey program.

Survey	None	Little	Moderate	Severe
Main Hawaiian Islands Survey	**109:49**	**67:24**	**116:28**	**230:10**
Emperor Seamount Chain Survey	**313:17**	**38:15**	**22:57**	**22:50**
Overall Project Totals	**423:06**	**105:39**	**139:25**	**253:00**

5. MONITORING AND DETECTION RESULTS

5.1. VISUAL DETECTIONS

Visual monitoring efforts during the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program resulted in a total of 13 detections of protected species, including eight detections of whales, four detections of dolphins, and one detection of pinnipeds. During the Main Hawaiian Islands Survey, there were three detections, including one detection of whales and two detections of dolphins. During the Emperor Seamount Chain Survey, there were 10 detections, including seven detections of whales, two detections of dolphins, and one detections of pinniped. **Error! Not a valid bookmark self-reference.** lists the total number of detections and total number of animals recorded for each protected species observed during the survey program. Photographs taken of visual detections can be found in Appendix I. More detailed information about each sighting event can be found in Appendix H.

Table 23. Number of visual detection records collected for each Protected Species during the Hawaiian-Emperor Seamount Chain seismic survey program.

Species	Main Hawaiian Islands Survey		Emperor Seamount Chain Survey		Overall Survey Program	
	Total Number Detection Records	Total Number Animals Recorded	Total Number Detection Records	Total Number Animals Recorded	Total Number Detection Records	Total Number Animals Recorded
Fin Whales	-	-	2	5	2	5
Sperm Whales	-	-	1	2	1	2
Unidentified Baleen Whales	-	-	3	4	3	4
Unidentified Whales	1	3	1	1	2	4
All Whales	**1**	**3**	**7**	**12**	**8**	**15**
Killer Whales	-	-	1	7	1	7
Short-finned Pilot Whales	1	8	-	-	1	8
Spinner Dolphins	1	8	-	-	1	8
Unidentified Dolphins	-	-	1	3	1	3
All Dolphins	**2**	**16**	**2**	**10**	**4**	**26**
Northern Fur Seal	-	-	1	1	1	1
All Pinnipeds	**-**	**-**	**1**	**1**	**1**	**1**
TOTAL Protected Species	**3**	**19**	**10**	**23**	**13**	**42**

During the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program, unidentified baleen whales were the most frequently observed species, totaling 23% of all protected species. Dolphins had the largest number of individuals sighted per species group, with most detections consisting of seven or eight individuals. Whales were sighted either individually or in small groups of two or three individuals. The one sighting of pinnipeds during the survey program consisted of one individual.

During the Main Hawaiian Islands Survey, all of the detections occurred while the vessel was near one of the islands (Figure 8). During the Emperor Seamount Chain Survey, all except one of the detections occurred while the vessel was near or over the seamounts (Figure 9).

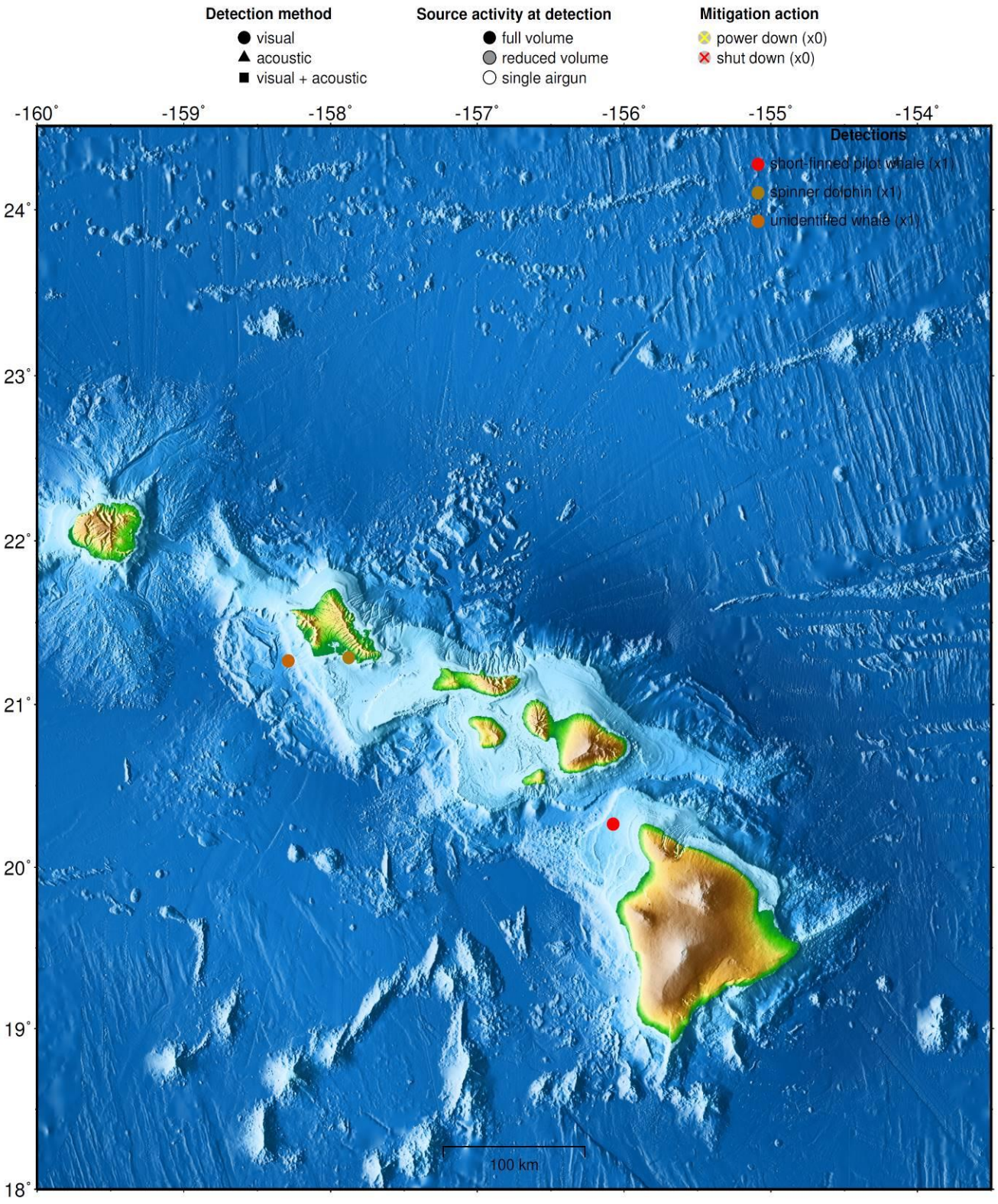

Figure 8: Protected species detections during the Main Hawaiian Islands survey.

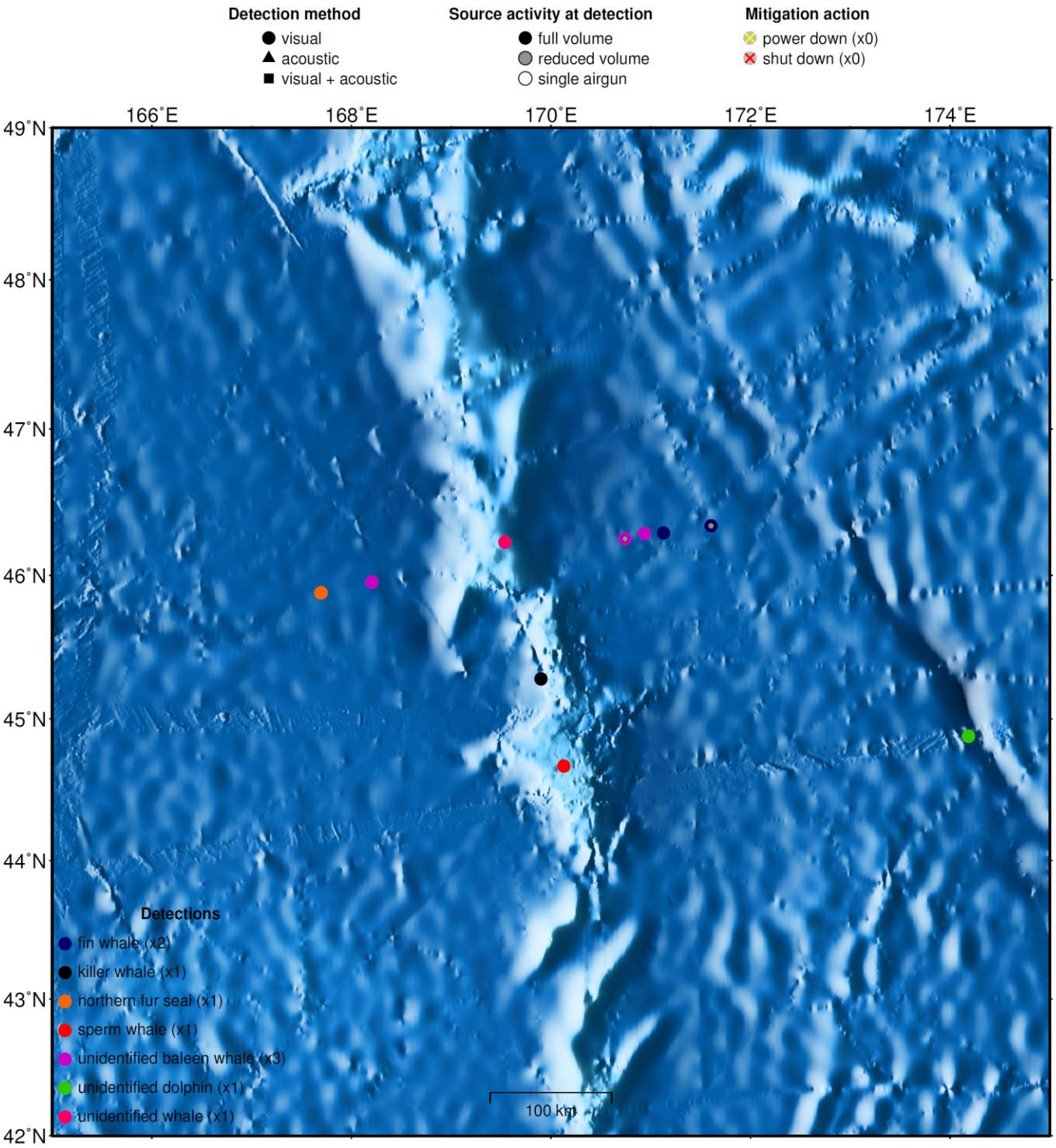

Figure 9: Protected species detections during the Emperor Seamount Chain survey.

During the Main Hawaiian Islands Survey, the one detection of unidentified whales occurred at the beginning of the survey while the vessel was transiting from the dock near the island of Oahu. The detection of short-finned pilot whales occurred near the Kohala peninsula of the island of Hawaii while the vessel was retrieving OBSs. The detection of spinner dolphins occurred near dock while the vessel was returning to port in the Island of Oahu at the end of the survey (Figure 10).

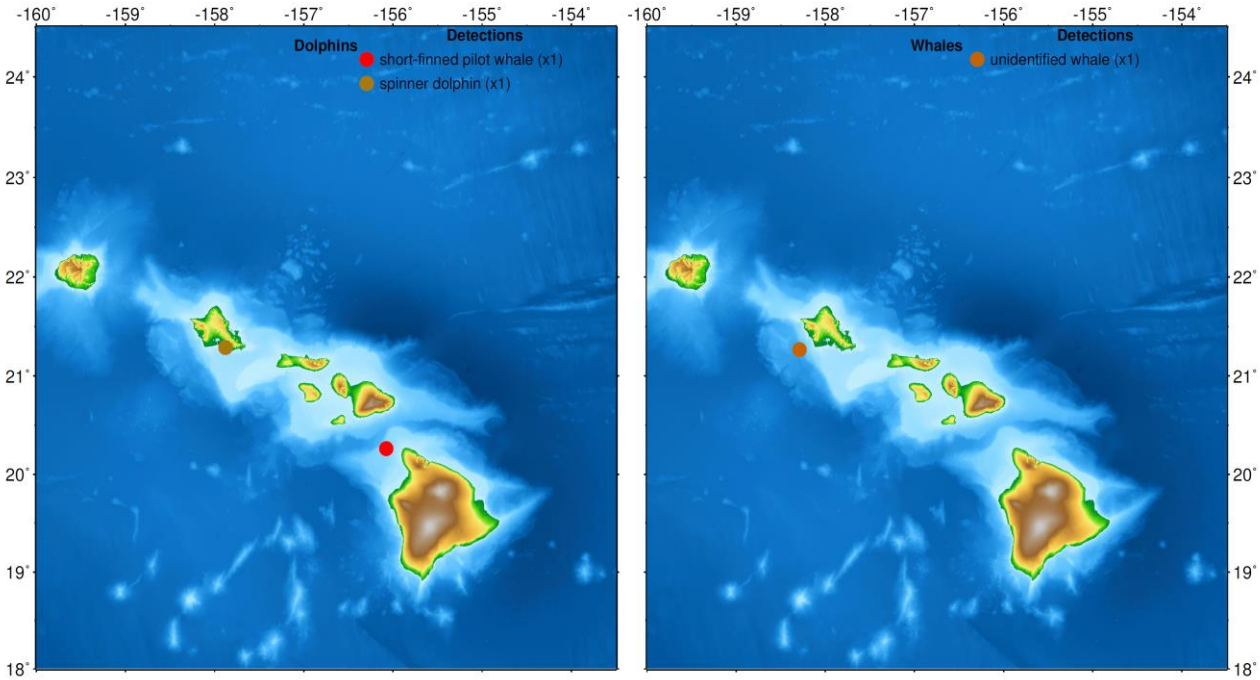

Figure 10: Protected species observed during the Main Hawaiian Islands survey sorted by species group.

During the Emperor Seamount Chain Survey, the sighting of unidentified dolphins occurred while the vessel was transiting within the survey area towards the first survey line of the project, while the sighting of killer whales occurred over the seamounts at the end of the survey operations. The two sightings of fin whales and three sightings of unidentified baleen whales occurred during week two of the survey while the vessel was conducting operations on the east-west survey line. The one sighting of sperm whales and one sighting of an unidentified whale occurred during the last week of the survey while the vessel was completing operations on the north-south survey line. The one sighting of a pinniped occurred on the west end of the east-west line during the first week of the survey operations (Figure 11).

There was a large variability in weather conditions throughout the North Pacific Ocean Hawaiian-Emperor Seamount Chain Survey Program, especially during the Emperor Seamount Chain survey. However, in general, visual detections occurred on days with high visibility, small swells, and calm seas (Figure 12).

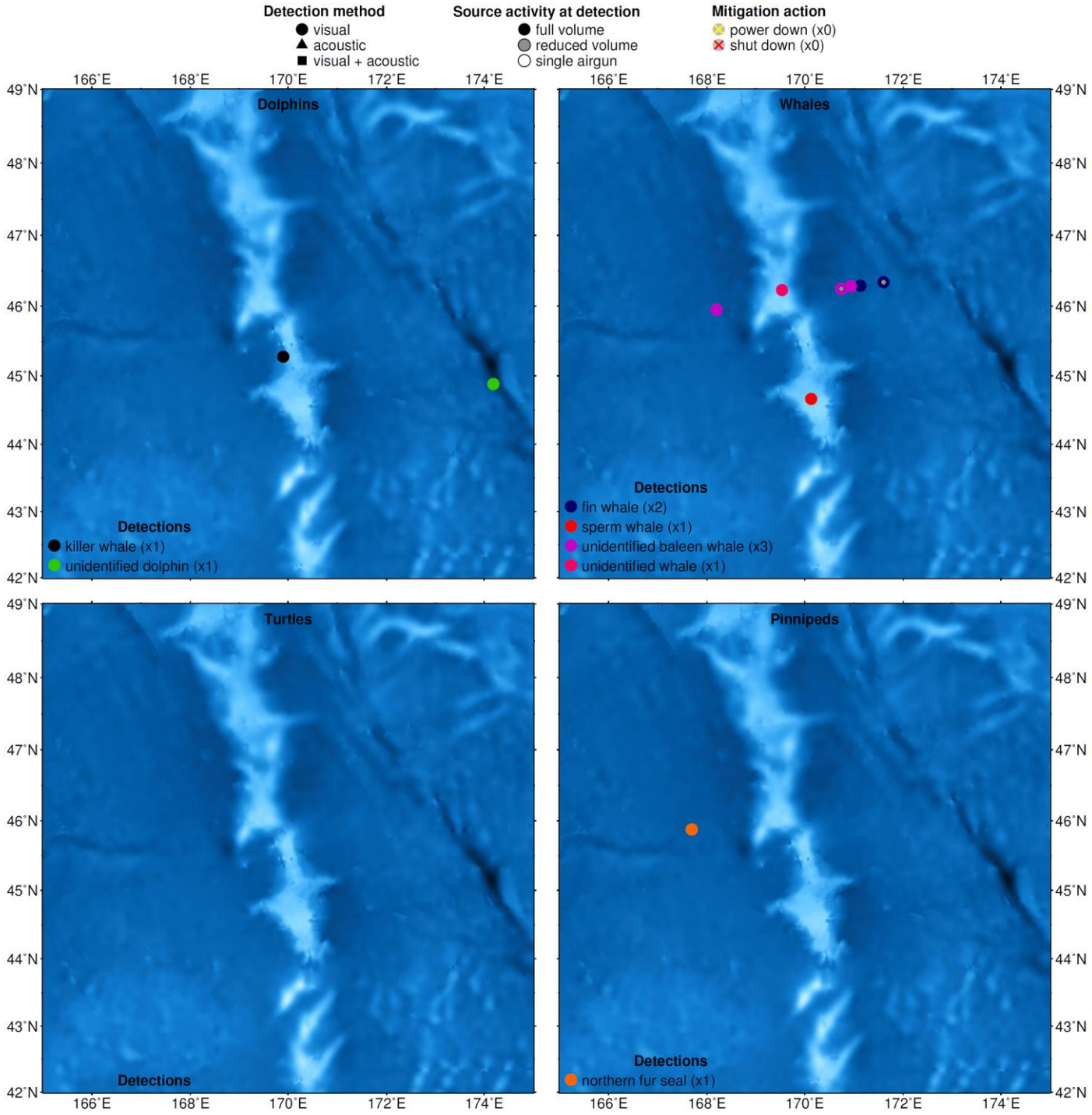

Figure 11: Protected Species observed during the Emperor Seamount Chain survey sorted by species group.

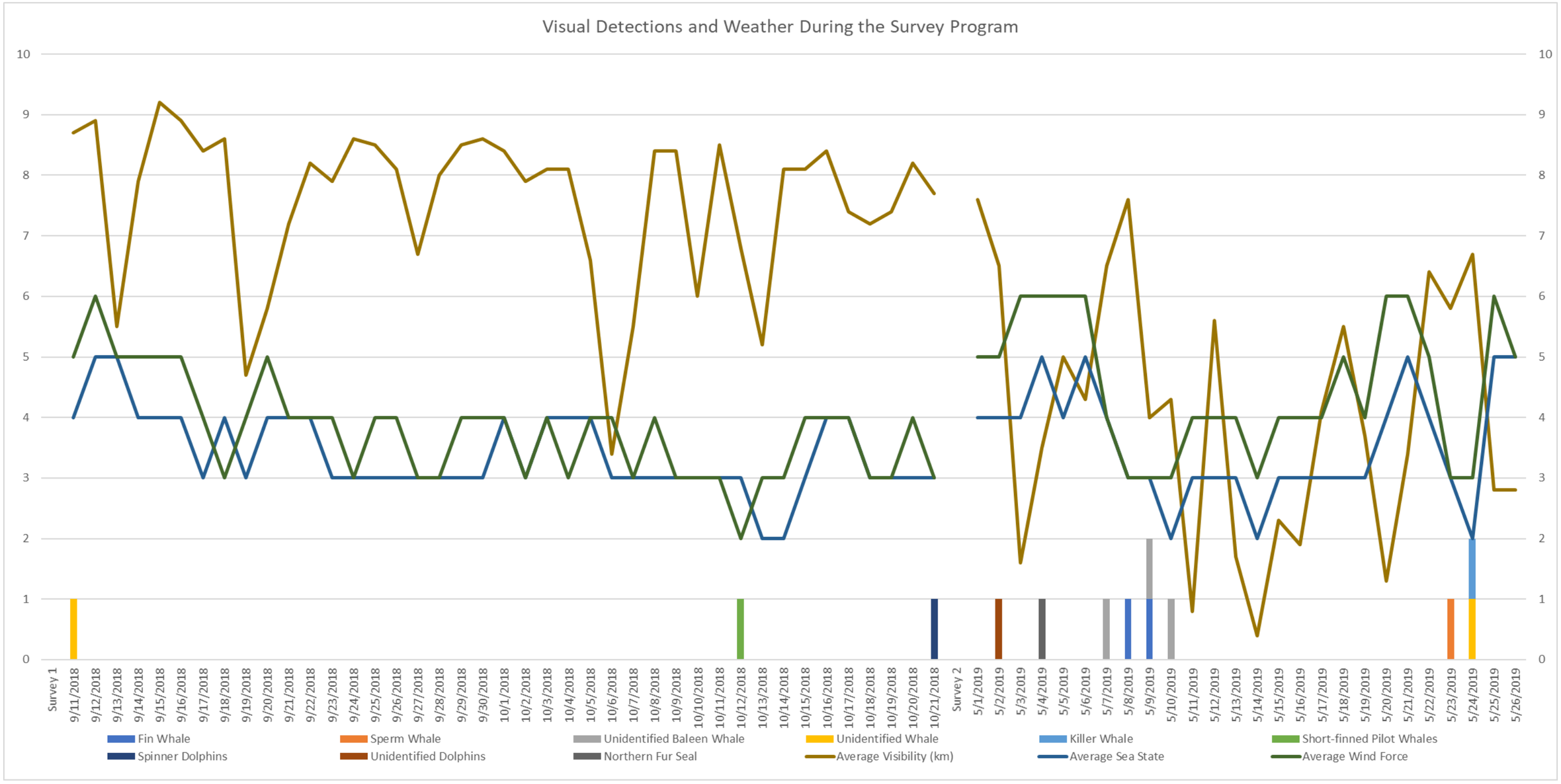

Figure 12: Number of protected species detections each day of the Hawaiian-Emperor Seamount Chain seismic survey program and corresponding weather data for each day.

Of the 13 visual detections of protected species during the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program, two detections (15%) occurred while the acoustic source was at full or reduced volume on a survey line, and 11 detections (85%) occurred while the acoustic source was silent (

Table 24). The two detections which occurred while the acoustic source was at full or reduced volume on a survey line consisted of one detection of fin whales and one detection of unidentified baleen whales. The fin whales had a closest observed distance of 1230 meters to the active source while the unidentified baleen whales had a closest observed distance of 1096 meters. The 11 detections during acoustic source silence all occurred while the source arrays were secured on board the vessel either during transits or during OBS deployment/retrieval operations. For these detections, the distance to the source was calculated as if the source arrays had been deployed. While the acoustic source was silent, whales had the furthest distances with an average of 2,205 meters, dolphins had the second furthest distances with an average of 489 meters, and pinnipeds had the closest distance of 183 meters. Had the acoustic source arrays been deployed, spinner dolphins would have had the closest distance of any of the species, with a range of one meter.

Table 24. Average closest approach of protected species to the acoustic source at various volumes during the Hawaiian-Emperor Seamount Chain seismic survey program.

Species Detected	Full or Reduced Volume on a Survey Line		Full or Reduced Volume Not on a Survey Line		Single 40 in³ Element		Ramp-up		Source Silent and Deployed		Source Silent and Onboard*	
	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)
Fin Whales	1	1230	-	-	-	-	-	-	-	-	1	1200
Sperm Whales	-	-	-	-	-	-	-	-	-	-	1	3215
Unidentified Baleen Whales	1	1096	-	-	-	-	-	-	-	-	2	2850
Unidentified Whales	-	-	-	-	-	-	-	-	-	-	2	1556
All Whales	**2**	**1163**	-	-	-	-	-	-	**-**	**-**	**6**	**2205**
Killer Whales	-	-	-	-	-	-	-	-	-	-	1	800
Short-finned Pilot Whales	-	-	-	-	-	-	-	-	-	-	1	858
Spinner Dolphins	-	-	-	-	-	-	-	-	-	-	1	1
Unidentified Dolphins	-	-	-	-	-	-	-	-	-	-	1	300
All Dolphins	-	-	-	-	-	-	-	-	**-**	**-**	**4**	**489**
Northern Fur Seal	-	-	-	-	-	-	-	-	-	-	1	183
All Pinnipeds	-	-	-	-	-	-	-	-	**-**	**-**	**1**	**183**
All Protected Species	**2**	**1163**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**11**	**1397**

*For detections which occurred during acoustic source silence while the arrays were onboard during transits, the closest distance to the source was calculated as if the arrays had been deployed.

5.1.1. Other Wildlife

Observations of other positively identified wildlife during the Hawaiian-Emperor Seamount Chain Survey Program included 39 species of birds, three species of fish, and one species of marine invertebrates. A complete list of birds and other marine wildlife observed and identified, in addition to the approximate number of individuals observed and the number of days on which they were observed, can be found in Appendix J. No impacts to any other wildlife species as a result of research activities were observed during the survey program.

There was one sighting of protected bird species during the survey program. On 21 May 2019, during the second Emperor Seamount Chain survey, one juvenile short-tailed albatross was observed for four minutes. The albatross was initially sighted off the starboard bow flying towards the stern of the vessel. The seabird was then observed flying around off the stern for approximately three minutes, and then flying away from the vessel on a north-westerly heading. No mitigation actions were required for this sighting of a protected seabird as the albatross was not observed diving or foraging within the exclusion zones.

5.2. ACOUSTIC DETECTIONS

There were no acoustic detections of protected species during the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program.

6. MITIGATION ACTION SUMMARY

There were no mitigation actions implemented during the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program due to detections of protected species.

6.1. PROTECTED SPECIES KNOWN TO HAVE BEEN EXPOSED TO 160 DECIBELS OR GREATER OF RECEIVED SOUND LEVELS

Numerous protected species are known to occur within the survey areas, including several species listed as endangered or threatened under the ESA. Endangered marine mammal species included: the North Pacific right, sei, fin, blue, and sperm whales, the Western North Pacific Distinct Population Segments (DPS) of humpback and gray whales, the Hawaiian Islands Insular DPS of false killer whales, the Western DPS of Steller sea lion, and the Hawaiian monk seal. ESA-listed sea turtles included the endangered hawksbill, leatherback, and loggerhead (North Pacific Ocean DPS) sea turtles, and the threatened green (Central North Pacific DPS) and olive ridley sea turtles. Listed seabirds included the endangered Hawaiian petrel, short-tailed albatross, and band-rumped storm petrel, and the threatened Newell's shearwater.

NMFS granted an IHA and ITS for the marine seismic survey allowing Level A harassment takes (exposure to sound pressure levels were there is a potential for auditory injury based upon each species hearing range) for two marine mammal species during the Main Hawaiian Islands Survey and for four marine mammal species during the Emperor Seamount Chain Survey, and Level B harassment takes (exposure to sound pressure levels equal to or greater than 160 dB re: 1 µPa (rms) where there is a potential for behavioral changes) for 28 marine mammal species during the Main Hawaiian Islands Survey and for 26 marine mammal species during the Emperor Seamount Chain Survey. NMFS also authorized takes for five species of sea turtles during the Main Hawaiian Islands Survey; however, there were no specific number of takes authorized for sea turtles during the Emperor Seamount Chain Survey. For sea turtles, behavioral harassment (Level B) was expected to occur in the 175 dB zone, and PTS (Level A) was expected to occur in the 195 dB zone. No takes were authorized for ESA-listed seabirds; however, mitigation actions would have been implemented for seabirds in the event that they were sighting diving or foraging within the 500 meter or 100 meter exclusion zones.

For the Main Hawaiian Islands Survey, a total of 11,066 individual marine mammals from 28 species (including five whale species and one dolphin species listed as endangered species) were authorized for takes in the IHA and ITS. Of this total, 11,043 individuals from all 28 species were authorized for Level B takes, and 23 individuals from two species were authorized for Level A takes. During the Main Hawaiian Islands seismic survey, no protected species were observed within the Level B Harassment zone, and no protected species were observed within the Level A harassment zone while the acoustic source was active (Table 25).

For the Emperor Seamount Chain Survey, a total of 11,090 individual marine mammals from 26 species (including seven whale species listed as endangered species) were authorized for takes in the IHA and ITS. Of this total, 11,024 individuals from all 26 species were authorized for Level B takes, and 66 individuals from four species were authorized for Level A takes. During the Emperor Seamount Chain seismic survey, four protected species were observed within the Level B Harassment zone and no protected species were observed within the Level A harassment zone whale the acoustic source was active (Table 26).

Table 25. Number of Authorized and Potential Level A and B Harassment Takes During the Main Hawaiian Islands Seismic Survey Program.

Species	IHA Authorized Level A Takes	Potential Level A Takes / PTS During the Program	IHA Authorized Level B Takes	Potential Level B Takes / TTS During the Program	Total IHA Authorized Takes	Total Potential Takes During the Program
ESA Listed Species						
Blue Whale	-	-	5	-	5	-
Fin Whale	-	-	4	-	4	-
Humpback Whale	-	-	2	-	2	-
Sei Whale	-	-	11	-	11	-
Sperm Whale	-	-	123	-	123	-
False Killer Whales*	-	-	60	-	60	-
Non-Listed Species						
Bryde's Whale	-	-	45	-	45	-
Minke Whale	-	-	1	-	1	-
Pygmy Sperm Whale	7	-	184	-	191	-
Dwarf Sperm Whale	16	-	454	-	470	-
Blainville's Beaked Whale	-	-	57	-	57	-
Cuvier's Beaked Whale	-	-	20	-	20	-
Deraniygala's Beaked Whale	-	-	124	-	124	-
Gunko-toothed Beaked Whale	-	-	124	-	124	-
Hubb's Beaked Whale	-	-	124	-	124	-
Longman's Beaked Whale	-	-	205	-	205	-
Common Bottlenose Dolphin	-	-	592	-	592	-
Fraser's Dolphin	-	-	1,381	-	1,381	-
Pantropical Spotted Dolphin	-	-	1,534	-	1,534	-
Risso's Dolphin	-	-	312	-	312	-
Rough-toothed Dolphin	-	-	1,949	-	1,949	-
Spinner Dolphin	-	-	460	-	460	-
Striped Dolphin	-	-	1,644	-	1,644	-
Killer Whale	-	-	5	-	5	-
Pygmy Killer Whale	-	-	286	-	286	-
Melon-headed Whale	-	-	810	-	810	-
Short-finned Pilot Whale	-	-	524	-	524	-
Hawaiian Monk Seal	-	-	3	-	3	-
Sea turtles						
Green Sea Turtle	-	-	7	-	7	-
Hawksbill Sea Turtle	-	-	1	-	1	-
Leatherback Sea Turtle	-	-	65	-	65	-
Loggerhead Sea Turtle	-	-	61	-	61	-
Olive Ridley Sea Turtle	-	-	32	-	32	-
Unidentified species						
Unidentified Whale	-	-	-	-	-	-
Unidentified Dolphin	-	-	-	-	-	-
Unidentified Pinniped	-	-	-	-	-	-
Unidentified Sea Turtle	-	-	-	-	-	-

*Main Hawaiian Islands Insular Population

Table 26: Number of Authorized and Potential Level A and B Harassment Takes During the Emperor Seamount Chain Seismic Survey Program.

Species	IHA Authorized Level A Takes	Potential Level A Takes / PTS During the Program	IHA Authorized Level B Takes	Potential Level B Takes / TTS During the Program	Total IHA Authorized Takes	Total Potential Takes During the Program
ESA Listed Species						
Blue Whale	-	-	5	-	5	-
Fin Whale	-	-	8	3	8	3
Gray Whale	-	-	2	-	2	-
Humpback Whale	2	-	16	-	18	-
North Pacific Right Whale	-	-	2	-	2	-
Sei Whale	3	-	11	-	14	-
Sperm Whale	-	-	90	-	90	-
Non-Listed Species						
Bryde's Whale	-	-	2	-	2	-
Minke Whale	5	-	98	-	103	-
Pygmy Sperm Whale	-	-	121	-	121	-
Dwarf Sperm Whale	-	-	298	-	298	-
Baird's Beaked Whale	-	-	121	-	121	-
Cuvier's Beaked Whale	-	-	225	-	225	-
Stejner's Beaked Whale	-	-	21	-	21	-
False Killer Whale	-	-	417	-	417	-
Killer Whale	-	-	1,253	-	1,253	-
Northern Right-Whale Dolphin	-	-	141	-	141	-
Pacific White-sided Dolphin	-	-	2,870	-	2,870	-
Risso's Dolphin	-	-	1,126	-	1,126	-
Short-beaked Common Dolphin	-	-	180	-	180	-
Short-finned Pilot Whale	-	-	1,713	-	1,713	-
Striped Dolphin	-	-	384	-	384	-
Dall's Porpoise	56	-	1,423	-	1,479	-
Northern Elephant Seal	-	-	343	-	343	-
Northern Fur Seal	-	-	149	-	149	-
Ribbon Seal	-	-	5	-	5	-
Sea turtles						
Green Sea Turtle	-	-	-	-	-	-
Hawksbill Sea Turtle	-	-	-	-	-	-
Leatherback Sea Turtle	-	-	-	-	-	-
Loggerhead Sea Turtle	-	-	-	-	-	-
Olive Ridley Sea Turtle	-	-	-	-	-	-
Unidentified species						
Unidentified Whale	-	-	-	1	-	1
Unidentified Dolphin	-	-	-	-	-	-
Unidentified Pinniped	-	-	-	-	-	-
Unidentified Sea Turtle	-	-	-	-	-	-

The number of potential takes may be an underestimation and, therefore, may be a minimum estimate of the actual number of protected species potentially exposed to received sound levels within the predicted Level A and Level B harassment zones. It is possible that the estimated numbers of animals recorded were underestimates due to some animals not being seen or having moved away before they were observed. This is most likely to have occurred with sea turtles that were not close enough to the surface to be sighted from the vessel, and large pods of dolphins where exact number of individuals is difficult to determine. The Beaufort Sea state has a large impact on the ability to visibly detect many smaller or unobtrusive marine species such as beaked whales and sea turtles. During the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program, there were many days where Beaufort Sea states (greater than level 4) may have resulted in some missed protected species detections. Only 55% of all visual monitoring observations throughout the survey program were conducted during Beaufort Sea states of level 3 or less.

Additionally, beyond hours of dawn, dusk and darkness, there were several occasions where the entire predicted 160 dB radii, 1,000 meter buffer zone, 500 meter exclusion zone, and 100 meter exclusion zone were not fully visible, which would have prevented sightings of protected species within those areas around the vessel. Throughout the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program, the entirety of the 160 decibel radii were not visible for 329 hours 39 minutes during visual monitoring efforts. The entire 1,000 meter buffer zone was not visible for 100 hours 20 minutes, the entire 500 meter exclusion zone was not visible for 68 hours 14 minutes, and the entire 100 meter exclusion zone was not visible for 46 hours 56 minutes. The majority of the occasions where these radii were not fully visible occurred during the Emperor Seamount Chain survey, where visibility was greatly reduced due to extended periods of dense fog and rain.

Previous analysis of R/V *Langseth* source received levels collected via hydrophone streamers in shallow waters (Crone 2014 and 2017), demonstrated that the measured mitigation zones were substantially smaller than those predicted. Therefore, animals observed within the predicted mitigation zones in shallow water for this survey may not have experienced received levels at those predicted levels. Furthermore, as described in the PEIS, Lloyd's mirror and surface release effects ameliorate the effects for animals at or near the sea surface.

Table 27 describes the behavior of all animals, including unidentified species, which were visually observed within the predicted Level A and Level B harassment zones while the acoustic source was active during the survey program. While there were no highly distinctive behavioral reactions observed in relation to the vessel or acoustic source during the seismic survey, the majority of the protected species detected were last observed moving away from the vessel.

Table 27: Behavior of species visually observed to be exposed to sound pressure levels of 160 dB or greater during the Hawaiian-Emperor Seamount Chain seismic survey program.

Species	Detection No.	No. of Animals	Highest Observed Sound Pressure Level (dB)	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
Unidentified Whale	6	1	160	Blowing	Unknown	Surfacing, blowing, moderate travel pace	Parallel to the vessel in the opposite direction
Fin Whale	7	3	160	Blowing	Parallel to the vessel in the opposite direction	Fast travel, blowing	Away from the vessel

6.2. IMPLEMENTATION AND EFFECTIVENESS OF THE BIOLOGICAL OPINION'S ITS AND IHA

In order to minimize the potential impacts to marine mammals and sea turtles during the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program, LDEO and PSOs were prepared to implement mitigation measures whenever these protected species were detected approaching, entering, or within the exclusion zones designated in the IHA and ITS. There were no mitigation actions implemented for protected species during the survey program. The confirmation of the implementation of each Term and Condition of the Biological Opinion's Incidental Take Statement are described within this report.

Additional mitigation measures in the IHA and ITS required that:

(1) The acoustic source would be shut-down if a large whale with a calf was observed at any distance from the vessel.
(2) The acoustic source would be shut-down if an aggregation (six or more individuals) of large whales was observed at any distance from the vessel.
(3) The acoustic source would be shut-down if a melon-headed whale or group of melon-headed whales were observed at any distance from the vessel in the range of the Kohala resident stock, which included melon-headed whales off the Kohala Peninsula and west coast of Hawaii Island in water depths of 2,500 meters or less.
(4) The acoustic source would be shut-down when an individual spinner or bottlenose dolphin or group of spinner or bottlenose dolphins was observed approaching or within the Level B harassment zone (6.7 kilometers) in the habitat of the specific main Hawaiian Island insular stock (within the 1,000 meter isobaths of each island) if the authorized takes had been met for any of these stocks.

Throughout the Hawaiian-Emperor Seamount Chain Seismic Survey Program, none of these additional mitigation measures were required to be implemented.

The IHA and ITS also waived the shut-down requirement for small dolphins of the *Tursiops*, *Delphinus*, *Lagenodelphis*, *Lagenorhynchus*, *Lissodelphis*, *Stenella*, and *Steno* genera. If observers could positively identify these species upon initial detection, the acoustic source would be powered-down instead of shut-down if the individuals(s) were visually detected within the 500 meter EZ. However, if there was any uncertainty to the species identification, the source would be shut-down. In addition, observers could elect to waive the power-down requirement if the delphinids of these genera appeared to be voluntarily approaching the vessel for the purpose of interacting with the vessel or towed gear. However, if any adverse reactions were observed from these dolphins, then a power-down was required. During the Hawaiian-Emperor Seamount Chain Seismic Survey Program, there were no instances where the shut-down exemption for any of these species was implemented.

In the event that an injured or dead protected species was discovered during the course of the survey program, and the lead visual observer determined that the cause of death was unknown or unrelated to the activities of the vessel, the incident was to be immediately reported. The report would include a detailed description of the incident, including pictures when possible, and information about the vessel's activities within the 24 hours prior to the discovery of the injured/dead protected species. Throughout the Hawaiian-Emperor Seamount Chain Seismic Survey Program, there were no sightings of dead protected species.

Passive acoustic monitoring was conducted throughout the surveys and the majority of acoustic monitoring was undertaken while the source was active. High levels of background noise on the hydrophone cable occur when the vessel traveled at higher speeds (greater than six knots), which made it impractical to conduct monitoring for baseline acoustic data collection while the vessel was in transit to and from the survey site. This prevented baseline acoustic data from being collected on the survey site and during transit while visual monitoring was ongoing for baseline data collection purposes. Throughout

the Hawaiian-Emperor Seamount Chain Seismic Survey Program, there were no acoustic detections of protected species.

For the Main Hawaiian Islands Survey, a total of 11,066 individual marine mammals from 28 species (including five whale species and one dolphin species listed as endangered species) were authorized for takes in the IHA and ITS. Of this total, 11,043 individuals from all 28 species were authorized for Level B takes, and 23 individuals from two species were authorized for Level A takes. In addition, 166 takes were authorized for five species of endangered sea turtles. During the survey, no protected species were observed within the predicted Level B or Level A harassment radii while the acoustic source was active.

For the Emperor Seamount Chain Survey, a total of 11,090 individual marine mammals from 26 species (including seven whale species listed as endangered species) were authorized for takes in the IHA and ITS. Of this total, 11,024 individuals from all 26 species were authorized for Level B takes, and 66 individuals from four species were authorized for Level A takes. There were no specific number of takes authorized for endangered sea turtle species during for this survey of the program. During the survey, a total of four protected species were observed within the predicted Level B harassment radius. This total represents less than one percent of the authorized Level B takes for the survey. There were no protected species observed within the predicted Level A harassment radius.

PSOs likely did not detect all animals present, however, it is highly unlikely that the actual number of animals present during survey operations reached anywhere near the fully authorized levels for all species. The combination of conservative predicted mitigation zones combined with conservative take estimation by NMFS (*i.e.,* the precautionary approach), appears for most species to have resulted in an overestimation of take and of overall impact on marine species from the activity.

The monitoring and mitigation measures required by the IHA and ITS appear to have been an effective means to protect the marine species encountered during survey operations.

7. LITERATURE CITED

NOAA, 2018. Endangered Species Act Section 7 Consultation Biological Opinion for a marine seismic survey by Lamont-Doherty Earth Observatory in the North Pacific Ocean and NFMS IHA issuance.

Crone, T.J., M. Tolstoy, and H. Carton. 2014. Estimating shallow water sound power levels and mitigation radii for the R/V Marcus G. Langseth using an 8 km long MCS streamer. Geochem., Geophys., Geosyst. 15(10):3793-3807.

Crone, T.J., M. Tolstoy, and H. Carton. 2017. Utilizing the R/V Marcus G. Langseth's streamer to measure the acoustic radiation of its seismic source in the shallow waters of New Jersey's continental shelf. PloS ONE 12(8): e0183096. http://doi.org/10.1371/journal.pone.0183

APPENDIX A: Incidental Harassment Authorization for the North Pacific Ocean Hawaiian-Emperor Seamount Chain Marine Geophysical Survey Program.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

AUG 24 2018

Sean Higgins
Director, Office of Marine Operations
Lamont-Doherty Earth Observatory
61 Rt. 9W
Palisades, NY 10964

Dear Mr. Higgins:

Enclosed is an Incidental Harassment Authorization (IHA) issued to Lamont-Doherty Earth Observatory, under the authority of Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*) to take, by Level A harassment and Level B harassment only, small numbers of marine mammals incidental to two marine geophysical surveys in the north Pacific Ocean in 2018/2019.

You are required to comply with the conditions contained in the IHA, including all mitigation, monitoring and reporting requirements. Along with mitigation measures, the IHA requires monitoring for the presence and behavior of marine mammals during all activities associated with the project.

If you have any questions concerning the IHA or its requirements, please contact Rob Pauline, Office of Protected Resources, National Marine Fisheries Service, at (301) 427-8408.

Sincerely,

Donna S. Wieting
Director, Office of Protected Resources

Enclosure

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

INCIDENTAL HARASSMENT AUTHORIZATION

The Lamont-Doherty Earth Observatory of Columbia University (L-DEO) and is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371(a)(5)(D)) to harass marine mammals incidental to a marine geophysical survey in the North Pacific Ocean, when adhering to the following terms and conditions.

1. This Incidental Harassment Authorization (IHA) is valid from September 1, 2018, through August 31, 2019.

2. This IHA is valid only for marine geophysical activity as specified in L-DEO's IHA application and using an array aboard the R/V *Langseth* with characteristics specified in the IHA application, in the Pacific Ocean near the main Hawaii Islands and Emperor Seamounts.

3. General Conditions

   (a) A copy of this IHA must be in the possession of L-DEO, the vessel operator, the lead protected species observer (PSO) and any other relevant designees of L-DEO operating under the authority of this IHA.

   (b) The species and numbers authorized for taking are listed in Tables 1 and Tables 2 (attached).

   (c) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in condition 3(b) of the Authorization or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA.

   (d) L-DEO or the vessel operator must conduct briefings between PSOs and vessel crew prior to the start of all seismic operations, and when new personnel join the work, in order to explain responsibilities, communication procedures, marine mammal monitoring protocol, and operational procedures.

4. Mitigation Measures

   The holder of this Authorization is required to implement the following mitigation measures:

   (a) L-DEO must use at least five dedicated, trained, NMFS-approved Protected Species Observers (PSOs). The PSOs must have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements.

(b) At least one of the visual and two of the acoustic PSOs aboard the vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience

(c) Visual Observation

(i) During survey operations *(e.g.*, any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of two visual PSOs must be on duty and conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during ramp-up, including nighttime ramp-ups, of the airgun array.

(ii) Visual PSOs must coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and must conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

(iii) Visual PSOs must immediately communicate all observations to the acoustic PSO(s) on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(iv) During good conditions (*e.g.*, daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs must conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

(v) Visual PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO

(d) Acoustic Monitoring

(i) The source vessel must use a towed passive acoustic monitoring system (PAM) which must be monitored by, at a minimum, one on duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.

(ii) Acoustic PSOs must immediately communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the

PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(iii) Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties may not exceed 12 hours per 24-hour period for any individual PSO.

(iv) Survey activity may continue for 30 minutes when the PAM system malfunctions or is damaged, while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional five hours without acoustic monitoring during daylight hours only under the following conditions:

a. Sea state is less than or equal to BSS 4;

b. With the exception of delphinids, no marine mammals detected solely by PAM in the applicable exclusion zone in the previous two hours;

c. NMFS is notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system; and

d. Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of five hours in any 24-hour period.

(e) Exclusion zone and buffer zone

(i) PSOs must establish and monitor a 500 m exclusion zone and 1,000 m buffer zone. The exclusion zone encompasses the area at and below the sea surface out to a radius of 500 meters from the edges of the airgun array (0–500 meters). The buffer zone encompasses the area at and below the sea surface from the edge of the 0–500 meter exclusion zone, out to a radius of 1,000 meters from the edges of the airgun array (500–1,000 meters). PSOs must monitor the beyond 1,000 meters and enumerate any takes that occur beyond the buffer zone.

(f) Pre-clearance and Ramp-up

(i) A ramp-up procedure must be followed at all times as part of the activation of the acoustic source, except as described under 4(f)(vi).

(ii) Ramp-up must not be initiated if any marine mammal is within the exclusion or buffer zone. If a marine mammal is observed within the exclusion zone or the buffer zone during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the zone or until an additional time period has elapsed with no further sightings (15 minutes for small odontocetes and pinnipeds and 30 minutes for mysticetes and large odontocetes all other species).

(iii) Ramp-up must begin by activating a single airgun of the smallest volume in the array and must continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Duration must not be less than 20 minutes.

(iv) PSOs must monitor the exclusion and buffer zones during ramp-up, and ramp-up must cease and the source must be shut down upon observation of a marine mammal within the exclusion zone. Once ramp-up has begun, observations of marine mammals within the buffer zone do not require shutdown or powerdown, but such observation must be communicated to the operator to prepare for the potential shutdown or powerdown.

(v) Ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up.

(vi) If the acoustic source is shut down for brief periods (i.e., less than 30 minutes) for reasons other than that described for shutdown and powerdown (*e.g.*, mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant visual and/or acoustic observation and no visual or acoustic detections of marine mammals have occurred within the applicable exclusion zone. For any longer shutdown, pre-clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (e.g., BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation was maintained, pre-clearance watch of 30 min is not required.

(vii) Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance of 30 min.

(g) Shutdown and Powerdown

(i) Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown or powerdown of the acoustic source if a marine mammal is detected within the 500 m exclusion zone (100 m when shutdown has been waived as described in 4(g)(v).

(ii) The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown and powerdown commands are conveyed swiftly while allowing PSOs to maintain watch.

(iii) When the airgun array is active (i.e., anytime one or more airguns is active, including during ramp-up and powerdown) and (1) a marine mammal (excluding delphinids) appears within or enters the exclusion zone and/or (2) a marine mammal is detected acoustically and localized within the exclusion zone, the acoustic source must be shut down. When shutdown is called for by a PSO, the airgun array must be immediately deactivated. Any questions regarding a PSO shutdown must be resolved after deactivation.

(iv) Shutdown must occur whenever PAM alone (without visual sighting), confirms presence of marine mammal(s) (other than delphinids) in the 500 m exclusion zone. During daylight hours, if the acoustic PSO cannot confirm presence within exclusion zone, visual PSOs must be notified but shutdown is not required.

(v) The shutdown requirement shall be waived for small dolphins of the following genera: *Tursiops, Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Stenella* and *Steno*.

a. The acoustic source must be powered down to 40-in^3 airgun if an individual belonging to these genera is visually detected within the 500 m exclusion zone.

b. When the acoustic source is powered down to the 40-in^3 airgun due to the presence of dolphins specified in 4(g)(v), an exclusion zone of 100 m and Level B harassment zone of 430 m will be in effect for species other than specified dolphin genera that may approach the survey vessel.

c. Powerdown conditions must be maintained until delphinids, for which shutdown is waived, are no longer observed within the 500 m exclusion zone, following which full-power operations may be resumed without ramp-up. Visual PSOs may elect to waive the powerdown requirement if delphinids for which shutdown is waived appear to be voluntarily approaching the vessel for the purpose of interacting with the vessel or towed gear, and must use best professional judgment in making this decision.

d. If PSOs observe any behaviors in delphinids for which shutdown is waived that indicate an adverse reaction, then powerdown must be initiated.

e. Visual PSOs must use best professional judgment in making the decision to call for a shutdown if there is uncertainty regarding identification (i.e., whether the observed marine mammal(s) belongs to one of the delphinid genera for which shutdown is waived).

(vi) Shutdown is required when a large whale with a calf or an aggregation of large whales is observed regardless of the distance from the *Langseth*.

(vii) Shutdown is required when a melon-headed whale or group of melon-headed whales is observed in the range of the Kohala resident stock. L-DEO must make a good faith effort to transit through the Kohala resident stock range during daylight hours. The Kohala resident stock boundary includes melon-headed whales off the Kohala Peninsula and west coast of Hawaii Island in less than 2,500 m of water.

(viii) Shutdown is required when a spinner or bottlenose dolphin or group of dolphins is observed approaching or is within the Level B harassment zone (6.7 km) in the habitat of the specific main Hawaiian Island insular stock if the authorized takes have been met for any of these stocks. The ranges of the Oahu/4-Islands and Hawaii Island insular stocks of spinner dolphin include waters within the 1,000 m isobaths of each island. Similarly, the boundaries of the Oahu and Hawaii Islands insular stocks of common bottlenose dolphins encompass areas within the 1,000 isobath of each island.

(ix) Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable exclusion zone (i.e., animal is not required to fully exit the buffer zone where applicable) or following a clearance period (15 minutes for small odontocetes and pinnipeds and 30 minutes for mysticetes and large odontocetes) with no further observation of the marine mammal(s).

(h) Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (specific distances detailed below), to ensure the potential for strike is minimized.

(i) Vessel speeds must be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of any marine mammal are observed near a vessel.

(ii) Vessels must maintain a minimum separation distance of 100 m from large whales (i.e., sperm whales and all baleen whales.

(iii) Vessels must attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel.

(iv) When marine mammals are sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distance. If marine mammals are sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This recommendation does not apply to any vessel towing gear.

(i) Actions to Minimize Additional Harm to Live Stranded (or Milling) Marine Mammals – In the event of a live stranding (or near-shore atypical milling) event within 50 km of the survey operations, where the NMFS stranding network is engaged in herding or other interventions to return animals to the water, the Director of OPR, NMFS (or designee) will advise L-DEO of the need to implement shutdown procedures for all active acoustic sources operating within 50 km of the stranding. Shutdown procedures for live stranding or milling marine mammals include the following:

(i) If at any time, the marine mammal(s) die or are euthanized, or if herding/intervention efforts are stopped, the Director of OPR, NMFS (or designee) will advise the IHA-holder that the shutdown around the animals' location is no longer needed.

(ii) Otherwise, shutdown procedures will remain in effect until the Director of OPR, NMFS (or designee) determines and advises the IHA-holder that all live animals involved have left the area (either of their own volition or following an intervention).

(iii) If further observations of the marine mammals indicate the potential for re-stranding, additional coordination with the IHA-holder will be required to determine what measures are necessary to minimize that likelihood (*e.g.*, extending the shutdown or moving operations farther away) and to implement those measures as appropriate.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring must be conducted in accordance with the following requirements:

(a) The operator must provide PSOs with bigeye binoculars (e.g., 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (i.e., Fujinon or equivalent) solely for PSO use. These must be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel.

(b) The operator must work with the selected third-party observer provider to ensure PSOs have all equipment (including backup equipment) needed to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals. Such equipment, at a minimum, must include:

(i) PAM must include a system that has been verified and tested by the acoustic PSO that will be using it during the trip for which monitoring is required.

(ii) At least one night-vision device suited for the marine environment for use during nighttime pre-clearance and ramp-up that features automatic brightness and gain control, bright light protection, infrared illumination, and/or optics suited for low-light situations (e.g., Exelis PVS-7 night vision goggles; Night Optics D-300 night vision monocular; FLIR M324XP thermal imaging camera or equivalents).

(iii) Reticle binoculars (e.g., 7 x 50) of appropriate quality (i.e., Fujinon or equivalent) (at least one per PSO, plus backups).

(iv) Global Positioning Units (GPS) (at least one per PSO, plus backups).

(v) Digital single-lens reflex cameras of appropriate quality that capture photographs and video (i.e., Canon or equivalent) (at least one per PSO, plus backups).

(vi) Compasses (at least one per PSO, plus backups).

(vii) Radios for communication among vessel crew and PSOs (at least one per PSO, plus backups).

(viii) Any other tools necessary to adequately perform necessary PSO tasks.

(c) Protected Species Observers (PSOs, Visual and Acoustic) Qualifications

(i) PSOs must be independent, dedicated, trained visual and acoustic PSOs and must be employed by a third-party observer provider.

(ii) PSOs must have no tasks other than to conduct observational effort (visual or acoustic), collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards), and

(iii) PSOs must have successfully completed an approved PSO training course appropriate for their designated task (visual or acoustic). Acoustic PSOs are required to complete specialized training for operating PAM systems and are encouraged to have familiarity with the vessel with which they will be working.

(iv) PSOs can act as acoustic or visual observers (but not at the same time) as long as they demonstrate that their training and experience are sufficient to perform the task at hand.

(v) NMFS must review and approve PSO resumes.

(vi) NMFS shall have one week to approve PSOs from the time that the necessary information is submitted, after which PSOs meeting the minimum requirements shall automatically be considered approved.

(vii) One visual PSO with experience as shown in 4(b) shall be designated as the lead for the entire protected species observation team. The lead must coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. To the maximum extent practicable, the lead PSO must devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

(viii) PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

(ix) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics.

(x) The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must be submitted to NMFS and must include written justification. Requests must be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored protected species surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

(d) Data Collection

(i) PSOs must use standardized data collection forms, whether hard copy or electronic. PSOs must record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior

before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source. If required mitigation was not implemented, PSOs should record a description of the circumstances.

(ii) At a minimum, the following information must be recorded:

a. Vessel names (source vessel and other vessels associated with survey) and call signs;

b. PSO names and affiliations;

c. Date and participants of PSO briefings (as discussed in General Requirement);

d. Dates of departures and returns to port with port name;

e. Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;

f. Vessel location (latitude/longitude) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;

g. Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change;

h. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;

i. Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions changed (e.g., vessel traffic, equipment malfunctions); and

j. Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (i.e., pre-clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.).

(iii) Upon visual observation of any protected species, the following information must be recorded:

a. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);

b. PSO who sighted the animal;

c. Time of sighting;

d. Vessel location at time of sighting;

e. Water depth;

f. Direction of vessel's travel (compass direction);

g. Direction of animal's travel relative to the vessel;

h. Pace of the animal;

i. Estimated distance to the animal and its heading relative to vessel at initial sighting;

j. Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified) and the composition of the group if there is a mix of species;

k. Estimated number of animals (high/low/best);

l. Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);

m. Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);

n. Detailed behavior observations (e.g., number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);

o. Animal's closest point of approach (CPA) and/or closest distance from any element of the acoustic source;

p. Platform activity at time of sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other); and

q. Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up) and time and location of the action.

(iv) If a marine mammal is detected while using the PAM system, the following information should be recorded:

a. An acoustic encounter identification number, and whether the detection was linked with a visual sighting;

b. Date and time when first and last heard;

c. Types and nature of sounds heard (e.g., clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal);

d. Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, and any other notable information.

6. Reporting

(a) L-DEO must submit a draft comprehensive report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The draft report must include the following:

(i) Summary of all activities conducted and sightings of protected species near the activities;

(ii) Full documentation of methods, results, and interpretation pertaining to all monitoring;

(iii) Summary of dates and locations of survey operations and all protected species sightings (dates, times, locations, activities, associated survey activities);

(iv) Geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines should include points recording any change in airgun status (e.g., when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa);

(v) GIS files in ESRI shapefile format and UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates must be referenced to the WGS84 geographic coordinate system;

(vi) Raw observational data;

(vii) Summary of the information submitted in interim monthly reports as well as additional data collected as described above in Data Collection and the IHA;

(viii) Estimates of the number and nature of exposures that occurred above the harassment threshold based on PSO observations, including an estimate of those on the trackline but not detected;

(ix) Certification from the lead PSO as to the accuracy of the report

a. The lead PSO may submit statement directly to NMFS concerning implementation and effectiveness of the required mitigation and monitoring.

(x) A final report must be submitted within 30 days following resolution of any comments on the draft report.

(b) Reporting Injured or Dead Marine Mammals

(i) Discovery of Injured or Dead Marine Mammal – In the event that personnel involved in the survey activities covered by the authorization discover an injured or dead marine mammal, L-DEO must report the incident to the Office of Protected Resources (OPR) (301-427-8401), NMFS and the NMFS Pacific Islands Regional Stranding Coordinator (808-725-5161) as soon as feasible. The report must include the following information:

a. Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);

b. Species identification (if known) or description of the animal(s) involved;

c. Condition of the animal(s) (including carcass condition if the animal is dead);

d. Observed behaviors of the animal(s), if alive;

e. If available, photographs or video footage of the animal(s); and

f. General circumstances under which the animal was discovered.

(ii) Vessel Strike – In the event of a ship strike of a marine mammal by any vessel involved in the activities covered by the authorization, L-DEO must report the incident to OPR, NMFS and to regional stranding coordinators as soon as feasible. The report must include the following information:

a. Time, date, and location (latitude/longitude) of the incident;

b. Species identification (if known) or description of the animal(s) involved;

c. Vessel's speed during and leading up to the incident;

d. Vessel's course/heading and what operations were being conducted (if applicable);

e. Status of all sound sources in use;

f. Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;

g. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;

h. Estimated size and length of animal that was struck;

i. Description of the behavior of the marine mammal immediately preceding and following the strike;

j. If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;

k. Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and

l. To the extent practicable, photographs or video footage of the animal(s).

(iii) Additional Information Requests – If NMFS determines that the circumstances of any marine mammal stranding found in the vicinity of the activity suggest investigation of the association with survey activities is warranted (example circumstances noted below), and an investigation into the stranding is being pursued, NMFS will submit a written request to the IHA-holder indicating that the following initial available information must be provided as soon as possible, but no later than 7 business days after the request for information.

a. Status of all sound source use in the 48 hours preceding the estimated time of stranding and within 50 km of the discovery/notification of the stranding by NMFS; and

b. If available, description of the behavior of any marine mammal(s) observed preceding (i.e., within 48 hours and 50 km) and immediately after the discovery of the stranding.

c. In the event that the investigation is still inconclusive, the investigation of the association of the survey activities is still warranted, and the investigation is still being pursued, NMFS may provide additional information requests, in writing, regarding the nature and location of survey operations prior to the time period above.

8. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

9. Renewals - On a case-by-case basis, NMFS may issue a second one-year IHA without additional notice when 1) another year of identical or nearly identical activities as described in the Specified Activities section is planned or 2) the activities would not be completed by the time the IHA expires and a second IHA would allow for completion of the activities beyond that described in the Dates and Duration section, provided all of the following conditions are met:

(a) A request for renewal is received no later than 60 days prior to expiration of the current IHA.

(b) The request for renewal must include the following:

(i) An explanation that the activities to be conducted beyond the initial dates either are identical to the previously analyzed activities or include changes so minor (e.g., reduction in pile size) that the changes do not affect the previous analyses, take estimates, or mitigation and monitoring requirements.

(ii) A preliminary monitoring report showing the results of the required monitoring to date and an explanation showing that the monitoring results do not indicate impacts of a scale or nature not previously analyzed or authorized.

(iii) Upon review of the request for renewal, the status of the affected species or stocks, and any other pertinent information, NMFS determines that there are no more than minor changes in the activities, the mitigation and monitoring measures remain the same and appropriate, and the original findings remain valid.

Donna S. Wieting,
Director, Office of Protected Resources,
National Marine Fisheries Service.

8/24/18
Date

Table 1. Numbers of Incidental Take of Marine Mammals Authorized During Hawaii Survey.

Species	Authorized Level A	Authorized Level B	Total Authorized Takes
Humpback Whale	0	2	2
Minke whale,	0	1	1
Bryde's whale	2	45	47
Sei whale	0	11	11
Fin whale	0	4	4
Blue whale	0	5	5
Sperm whale	0	123	123
Pygmy sperm whale	7	184	191
Dwarf sperm whale	16	454	470
Cuvier's beaked whale	0	20	20
Longman's beaked whale	0	205	205
Blainville's beaked whale	0	57	57
Ginkgo-toothed beaked whale	0	124	124
Deraniygala's beaked whale	0	124	124
Hubb's beaked whale	0	124	124
Rough-toothed dolphin	0	1,949	1,949
Common bottlenose dolphin	0	592	592
Pantropical spotted dolphin	0	1,534	1,534
Spinner dolphin	0	460	460
Striped dolphin	0	1,644	1,644
Fraser's dolphin	0	1,381	1,381
Risso's dolphin	0	312	312
Melon-headed whale	0	810	810
Pygmy killer whale	0	286	286
False Killer whale	0	60	60

Killer whale	0	5	5
Short-finned pilot whale	0	524	524
Hawaiian monk seal	0	3	3

Table 2. Numbers of Incidental Take of Marine Mammals Authorized During Emperor Seamounts Survey.

Species	Authorized Level A	Authorized Level B	Total Authorized Takes
Gray whale	0	2	2
North Pacific right whale	0	2	2
Humpback whale	2	16	18
Minke whale	5	98	103
Bryde's whale	0	2	2
Sei whale	3	11	14
Fin whale	0	8	8
Blue whale	0	5	5
Sperm whale	0	90	90
Pygmy sperm whale	0	121	121
Dwarf sperm whale	0	298	298
Cuvier's beaked whale	0	225	225
Stejner's beaked whale	0	21	21
Baird's beaked whale	0	121	121
Short-beaked common dolphin	0	180	180
Striped dolphin	0	384	384
Pacific white-sided dolphin	0	2,870	2,870
Northern right whale dolphin	0	141	141
Risso's dolphin	0	1,126	1,126
False killer whale	0	417	417
Killer whale	0	1,253	1,253
Short-finned pilot whale	0	1,713	1,713

Dall's porpoise	56	1,423	1,479
Northern fur seal	0	149	149
Northern elephant seal	0	343	343
Ribbon seal	0	5	5

APPENDIX B: Basic Data Summary Form

BASIC DATA FORM						
LDEO Project Number		MGL1806 and MGL1902				
Seismic Contractor		L-DEO				
Area Surveyed During Reporting Period		Line Number	Start Latitude	Start Longitude	End Latitude	End Longitude
		Main Hawaiian Islands Survey				
		OB01	22.14335°N	153.96522°W	18.80868°N	157.65411°W
		OB2S	21.98630°N	158.35353°W	19.21725°N	159.14319°W
		OB2N	23.79983°N	157.81489°W	21.88063°N	158.38325°W
		MC01	18.76769°N	157.68049°W	22.10519°N	154.00106°W
		MC02	19.19383°N	159.14522°W	23.83948N	157.79827°W
		MC03	22.06934°N	153.95417°W	21.15241°N	153.91309°W
		MC04	22.11578°N	153.94734°W	20.56053°N	154.52350°W
		MC05	20.56481°N	154.54092°W	22.50337°N	158.52056°W
		MC06	21.86550°N	158.40616°W	21.51598°N	159.00109°W
		MC07	21.17246°N	158.97815°W	19.62206°N	156.38611°W
		MC08	23.28630°N	155.44322°W	21.58251°N	156.57939°W
		Emperor Seamount Chain Survey				
		OB01	45.73767°N	165.99148°E	46.40580°N	172.32063°E
		OB02	47.36853°N	169.07075°E	43.90570°N	170.41305°E
		MC01	45.70540°N	166.38098°E	46.44098°N	172.76271°E
		MC02	47.07926°N	169.18948°E	43.74194°N	170.47228°E
		MC03	46.29105°N	172.33078°E	47.15310°N	169.19658°E
		MC04	45.36597°N	166.24039°E	45.70147°N	166.36810°E
Survey Type		2-D OBS and MCS				
Vessel and/or Rig Name		R/V *Marcus G. Langseth*				
Permit Number		IHA issued on 24 August 2018				
Location / Distance of Airgun Deployment		220 meters astern (MHI survey) and 230 meters astern (ESC survey)				
Water Depth	**MHI Survey**	637 meters minimum and 7,885 meters maximum				
	ESC Survey	1,129 meters minimum and 8,206 meters maximum				
Dates of Project	**MHI Survey**	11 September 2018		THROUGH	21 October 2018	
	ESC Survey	23 April 2019		THROUGH	01 June 2019	

Total time airguns operating – all power levels:	771:20
Time airguns operating on survey lines:	714:26
Time airguns operating not on a survey line:	53:56
Amount of time mitigation gun (40 in³) operations:	00:16
Amount of time in ramp-up:	02:35
Number daytime ramp-ups:	3
Number of night time ramp-ups:	4
Number of ramp-ups from mitigation source:	0
Amount of time conducted in airgun testing:	00:07
Duration of visual observations:	921:10
Duration of observations while source active:	454:16
Duration of observation during source silence:	466:54
Duration of acoustic monitoring:	796:54
Duration of acoustic monitoring while source active:	768:49
Duration of acoustic monitoring during source silence:	28:05
Duration of simultaneous acoustic and visual monitoring:	465:09
Lead Protected Species Observer:	Amanda Dubuque (both surveys)
Protected Species Observers: MHI Survey	Bianca Mares, Grace DeLeon, Diana Maldonado

Protected Species Observers: ESC Survey	Yesenia Balderas, Ana Salomon, Andrea Zavala
Lead Acoustic Observer:	Lori Cabrera (MHI), Karla Rios (ESC)
Number of Marine Mammals Visually Detected:	13
Number of Marine Mammals Acoustically Detected:	0
Number of Simultaneous Visual and Acoustic Detections:	0
Number of Sea Turtles detected:	0
Total Number of Protected Species Detections:	13
List Mitigation Actions	None
Duration of operational downtime due to mitigation:	None

APPENDIX C: Passive Acoustic Monitoring System Specifications

1.1 Heavy Tow Cable with separate hydrophone array
Tow Cable serial number SM 5882 (replaced on 26 September 2018), and SM 4946

Mechanical Information
Length = 230 m
Outer diameter = 16.5 mm (+/- 0.5 mm)
Ship-side connector: ITT 19-way, male
Wet-end connector: Seiche, with 36-way Lemo insert, female.
Weight = approximately 94 kg (in air)

1.2 Hydrophone array cable
Cable serial number SM 4964 (replaced on 26 September 2018), and SM 4073

Mechanical Information
Type = Detachable 20 m, 4-ch Array
Length = 20 m
Diameter = 17 mm (over cable), 32 mm (over mouldings), 65 mm (over connector)
Connector = Seiche connector with 36-way Lemo insert, male.
Weight = approximately 10 kg (in air)

Hydrophone elements
Array elements = four spherical hydrophones / preamplifiers, one depth sensor
Hydrophone 1 = 200-200,000 Hz (-3 dB), sensitivity -166dB re 1V/uPa; 0.00 m
Hydrophone 2 = 200-200,000 Hz (-3 dB), sensitivity -166dB re 1V/uPa; at 2.00 m
Hydrophone 3 = 2,000-200,000 Hz (-3 dB), sensitivity -166dB re 1V/uPa; at 15.00 m
Hydrophone 4 = 2,000-200,000 Hz (-3 dB), sensitivity -166dB re 1V/uPa; at 15.25 m
Depth sensor = 10-bar pressure rating.

1.3 Deck cable
Deck serial number SM 4952

Mechanical Information
Length 100m
Diameter 14mm cable, 45mm at male connector, 65mm at female connector
Weight 25kg
Connectors ITT 19 pin

APPENDIX D: PAM Hydrophone Deployment on the R/V *Marcus G. Langseth*

Deployment and retrieval of the hydrophone cable requires the PAM operator and at least one additional person to complete.

Overview

Two hydrophone cables were supplied for the survey, both consisting of a 230 meter steel reinforced tow cable with a detachable 20 meter hydrophone array. The arrays consist of two low-frequency hydrophones (200 hertz to 200 kilohertz), two high-frequency hydrophone elements (two kilohertz to 200 kilohertz) and a depth gauge (100 meter capacity) potted directly into the cable. The four hydrophones have been positioned in two pairs, with the first pair positioned roughly 13 meters ahead of the second pair (**Error! Reference source not found.**). Two chains approximately six kilograms each in weight (12 kilograms total) were taped two meters ahead of the hydrophone array connector on the steel reinforced tow cable.

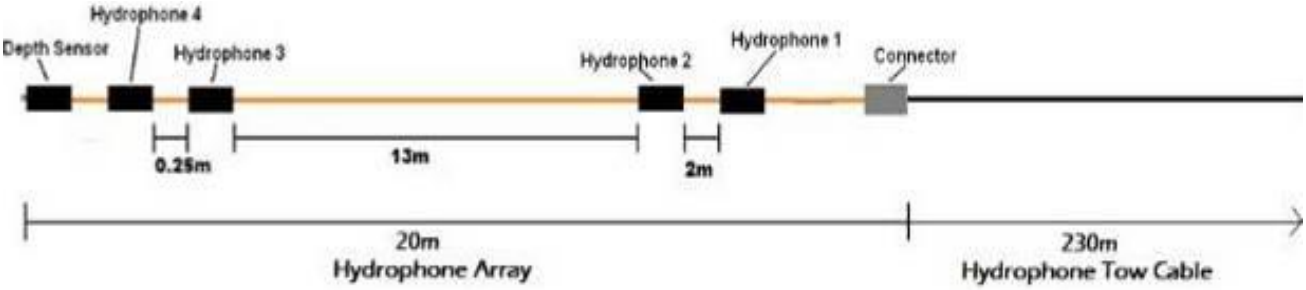

Figure 13: Two part hydrophone cable with a 230 meter tow cable and detachable 20 meter hydrophone array

The hydrophone cable was spooled onto a hydraulic winch located on the port side of the gun deck (**Error! Reference source not found.**). A 100 meter deck cable connected the hydrophone cable on the gun deck to the PAM station in the main science lab (**Error! Reference source not found.**). Due to the structural design of the vessel, two 100 meter deck cables were installed in port, prior to the project. One of the deck cables was designated as the main cable and the other as a spare. The main deck cable was connected to an electronic processing unit (EPU) located, along with two monitors and other monitoring equipment, at the PAM station in the main science lab (**Error! Reference source not found.**). The rack-mounted EPU was secured in the event of rough weather. A GPS feed (GNGGA string) was supplied to the system by the ships navigation Seapath 200.

The hydrophone cable was deployed directly off the stern of the vessel, just aft of the winch. To minimize the risk of entanglement with the seismic gear, the cable was attached, via a Yales grip, to a lifting rope, which offset the towing point of the cable approximately two meters to port (**Error! Reference source not found.**). A Chinese finger was attached to the hydrophone cable as a tow point to reduce the tension on the cable that remained spooled on the winch when deployed. For the Main Hawaiian Islands survey, approximately 80 meters of hydrophone cable were deployed astern of the vessel. However, the two length was increased to 110 meters from the depth gauge after a few days in attempt to increase the tow depth of the cable. For the Emperor Seamount Chain Survey, the deployment length of the cable was approximately 100 meters.

Figure 14: PAM cable spooled onto the winch.

Figure 15: Hydrophone cable on the winch connected to the main deck cable.

Figure 16: Passive Acoustic Monitoring Station in the Main Science Lab

Figure 17: The PAM cable connecting to the offset rope via shackle.

Deployment Tasks

- Ensure that the data processing unit was powered down.
- Alert the bridge and lab of the pending hydrophone deployment.
- Ensure that the deck cable was disconnected from the hydrophone tow cable. Do not allow connectors to rotate with the winches unless they are strapped down as they can impact or snag and snap.
- Power on the winch.
- Avoid excess tension on the cable.
- Deploy in a slow controlled manner to prevent crossover on the winch.
- Respect the cables minimum bend angles and ensure are not bent on either side of cable moldings/pottings.
- Protect cable from abrasions and chaffing.
- Let out the proper length of hydrophone cable off the winch for the deployment method used.
- Connect the Chinese finger to the offset ropes.
- Power off the winch.
- Connect the hydrophone tow cable to the deck cable.
- Power on the data processing unit.

Retrieval Tasks

- Ensure that the data processing unit is powered down.
- Alert the bridge and lab of the pending hydrophone cable retrieval.
- Disconnect the hydrophone cable from the tow cable. Tape the connectors and ensure they are stowed/secured clear of the moving winch.
- Power on the winch.
- Disconnect the Chinese fingers on the cable from the offset ropes.
- Retrieve the cable in a slow controlled manner to prevent crossover on the winch.
- Power off the winch.

Always ensure that if the winch is powered on that the tow cable is disconnect from the deck cable and the connectors are properly stowed.

Health Safety and Environment (HSE) Requirements

Normal working deck Personal Protective Equipment (PPE) was required (hard hat, boots, gloves, eye protection). A life vest was required for any work involving items going over the side. The operation carried relatively low risk. Hazards included working close to the side of the vessel, trip hazards, and pinch points at the winch.

A Job Safety Analysis (JSA) was completed for this task. Further review of JSA was required in the event of modifications to the procedures.

APPENDIX E: Survey Lines Acquired

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced (UTC)	Date Acquisition Completed	Time Acquisition Completed (UTC)
Main Hawaiian Islands Survey				
MGL1806OB01	2018-09-20	17:25	2018-09-23	21:10
MGL1806MC01	2018-09-24	02:39	2018-09-26	21:39
MGL1806MC03	2018-09-26	22:47	2018-09-27	11:36
MGL1806MC04	2018-09-27	12:21	2018-09-27	23:43
MGL1806MC05	2018-09-27	23:58	2018-09-30	11:00
MGL1806OB2S	2018-09-30	22:18	2018-10-02	15:56
MGL1806MC02	2018-10-02	20:34	2018-10-05	16:18
MGL1806OB2N	2018-10-05	20:22	2018-10-07	01:23
MGL1806MC06	2018-10-07	01:46	2018-10-07	11:07
MGL1806MC07	2018-10-07	16:31	2018-10-09	10:30
MGL1806MC08	2018-10-19	11:24	2018-10-20	14:15
Emperor Seamount Chain Survey				
MGL1902OB01	2019-05-05	22:01	2019-05-07	03:09
MGL1902OB01B	2019-05-07	05:22	2019-05-08	13:38
MGL1902MC04	2019-05-12	03:45	2019-05-12	09:49
MGL1902MC01	2019-05-12	09:57	2019-05-15	03:59
MGL1902MC03	2019-05-15	10:09	2019-05-16	22:48
MGL1902MC02	2019-05-16	23:53	2019-05-19	02:05
MGL1902OB02	2019-05-21	03:38	2019-05-23	08:53

APPENDIX F: Changes in Acoustic Source Volume During Survey Operations

Date	Time (UTC)	Start Volume (in^3)	Start Active Elements	End Volume (in^3)	End Active Elements	Comments
Main Hawaiian Islands Survey						
2018-09-20	13:08	6600	36	4950	27	String 4 disabled for repair
2018-09-20	13:12	4950	27	3300	18	String 3 disabled to retrieve string 4
2018-09-20	14:36	3300	18	4950	27	String 4 re-enabled
2018-09-20	14:40	4950	27	6600	36	String 3 re-enabled
2018-09-20	18:18	6600	36	3300	18	Disable strings 1 & 2 to repair separation rope on String 1
2018-09-20	18:43	3300	18	6600	36	Strings 1 & 2 re-enabled
2018-09-23	12:10	6600	36	3300	18	Strings 1 & 2 disabled for maintenance retrieval
2018-09-24	16:45	6600	36	3300	18	Strings 3 & 4 disabled to repair tow rope on string 4
2018-09-24	16:54	3300	18	6600	36	Strings 3 & 4 re-enabled
2018-09-25	05:33	6600	36	6420	36	String 2 main element switched with spare
2018-09-25	12:21	6420	36	6060	35	String 3 main element disabled
2018-09-25	12:36	6060	35	4770	27	String 3 disabled for maintenance retrieval
2018-09-25	13:35	4770	27	6420	36	String 3 re-enabled
2018-09-26	01:10	6420	36	6200	35	String 2 element 9 failed to fire
2018-09-26	01:25	6200	35	6380	36	String 4 element 5 online in place of String 3 element 9
2018-09-26	15:47	6380	36	6160	35	String 2 element 10 failed and disabled
2018-09-26	15:52	6160	35	5130	28	String 2 disabled for maintenance retrieval
2018-09-26	17:12	5130	28	6600	36	String 2 re-enabled
2018-09-30	11:02	6600	36	3300	18	Strings 1 & 2 disabled to repair tow point on String 1
2018-09-30	11:52	3300	18	4930	27	String 1 re-enabled
2018-09-30	12:01	4950	27	3300	18	String 2 disabled for maintenance retrieval
2018-09-30	18:06	3300	18	4950	27	String 4 re-enabled
2018-09-30	18:17	4950	27	3300	28	String 4 disabled for additional maintenance retrieval
2018-09-30	19:35	3300	18	4950	27	String 4 re-enabled
2018-09-30	19:53	4950	27	6600	36	Resume full volume on all strings after maintenance
Emperor Seamount Chain Survey						
2019-05-05	17:10	6600	36	3300	18	Strings 3 & 4 disabled for maintenance retrieval
2019-05-05	20:56	3300	18	6600	36	Strings 3 & 4 re-enabled
2019-05-05	21:00	6600	36	6380	36	Main elements switched with spares
2019-05-07	01:44	6380	36	6470	36	Switch element on string 3 with spare due to autofire
2019-05-07	03:40	6470	36	4730	27	String 3 disabled for maintenance retrieval
2019-05-07	05:00	4730	27	6380	36	String 3 re-enabled
2019-05-08	13:39	6380	36	580	2	Testing of 2 elements after EOL
2019-05-12	04:00	6600	36	6420	36	Main element on string 1 switched with spare
2019-05-12	08:47	6420	36	6240	36	Main element on string 4 switched with spare
2019-05-15	01:49	6240	36	3120	18	Strings 3 & 4 disabled – auto-fire on string 4
2019-05-15	03:51	3120	18	6420	36	Strings 3 & 4 re-enabled after maintenance on string 4
2019-05-15	05:15	6420	36	3300	18	Strings 1 & 2 disabled for maintenance
2019-05-15	06:25	3300	18	6420	36	Strings 1 & 2 re-enabled briefly before retrieval

Date	Time (UTC)	Start Volume (in^3)	Start Active Elements	End Volume (in^3)	End Active Elements	Comments
2019-05-15	06:30	6420	36	3300	18	Strings 1 & 2 re-disabled for maintenance
2019-05-15	08:34	3300	18	6600	36	Strings 1 & 2 re-enabled
2019-05-15	10:05	6600	36	6420	36	Main element on string 1 switched with spare
2019-05-15	16:35	6420	36	40	1	Volume reduced as compressors were shut-down
2019-05-15	16:40	40	1	6420	36	Volume increased after compressors were re-started
2019-05-16	07:17	6420	36	6480	36	Main element on string 3 switched with spare
2019-05-16	22:48	6480	36	40	1	Volume reduced for line change
2019-05-16	23:00	40	1	3120	18	PSOs determined operation of the single 40in3 element was not appropriate for the situation, so source volume was increased for the remainder of the line change
2019-05-16	23:53	3120	18	6480	36	Volume increased for the start of the next survey line

APPENDIX G: Acoustic Monitoring Downtime

Acoustic Monitoring Stopped		Acoustic Monitoring Resumed		Total Downtime	Total Downtime with Source Active	Total Downtime with Source Silent	Reason/Comment
Date	Time (UTC)	Date	Time (UTC)				
Main Hawaiian Islands Survey							
2018-09-21	12:38	2018-09-21	13:29	00:51	00:26	00:25	PAM computer failure – DPU replaced with spare – source silenced at 13:04 UTC as PAM was unable to resume within 30 minute limit per IHA
2018-09-23	23:32	2018-09-24	00:10	00:38	-	00:38	Hydrophone cable adjustment – added 6 kg more chain weight and added 30 meters to tow length
2018-09-26	16:26	2018-09-26	16:30	00:04	00:04	-	Restarted DPU due to issue with computer programs – computer slow to re-start
2018-09-26	21:44	2018-09-26	23:45	02:01	02:01	-	Replaced hydrophone array and then replaced tow cable to fix signal loss and electrical interference on damaged cable previously used
2018-10-09	10:33	2018-10-19	06:07	235:34	-	235:34	Acoustic monitoring and source operations suspended for OBS retrieval operations, and resumed for one final MCS survey line.
Emperor Seamount Chain Survey							
2019-05-08	15:33	2019-05-12	00:08	80:35	-	80:35	Acoustic monitoring and source operations suspended for OBS retrieval operations and streamer deployment
2019-05-19	04:11	2019-05-20	22:41	42:30	-	42:30	Acoustic monitoring and source operations suspended to retrieve the streamer and deploy the OBSs on the last OBS line

APPENDIX H: Summary of Visual Detections of Protected Species during the Hawaiian-Emperor Seamount Chain Survey Program

Movement Codes: **TV**: towards vessel; **AV**: away from vessel; **PV/SD**: parallel vessel, same direction; **PV/OD**: parallel vessel, opposite direction; **PE (AH/BH):** perpendicular (crossing ahead or behind); **MI**: milling; **SA**: stationary; **V:** variable, **UN**: unknown**; OM**: other movement

Behavioral Codes: **NS**: normal swimming; **FT**: fast travel; **ST**: slow travel; **PO**: porpoising; **SS**: swimming below surface; **MI**: milling: **BR**: bow/wake riding; **BA**: resting/basking at surface; **FL:** floating; **SA** :surface active (lob tailing/pectoral slapping, full/partial breaching)**; R:** rolling; **DI**: dive; **DF**: dive with fluke; **FF**: feeding/foraging; **SB**: social behavior; **MT**: mating behavior; **BV**: blow visible (whale); **SV**: only splashes visible (dolphins); **DV**: dorsal fin visible; **OB**: other behavior

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behavior		CPA Source / Source Activity	Mitigation Action	Comments
1	2018-09-11	17:32	Unidentified Whale	3	21.26659°N 158.28959°W	Not Firing/Silent	PV/SD; PE/BH	SR, BV, NS	1743m/Silent	None	Acoustic source was silent and on board while the vessel was transiting to the survey area. Whales were not considered to be potential takes
2	2018-10-12	20:47	Short-finned Pilot Whales	8	20.26352°N 156.07655°W	Silent	PV/SD; MI	SR, ST, MI	858m/Silent	None	Acoustic source was silent and on board the vessel during OBS retrieval operations. Detection occurred near the Kohala peninsula of the Hawaii Island. Dolphins were not considered to be potential takes.
3	2018-10-21	18:08	Spinner Dolphin	8	21.28667°N 157.87667°W	Not Firing/Silent	PV/OD; PE(BH)	SS, SA	1m/Silent	None	Acoustic source was silent and on board while the vessel was transiting into port. Detection occurred near the dock.
4	2019-05-02	05:59	Unidentified Dolphin	3	44.88567°N 174.12802°E	Silent	PV/OD; AV	SR, FT	300m/Silent	None	Detection occurred while the acoustic source was silent and onboard while the vessel was transiting within the survey area. Dolphins last sighted outside of the 500m EZ.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behavior		CPA Source / Source Activity	Mitigation Action	Comments
5	2019-05-04	18:24	Northern Fur Seal	1	45.87880°N 167.02736°E	Silent	PV/SD; AV	SS, NS, SR, SA, JP, DI	183m/Silent	None	Detection occurred while the acoustic source was silent and onboard while the vessel was milling within the survey area. Pinniped last sighted within the 500m EZ.
6	2019-05-07	22:53	Unidentified Baleen Whale	1	46.25193°N 170.74777°E	Reduced Volume on a survey line	UN; PV/OD	BV, NS	1096m/RV Online	None	Whale was last sighted in 160 dB radius and was considered to be a potential Level B take.
7	2019-05-08	06:57	Fin Whales	3	46.33858°N 171.60511°E	Reduced Volume on a survey line	PV/OD; AV	BV, SR, FT	1230m/RV online	None	Whales were last sighted in 160 dB radius and were considered to be potential Level B takes.
8	2019-05-09	04:36	Fin Whales	2	46.28992°N 171.11603°E	Silent	PE(AH), PV/OD	BV, FT, DI	1200m/Silent	None	Acoustic source was silent and on board the vessel during OBS retrieval operations.
9	2019-05-09	05:59	Unidentified Baleen Whale	2	46.28440°N 170.94080°E	Silent	SA	BV	4700m/Silent	None	Acoustic source was silent and on board the vessel during OBS retrieval operations.
10	2019-05-10	18:51	Unidentified Baleen Whale	1	45.95421°N 168.20515°E	Silent	UN	BV	1000m/Silent	None	Acoustic source was silent and on board the vessel during OBS retrieval operations.
11	2019-05-23	23:02	Sperm Whales	2	44.66816°N 170.12832°E	Silent	AV	BV; BA; DF	3215m/Silent	None	Acoustic source silent and on board during OBS retrieval operations
12	2019-05-24	06:17	Killer Whales	7	45.29787°N 169.90012°E	Silent	PE(AH); PV/OD	SR; ST	800m/Silent	None	Acoustic source silent and on board during OBS retrieval operations
13	2019-05-24	18:34	Unidentified Whale	1	46.22924°N 169.53730°E	Silent	PV/SD	BV; FT	1369m/Silent	None	Acoustic source silent and on board during OBS retrieval operations

APPENDIX I: Photographs of Identified Protected Species Visually Detected during the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program.

Figure 18: Visual Detection #2; Short-finned Pilot Whales; 12 October 2018.

Figure 19: Visual Detection #3; Spinner Dolphins; 21 October 2018.

Figure 20: Visual Detection #3; Spinner Dolphins; 21 October 2018.

Figure 21: Visual Detection #4; Northern Fur Seal; 4 May 2019.

Figure 22: Visual Detection #7; 8 May 2019.

Figure 23: Visual Detection #8; Fin Whales; 9 May 2019.

Figure 24: Visual Detection #11; Sperm Whales; 23 May 2019.

Figure 25: Visual Detection #12; Killer Whales; 24 May 2019.

Appendix J: Species of Birds and Other Wildlife Observed during the North Pacific Ocean Hawaiian-Emperor Seamount Chain Seismic Survey Program

Birds: Common Name	Family	Genus	Species	Approximate Number Individuals Observed	Approximate Number of Days Species Was Observed
Ancient Murrelet	Alcidae	*Synthliboramphus*	*antiguus*	6	1
Black-footed Albatross	Procellariidae	*Phoebastria*	*nigripes*	5	3
Black-legged Kittiwake	Laridae	*Pissa*	*tridactyla*	2	1
Black-winged Petrel	Procellariidae	*Pterodroma*	*nigripennis*	2	2
Brambling	Fringillidae	*Fringilla*	*montifringilla*	7	7
Brown Booby	Sulidae	*Sula*	*leucogaster*	8	5
Common Murre	Alcidae	*Uria*	*aalge*	3	3
Cook's Petrel	Procellariidae	*Pterodroma*	*cooki*	5	4
Great Egret	Ardeidae	*Ardea*	*alba*	7	1
Great Frigatebird	Fregatidae	*Frigata*	*minor*	16	9
Green-winged Teal	Anatidae	*Anas*	*crecca*	7	1
Herald Petrel	Procellariidae	*Pterodroma*	*arminjoniana*	6	6
Herring Gull	Laridae	*Larus*	*argentatus*	1	1
Horned Grebe	Podicipedidae	*Podiceps*	*auritus*	1	1
Horned Puffin	Alcidae	*Fratercula*	*corniculata*	9	1
Juan Fernandez Petral	Procellariidae	*Pterodroma*	*externa*	3	2
Laysan Albatross	Diomedeidae	*Phoebastria*	*immutabillis*	87	25
Leach’s Storm-petrel	Hydrobatidae	*Oceanodroma*	*leucorhoa*	4	4
Lesser Scuap	Anatidae	*Aythya*	*affinis*	5	2
Long-tailed Skua	Stercorariidae	*Stercorarius*	*longicaudus*	3	2
Masked Booby	Sulidae	*Sula*	*dactylatra*	26	13
McCown’s Longspur	Calcariidae	*Rhynchophanes*	*mccownii*	1	1
Mottled Petrel	Procellariidae	*Pterodroma*	*inexpectata*	202	18
Northern Fulmar	Procellariidae	*Fulmarus*	*glacialis*	3	3
Pacific Golden Plover	Charadriidae	*Pluvialis*	*fulva*	1	1
Pomarine Skua	Stercorariidae	*Stercoraius*	*pomarinus*	1	1
Red-footed Booby	Sulidae	*Sula*	*sula*	224	34
Red-tailed tropicbird	Phaethontidae	*Phaethon*	*rubricauda*	4	4
Red Phalarope	Scolopacidae	*Phalaropus*	*fulicarius*	1	1
Rock Pigeon	Columbidae	*Columba*	*livia*	3	2
Ruddy Turnstone	Scolopacidae	*Arenaria*	*interpres*	1	1
Short-tailed Albatross	Diomedeidae	*Phoebastria*	*albatrus*	1	1

Birds: Common Name	Family	Genus	Species	Approximate Number Individuals Observed	Approximate Number of Days Species Was Observed
Short-tailed Shearwater	Procellariidae	*Puffinus*	*tenuirostris*	75	18
Tufted Puffin	Alcidae	*Fratercula*	*cirrhata*	225	23
Wandering Tattler	Scolopacidae	*Tringa*	*incana*	1	1
Wedge-tailed Shearwater	Procellariidae	*Ardenna*	*pacifica*	582	32
White Tern	Laridae	*Gygis*	*alba*	1	1
White-tailed tropicbird	Phaethontidae	*Phaethon*	*lepturus*	54	21
Wrimbrel	Scolopacidae	*Numenius*	*phaeopus*	1	1

Fish: Common Name	Family	Genus	Species	Approximate Number Individuals Observed	Approximate Number of Days Species Was Observed
Flying Fish	Exocoetidae	*n/a*	*n/a*	3761	35
Mahi	Coryphaenidae	*Coryphaena*	*hippurus*	19	6
Manta Ray	Myliobatidae	*n/a*	*n/a*	1	1
Sailfin Flying Fish	Exocoetidae	*Parexocoetus*	*brachypterus*	19	4
Whale shark	Rhinocodontidae	*Rhicodontidae*	*typus*	2	2

Marine Invertebrates: Common Name	Family	Genus	Species	Approximate Number Individuals Observed	Approximate Number of Days Species Was Observed
Egg Yolk Jellyfish	Ulmaridae	*Phacellophora*	*camtschatica*	5	3