Protected Species Mitigation and Monitoring Report

Korenaga Marine Geophysical Survey
on the Shatsky Rise in the Northwest Pacific Ocean

23 March 2012- 15 April 2012

R/V Marcus G. Langseth

Prepared for

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1. EXECUTIVE SUMMARY

The National Science Foundation (NSF) owned research vessel (R/V), *Marcus G. Langseth*, operated by Lamont-Doherty Earth Observatory (L-DEO), a part of Columbia University, conducted a seismic survey on the Shatsky Rise in the Northwest Pacific Ocean. The purpose of the survey was to decipher the crustal structure of the Shatsky Rise. The *Langseth* left Apra Harbor, in Guam, on 23 March 2012 and began the survey on 29 March 2012. The survey was completed on 6 April 2012 and the *Langseth* arrived in Honolulu on 15 April 2012.

L-DEO submitted an application to the National Marine Fisheries Service (NMFS) for a permit to harass marine mammals, incidental to the marine geophysical survey. An Incidental Harassment Authorization (IHA) was granted on 23 March 2012 (Appendix A) with several mitigation measures that stipulated harassment to marine mammals. Mitigation measures were implemented to minimize potential impacts to marine mammals throughout the duration of the survey. Mitigation measures included, but were not limited to, the use of NMFS approved Protected Species Observers (PSOs) for both visual and acoustic monitoring, establishment of safety radii, and implementation of ramp-up, power-down and shut-down procedures.

RPS was contracted by L-DEO to provide continuous protected species observation coverage and to fulfill the environmental regulatory requirements and reporting mandated by NMFS in the IHA. Five PSOs, with one functioning as the primary passive acoustic monitoring (PAM) operator, were present on board the *Langseth* throughout the survey in this capacity.

PSOs undertook a combination of visual and acoustic watches, conducting a total of 298 hours 14 minutes of visual observations and 120 hours 32 minutes of acoustic monitoring over the course of the survey.

This visual monitoring effort produced a project total of nine protected species detection records; seven for cetaceans and one for a pinniped. Of the eight cetacean records collected, three records were collected for mysticetes, one record of odontocetes, three records of unidentified large cetaceans, and one record of unidentified small cetaceans. The pinniped detection was of an otariid. There were no detections of sea turtles during the survey. There were no acoustic detections using the PAM system.

Detections of protected species resulted in one mitigation action being implemented; a power-down of the acoustic source. During all visual detections the protected species remained outside of the 180 dB safety radius. A known eight cetaceans and one pinniped were exposed to received sound levels equal to or greater than 160 dB of sound from the acoustic source, constituting a level B harassment take as defined by NMFS. Cetacean Level B harassment takes included eight sperm whale takes and one Northern fur seal take.

A project summary sheet of observation, detection, and operational totals can be found in Appendix B.

2. INTRODUCTION

The following report details protected species monitoring and mitigation as well as seismic survey operations undertaken as part of the Korenaga seismic survey on board the *R/V Langseth* from 23 March to 15 April 2012 in the Northwest Pacific Ocean.

This document serves to meet the reporting requirements dictated in the IHA issued to L-DEO by NMFS on 23 March 2012. The IHA authorized non-lethal takes of Level B harassment of specific marine mammals incidental to a marine seismic survey program. NMFS has stated that seismic source received sound levels greater than 160 dB could potentially disturb marine mammals, temporarily disrupting behavior, such that they could be considered as "takes" of these exposed animals. Potential consequences of Level B harassment taking could include effects such as temporary or permanent hearing threshold shifts, behavior modification and other reactions. It is unknown to what extent cetaceans exposed to seismic noise of this level would express these effects, and in order to take a precautionary approach, NMFS requires that provisions such as safety radii, power-downs and shut-downs be implemented to mitigate for these potential adverse effects.

2.1. PROJECT OVERVIEW AND LOCATION

The survey was conducted on the Shatsky Rise in the Northwest Pacific Ocean. The survey took place in the approximate area 33.5 to 36° North and 156 to 161° East, where water depths ranged from ~3000m to >5000m (Figure 1). The *Langseth* deployed an array of 36 airguns as an energy source. The receiving system consisted of one six-kilometer hydrophone streamer. As the airgun array was towed along the survey lines, the hydrophone streamer received the returning acoustic signals and transferred the data to the onboard processing system.

The total survey effort consisted of approximately 1403 km of transect lines. The *Langseth*'s cruising speed was about 10-12 knots during transits and varied between 4 and 5 knots during the seismic survey. Seismic acquisition began on 29 March 2012 and continued until 06 April 2012.

L-DEO completed the seismic survey over the Shatsky Rise, a large igneous plateau in the Northwest Pacific Ocean, that was started in 2010. The survey could not be completed in 2010 because the survey was disrupted twice by medical diversions to Japan. The survey will provide data necessary to decipher the crustal structure of the Shatsky Rise. The sheer scale of plateau formation implies a potential role in environmental crises such as oceanic anoxia and mass extinctions. Likewise, oceanic plateaus may be important for the growth of continental crust. Hence, the information provided by this survey will address major questions of Earth history, geodynamics, and tectonics, and could have a profound impact on our understanding of terrestrial magmatism and mantle convection. The survey may also obtain data that could be used to improve estimates of regional earthquake occurrence and distribution.

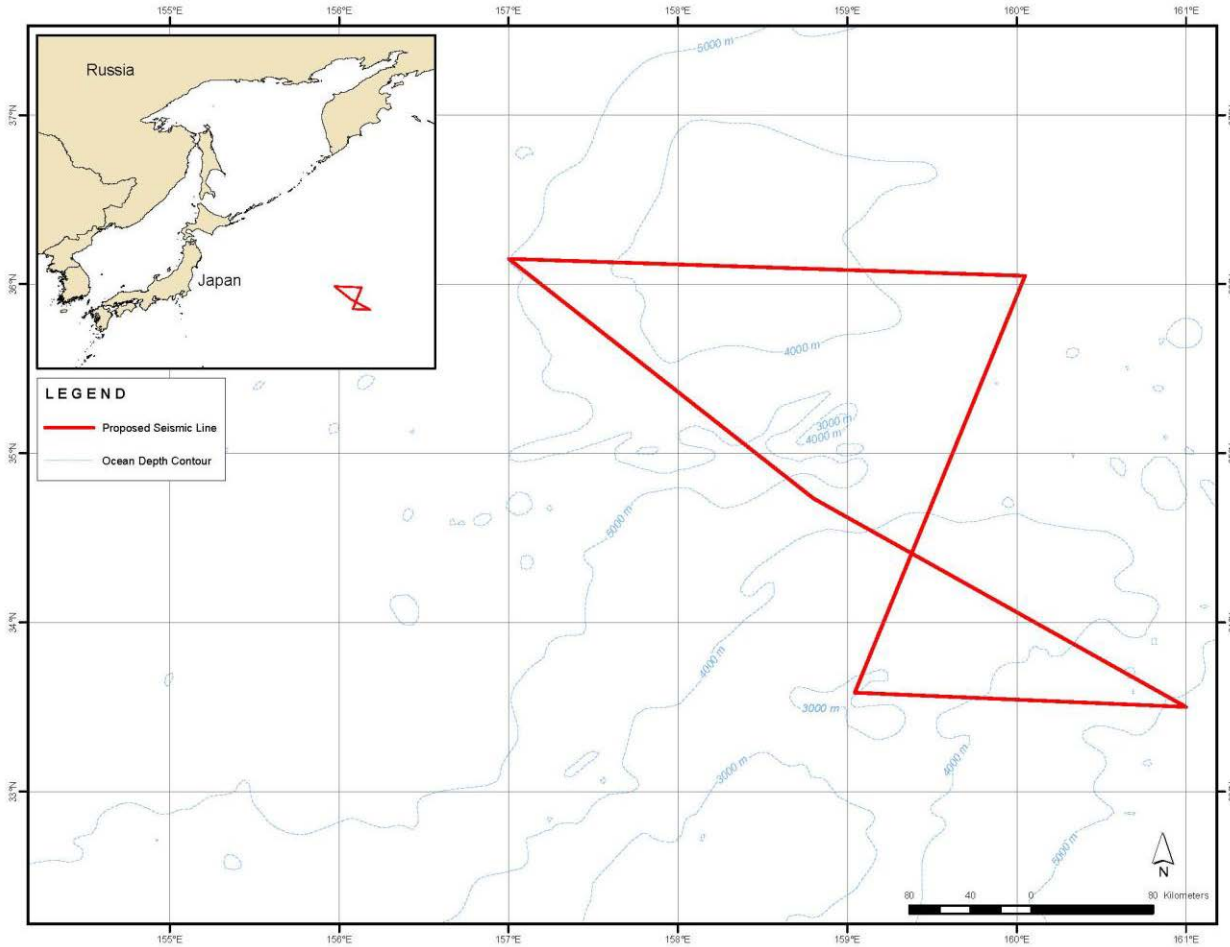

Figure 1. Location of the Korenaga marine geophysical survey in the Northwest Pacific Ocean (LGL 2011).

2.1.1. Energy Source

The acoustic source consisted of four towed airgun sub-arrays and one hydrophone streamer cable. The sub-arrays were deployed centrally astern as a single acoustic source with each array separated by eight meters. The airguns were towed at a depth of nine meters and were situated 232 meters from the Navigational Reference Point (NRP), which was located on the PSO observation tower.

Each source array utilized a mixture of Bolt 1500LL and Bolt 1900LLX airguns ranging in volume from the smallest airgun of 40 in³ to 360 in³. Each sub-array contained ten airguns, with the first and last spaced 16 meters apart. Only nine airguns on each sub-array were firing during survey acquisition, with the tenth gun utilized as a spare. The total volume of each sub-array was 1,650 in³. The full power source of four sub-arrays (36 airguns) had a total discharge volume of 6,600 in³ and a pressure of 1,900 psi. Each discharge of the source consisted of a single brief pulse of sound (duration of approximately 0.1 second) with the greatest energy output occurring in the two to 188 hertz frequency range.

The shot point interval for the MCS survey was 50 meters, equating to approximately 23 seconds at typical survey speed. The sound signal receiving system during the acquisition of

the MCS transect lines consisted of a single six kilometer long hydrophone streamer, which received the returning acoustic signals and transferred the data to the processing system located on board the vessel. Due to the length and placement of the cables, the maneuverability of the vessel was limited to turns of five degrees per minute while the gear was being towed.

In addition to the operations of the airgun array, a Kongsberg EM 122 multibeam echosounder (MBES), a Knudsen Chirp 3260 sub-bottom profiler (SBP), and a hull-mounted acoustic Doppler current profiler (ADCP) was operated from the *Langseth* continuously throughout the cruise. These sound sources were operated from the *Langseth* simultaneous with the airgun array.

3. MITIGATION AND MONITORING METHODS

The PSO monitoring program on the *Langseth* was established to meet the IHA requirements that were issued to the L-DEO by NMFS, which included both monitoring and mitigation objectives. The survey mitigation program is designed to minimize potential impacts of the *Langseth*'s seismic program on marine turtles, marine mammals, and other protected species of interest. The following monitoring protocols were followed to meet these objectives.

- Visual observations were established to provide real-time sighting data, allowing for the implementation of mitigation procedures as necessary.
- Operation of a PAM system to compliment visual observations and provide additional marine mammal detection data.
- Ascertain the effects of marine mammals and marine turtles exposed to sound levels constituting a "take".

In addition to the mitigation objectives outlined in the IHA, PSOs collected and analyzed necessary data mandated by the IHA for this report including but not limited to:

- Dates, times and locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and related activities during all seismic operations and marine mammal detections.
- Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity including the number of power-downs and shut-downs, were observed and logged throughout all monitoring actions.
- An estimate of the number, decided by species, of marine mammals that: (A) are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 µPa (rms), 180 dB re 1 µPa (rms) and/or 190 dB re 1 µPa (rms) along with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on modeling results) to the seismic activity at received levels greater than or equal to 160 dB re 1 µPa (rms), 180 dB re 1 µPa (rms) and/or 190 dB re 1 µPa (rms) along with a discussion of the plausible consequences of that exposure on the individuals that were within the safety radii.
- A description of the implementation and effectiveness of the: (A) terms and conditions of the ITS and (B) mitigation measures of the IHA.

3.1. VISUAL MONITORING SURVEY METHODOLOGY

There were five trained and experienced PSOs on board to conduct the monitoring for marine mammals, record and report on observations, and request mitigation actions in accordance to the IHA. The PSOs on board were NMFS-approved and held certifications from a recognized Joint Nature Conservation Committee (JNCC) course and/or approved Bureau of Ocean Energy Management (BOEM) course. Visual monitoring was primarily carried out from an observation tower (Figure 2) located 18.9 meters above the water surface which afforded the PSOs a 360 degree viewpoint around the acoustic source.

Figure 2. Protected Species Observer observation tower with mounted big-eye binoculars.

The PSO tower was equipped with Fujinon 7x50 binoculars as well as two mounted 25x150 Big-eye binoculars. Inside the tent located in the middle of the platform was a laptop for data collection as well as a telephone for communication with the PAM station, bridge, or main lab. Also inside the tent was a monitor that displayed current information about the vessel's position, speed, and heading, along with water depth, wind speed and direction, and source activity. Most observations were held from the tower; however, when there was severe weather or poor environmental conditions observations would be performed from the bridge (~12.8m above sea level) or the catwalk (~12.3m above sea level) in front of the bridge. Night Quest NQ2200 Night Vision Devices were also available to conduct night time observations for nighttime ramp-ups of the acoustic source, but were not used during this survey.

Visual monitoring methods were implemented in accordance with the survey requirements outlined in the IHA. At least one PSO, but most often two PSOs, watched for marine mammals and sea turtles at all times while airguns operated during daylight periods and whenever the vessel was underway when the airguns were not firing.

When the acoustic source was activated from silence, PSOs maintained a two-person watch for 30 minutes prior to the activation of the source. Visual watches commenced each day before sunrise, beginning as soon as the safety radii were visible, and continued past sunset until the safety radii became obscured. Start of observation times ranged from 15:56 to 19:58 UTC, while end of observation times ranged from 5:20 to 8:48 UTC.

A visual monitoring schedule was established by the PSOs where each person completed visual observations watches which varied in length between one to four hours, one to three times a day, for a total of four to six hours of visual monitoring per day. This schedule was arranged to ensure that two PSOs were on visual observation duty at all times except during meal breaks when PSOs would each maintain a solo watch so that the entire team could eat while maintaining both visual and acoustic monitoring. Solo watches lasted less than 45 minutes and occurred each day at meal times.

Observations were focused forward of the vessel and to the sides but with regular sweeps through the area around the active acoustic source. PSOs searched for blows indicating the presence of a marine mammal, splashes or disturbances to the sea surface, the presence of large flocks of feeding seabirds and other sighting cues which may indicate the possible presence of a protected species.

Upon the visual detection of a protected species, PSOs would first identify the animals range to the acoustic source while identifying the observed animal (cetacean, pinniped, or sea turtle) to determine which safety radius applied to the animal. The visual PSOs would then notify the PAM operator, who was located in the main science lab, that there was an animal inside or outside of the safety radius. If the animal was observed inside the safety radius and a mitigation action was necessary, the PAM operator would relay the message to the seismic technician who was sitting nearby. Table 1 describes the various exclusion zone radii applied to cetaceans and pinnipeds, as well as the distances that constituted the Level-B harassment zone. The PAM operator was also notified of all marine mammal sightings as soon as possible in order to enable recordings so that they could be reanalyzed for detections by one of the more experienced acoustic operators to determine whether vocalizations had been detected on the PAM system during the sighting.

Table 1. Exclusion zone (EZ) radii for triggering mitigation.

Source and Volume	Array Tow Depth (m)	Water Depth (m)	Power/Shut-down EZ for Pinnipeds 190 dB (m)	Power/Shut-down EZ for Cetaceans 180 dB (m)	Level-B Harassment Zone 160 dB (m)
Single bolt airgun (40 in³)	9	Deep (>1,000)	12	40	385
4 strings 36 airguns (6600 in³)	9	Deep (>1,000)	400	940	3,850

When a protected species was observed range estimations were made using reticle binoculars, the naked eye, and by relating the animal to an object at a known distance, such as the acoustic array located 232 meters from the PSO tower. Specific species identifications were made whenever distance, length of sighting and visual observation conditions allowed. PSOs observed anatomical features of animals sighted with the naked eye and through the big-eyes and reticule binoculars and noted behavior of the animal or group. Photographs were taken during most sightings. Sometimes photographs were not taken due to the brevity of a sighting. The camera used was a Canon EOS 60D with a 300 millimeter telephoto lens. Marine mammal and sea turtle identification manuals were consulted and photos were examined during visual watch breaks to confirm identifications.

During or immediately after each sighting event PSOs recorded the position, time at first and last sighting, number of animals present (adults and juveniles), the initial and any subsequent behaviors observed, the initial range, bearing and movement of the animal(s), the source activity at the initial and final detections and any mitigation measures that were applied. Specific information regarding the animal(s) closest approach to the vessel, acoustic source and the acoustic source output at the closest approach were recorded to determine if the animals had been exposed to 160 dB and/or 180/190 dB of sound from the source during the sighting

event. Additionally, the vessel position, water depth, vessel heading and speed, the wind speed and direction, Beaufort sea state, swell level, visibility and glare were recorded every half an hour at minimum or every time environmental conditions, vessel, or seismic activity changed. Each sighting event was linked to an entry on a datasheet such that environmental conditions were available for each sighting event.

3.2. ACOUSTIC MONITORING SURVEY METHODOLOGY

PAM was used to augment visual monitoring efforts, by helping to detect, identify, and locate marine mammals within the area. PAM was also used during periods of darkness or low visibility when visual monitoring might not be applicable or effective. The PAM system was monitored to the maximum extent possible, 24-hours a day during seismic operations, and the times when monitoring was possible while the airguns were not in operation. PAM was not used exclusively to execute any mitigation actions without a concurrent visual sighting of the marine mammal.

Two PSOs who were trained and experienced with the use of PAM, were present throughout the cruise. One person was designated as the PAM operator to oversee and conduct the PAM operations. All PSOs completed an introductory PAM training provided by the PAM Operator in the initial days of the hydrophone deployment during which basic PAM system operation was covered. To achieve 24-hours of monitoring, the PSOs and the PAM operator rotated through acoustic monitoring shifts with the PAM operator monitoring many of the night time hours when PSOs were not making visual observations and the PAM was the only system in use for detecting cetaceans. Monitoring shifts lasted two to six hours. During daylight hours, acoustic operators were in communication with visual PSOs in the tower relaying sighting and seismic activity information. The PAM system was located in the main science lab to provide adequate space for the system, allow a quick exchange of communications with the visual PSOs on watch and seismic technicians, and to provide access to the vessel's instrumentation. The vessel's position, water depth, heading and speed, vessel and airgun activity were recorded every hour.

Acoustic monitoring for marine mammals was conducted aurally with *Sennheiser* headphones and visually with *Pamguard Beta 1.9.01*. Delphinid whistles, clicks, and burst pulses as well as sperm whale and baleen whale vocalizations may be viewed on a spectrogram display within *Pamguard*. Sperm whale, beaked whale, *Kogia* species, and delphinid echolocation clicks may be viewed on low and high frequency click detector displays. The spectrogram's amplitude range and appearance were adjusted as needed to suit the operator's preference to maximize the vocalizations appearance above the pictured background noise.

3.2.1. Passive Acoustic Monitoring Parameters

Acoustic monitoring was carried out using a PAM system developed by Seiche Measurements Limited. PAM system specifications can be found in Appendix C. The PAM system consists of seven main components: a 250m hydrophone tow cable, a 100m deck cable, a data processing unit, two laptops, an acoustic analysis software package, and headphones for aural monitoring.

The hydrophone cable contains four hydrophone elements and a depth gauge molded into a 5m section of the cable. Three of the hydrophone elements are broadband (2 to 200kHz) and the fourth element is for sampling lower frequencies (75Hz to 30kHz). Preamplifiers are also embedded into the array cable just ahead of each hydrophone element. The four-element linear hydrophone array permits a large range for sampling marine mammal vocalizations.

The electronic processing unit contained a buffer processing unit with USB output, an *RME Fireface 800 ADC* processing unit with firewire output, a *Behringer Ultralink Pro mixer*, a *Behringer Ultralink Pro graphic equalizer* and a Sennheiser radio headphone transmitter. Two laptops were set-up in the main lab next to the electronic processing unit to display a high frequency range on one laptop (hereafter referred to as the HF laptop), using the signal from two hydrophones, and the low frequency on the other laptop (LF laptop) receiving signal from all four hydrophones. A GPS feed of INGGA strings was supplied from the ship's navigation system and connected to the LF laptop, reading data every 20 seconds.

The high frequency (HF) system was used to detect and localize ultrasonic pulses used by some dolphins, beaked whales and *Kogia* species. The signal from two hydrophones was digitized using an analogue-digital National Instruments data acquisition (DAQ) soundcard at a sampling rate of 500 kilohertz, then processed and displayed on a laptop computer using the program *Pamguard Beta 1.9.01* via USB connection. The amplitude of clicks detected at the front hydrophone was measured at 5th order Butterworth band-pass filters ranging from 35 kilohertz to 120 kilohertz with a high pass digital pre-filter set at 35 kilohertz (Butterworth 2nd order). *Pamguard* can use the difference between the time that a sound signal arrived at each of the two hydrophones to calculate and display the bearing to the source of the sound. A scrolling bearing time display in *Pamguard* also can display the detected clicks within the HF envelope band pass filter in real time, which would allow the identification and directional mapping of detected animal click trains.

The low frequency (LF) system was used to detect sounds produced by marine mammals in the human audible band between approximately four kilohertz and 24 kilohertz. The low frequency system used four hydrophones; the signal was interfaced via a firewire cable to a laptop computer, where it was digitized at 48 kilohertz per channel. The LF hydrophone signal was further processed within the *Pamguard* monitoring software by applying Engine Noise Fast Fourier Transform (FFT) filters including click suppression and spectral noise removal filters (median filter, average subtraction, Gaussian kernel smoothing and thresholding). In addition to the Spectrogram available for each of the four hydrophones, modules for Click Detector, Mapping, Sound Recording and Radar displays for bearings of whistles and moans were configured. The bearings and distance to detected whistles and moans can be 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. The vessel's GPS connected to the LF laptop via serial USB and allowed delphinid whistles and other cetacean vocalizations to be plotted onto a map module where bearing and range to the vocalizing animal's actual position could be obtained. A mixer unit enabled the operator to adjust stereo signal levels from each of the four hydrophones. The PAM Operator monitored the hydrophone signals aurally using headphones.

3.2.2. Hydrophone Deployment

The vessel had a winch installed on the port stern deckhead of the gun deck for deployment of the PAM hydrophone cable. Two deck cables, the main cable and a spare, were installed along the gun deck deckhead running from the winch to the science lab. Figure 3 shows the position of the hydrophone deployments in relation to the vessel and seismic equipment. Photos of the hydrophone deployment methods and equipment discussed above can be found in Appendix D.

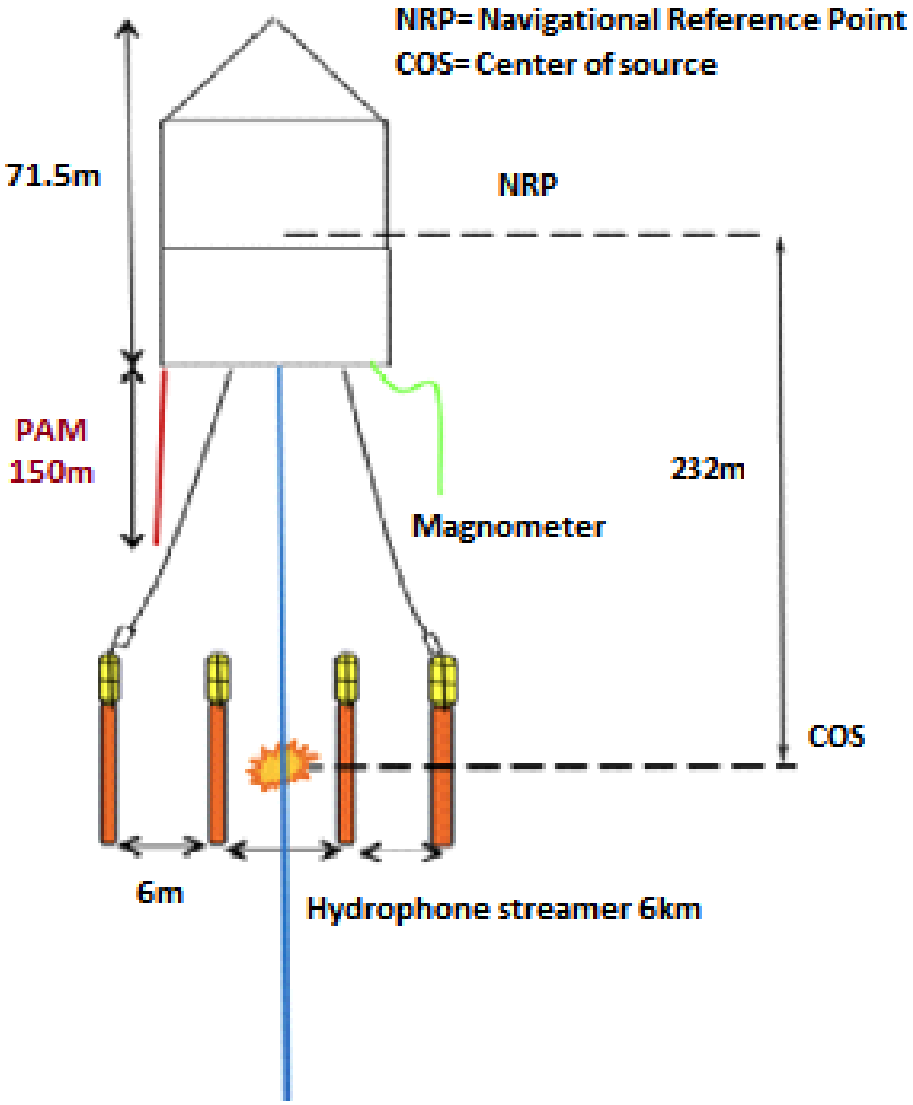

Figure 3. Location of the hydrophone deployment.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

The *R/V Langseth* departed Apra Harbor, Guam for the seismic survey site at 22:09 UTC on 23 March 2012. The seismic gear was deployed and the use of the acoustic source commenced at 20:09 UTC on 29 March 2012. Acquisition began on the first MCS survey line began at 06:29 UTC on 30 March 2012. Acquisition of the MCS survey lines was completed at 15:59 UTC on 6 April 2012. At this time the seismic gear was brought on board and the *Langseth* began the transit to Honolulu, Hawaii arriving at 18:15 UTC on 15 April 2012. Table 2 outlines the dates and times of acquisition for each survey line.

Table 2. Korenaga marine geophysical survey multi-channel seismic lines acquired.

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
MGL1206MCST1 Seq001	29-Mar-12	20:41	30-Mar-12	06:17
MGL1206MCS01 Seq002	30-Mar-12	06:29	31-Mar-12	15:59
MGL1206MCS02 Seq003	31-Mar-12	15:51	02-Apr-12	03:46
MGL1206MCS03 Seq004	02-Apr-12	04:27	03-Apr-12	10:54
MGL1206MCS04 Seq005	03-Apr-12	13:18	04-Apr-12	23:45
MGL1206MCSD2 Seq006	05-Apr-12	02:34	05-Apr-12	11:55
MGL1206MCSD2A Seq007	05-Apr-12	15:45	06-Apr-12	15:59

The acoustic source was active throughout the survey, with no periods of source silence, for a total of 186 hours 17 minutes of source activity. This includes ramp-up of the airguns, full power and partial power firing both online and during line changes, and operation of a single 40 in³ mitigation airgun (Figure 4). The mitigation source was to be used during mitigation power-downs initiated for protected species inside the safety radius as well as for mechanical/technical reasons and was active for 18 minutes during the survey. Full power source operations, while online, accounted for 94% (174 hours 45 minutes) of airgun activity during the project. Also because the data was still usable while shooting at partial power (volume ranging from 3660 in³ to 5710 in³) portions of survey lines were sometimes shot using partial power while maintenance was performed on an array, accounting for 1 hours 33 minutes of array activity. Line changes were all shot at full or partial power, totalling 9 hours 59 minutes of array activity. Additionally, the full volume of the acoustic source (36 airguns firing) ranged from 6140 in³ to 6600 in³, caused by various guns of different sizes being changed out on the arrays.

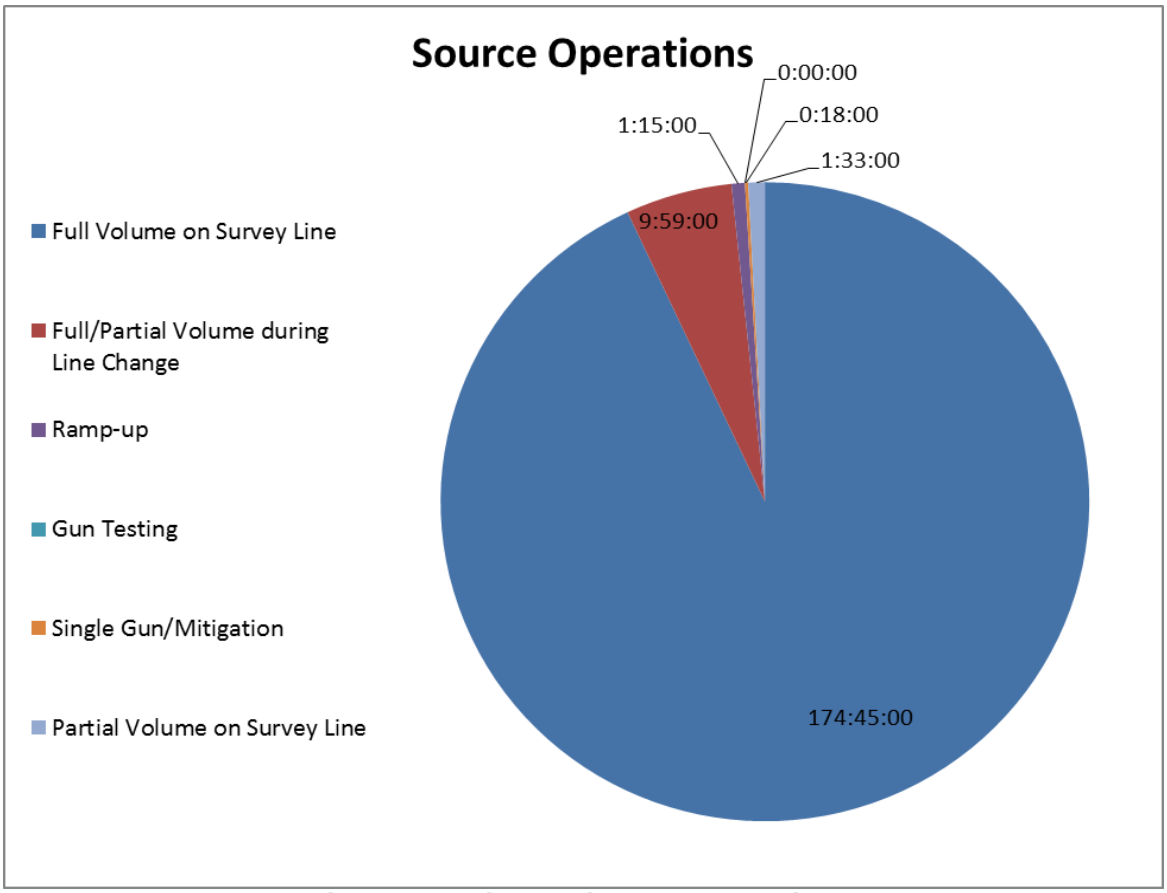

Figure 4. Total acoustic source operations.

The acoustic source was ramped up twice over the course of the survey in order to commence full power survey operations (Table 3). The first ramp up of the acoustic source was conducted from silence over the duration of 31 minutes. This ramp up was conducted to begin use of the acoustic source at the beginning of the survey. The second ramp up was conducted from the mitigation gun over the duration of 44 minutes. This ramp up was conducted to return to full power production after a mitigation power-down of the acoustic source due to a pinniped being observed within the 190 dB safety radius. The ramp ups were conducted using the NMFS approved automated gun controller program, DigiShot which adds guns sequentially to achieve full source over the required period of time. Since a doubling of the number of airguns is typically equal to a 6 dB increase in sound level, the array was not ramped up if more than half of the airguns in the array were already firing.

Table 3. Total acoustic source operations during Korenaga marine geophysical survey.

Acoustic Source Operations	Number	Duration (hh:mm)
Gun Tests		**0:00**
Ramp-up	**2**	**1:15**
Day time ramp-ups from silence	**1**	
Day time ramp-ups from mitigation	**1**	
Night time ramp-ups from mitigation	**0**	
Full power survey acquisition		**174:45**
Partial power survey acquisition		**1:33**
Full/partial power line changes		**9:59**
Single airgun (40 in³)		**0:18**
Total time acoustic source was active		**186:17**

4.2. VISUAL MONITORING SURVEY SUMMARY

The PSOs began visual observations immediately upon departure and while in transit to the survey site. This was done to collect baseline data about protected species abundance in the area. Visual monitoring began at 22:21 UTC on 23 March 2012 and continued until 5:20 UTC on 15 April 2012 when the vessel arrived at Honolulu Harbor at the completion of the survey project. Visual monitoring was over a period of about 23 days. Monitoring was conducted by two PSOs each day between just before dawn until just after dusk, when it was too dark for the entire safety radius to be visible, averaging approximately 13 hours 15 minutes of visual observations per day.

Visual watches were held by two PSOs except during the scheduled meal hours for lunch and dinner when a single PSO continued visual monitoring, in addition to acoustic monitoring conducted by the PAM operator on duty while each PSO rotated for a meal break. Single PSO visual observations during these periods lasted a maximum of 45 minutes. In the event of a sighting event during a single PSO watch a second PSO would be notified and would immediately return to assist observations.

The acoustic source was active during the minority of visual monitoring (35%) and the majority of acoustic monitoring (99.9%), as shown in Figure 5. Once the survey began the acoustic source was not disabled until the end of the survey.

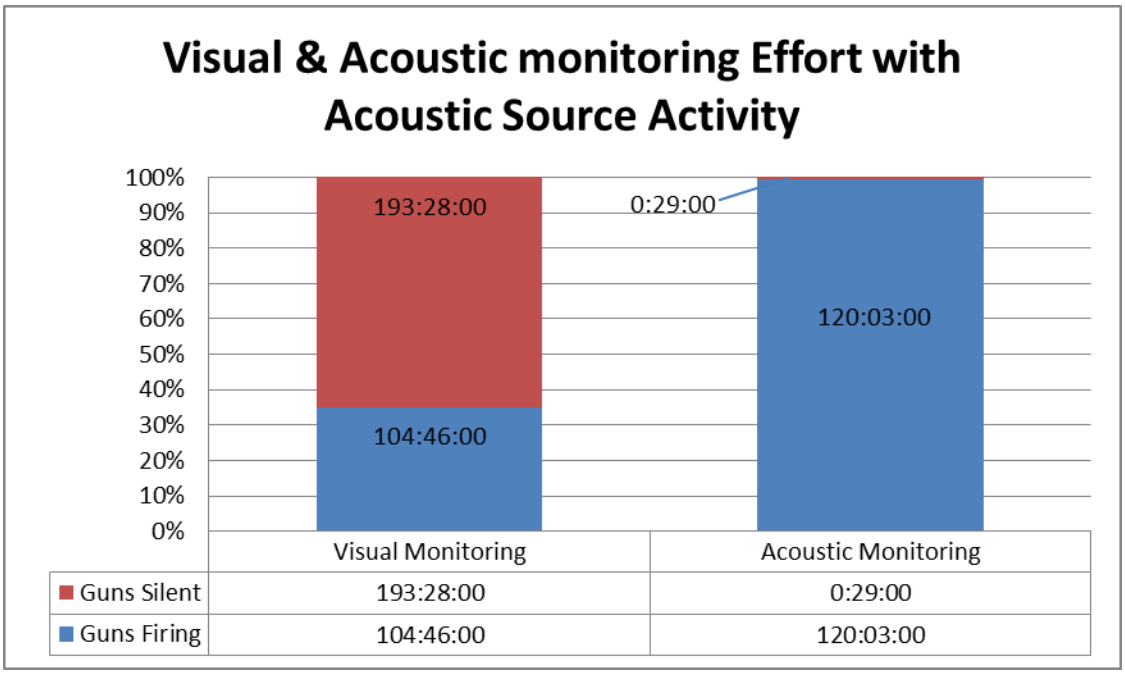

Figure 5. Duration of visual and acoustic monitoring effort while the acoustic source was active vs. silent.

Total visual monitoring effort, divided by monitoring effort while the acoustic source was active and monitoring effort while the source was silent, is listed in Table 4.

Table 4. Total visual monitoring effort.

Visual Monitoring Effort	Duration (hh:mm)
Total monitoring while acoustic source active	**104:46**
Total monitoring while acoustic source silent	**193:28**
Total monitoring effort	**298:14**

The PSOs preferred to conduct visual observations from the PSO tower, which provided the PSOs with a 360° view of the water around the vessel and acoustic source. However, visual watches would be conducted from the catwalk or bridge for any health or safety reason or during periods with high winds, large swells, or heavy rain. As Figure 6 demonstrates approximately 66% of visual monitoring was conducted from the PSO tower during the Korenaga marine geophysical survey.

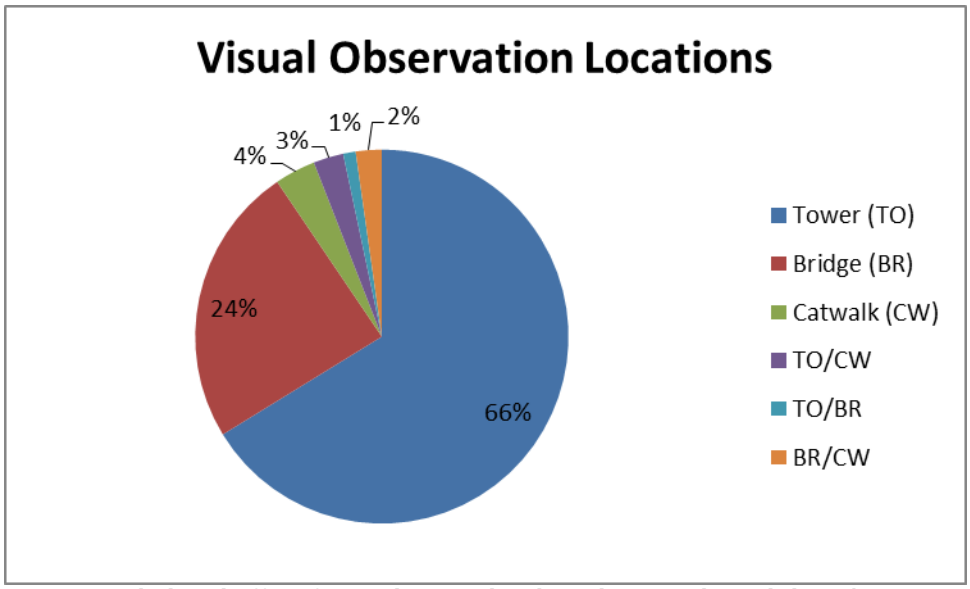

Figure 6. Total visual effort from observation locations on board the R/V Langseth.

4.3. ACOUSTIC MONITORING SURVEY SUMMARY

The hydrophone cable was deployed for the first time on 29 March 2012 after the vessel had completed deployment of the source arrays. Acoustic monitoring began immediately at 19:40 UTC and continued throughout the project with PSOs monitoring the hydrophones aurally and monitoring the *Pamguard* detection software visually both day and night. Acoustic monitoring for the project ended at 15:30 on 06 April 2012 when the hydrophone cable was retrieved in preparation for the retrieval of the seismic equipment. Over the course of the project, PSOs conducted 120 hours and 32 minutes of acoustic monitoring, all but 29 minutes occurred while the acoustic source was active (Table 5).

Table 5. Total passive acoustic monitoring (PAM) effort.

Passive Acoustic Monitoring Effort	Duration (hh:mm)
Total night time monitoring	**50:26**
Total day time monitoring	**70:06**
Total monitoring while acoustic source active	**120:03**
Total monitoring while acoustic source silent	**00:29**
Total acoustic monitoring	**120:32**

The majority of acoustic monitoring downtime was attributed to weather when the cable was retrieved to prevent entanglement with the seismic gear (Table 6). The cable would remain on board until the sea state had decreased to a sufficient level to ensure the cable was safe to deploy without risk of entanglement. Weather accounted for 65 hours and 49 minutes of acoustic monitoring downtown. Acoustic monitoring was suspended for 1 hour and 29 minutes when the hydrophone cable was retrieved prior to the retrieval of source arrays 3 and 4 for repairs and maintenance. A description of each instance of acoustic monitoring downtime is located in Appendix E.

Table 6. Passive acoustic monitoring (PAM) downtime.

Passive Acoustic Monitoring Downtime	Duration (hh:mm)
Weather	**65:49**
Seismic equipment repairs	**01:29**
Total Passive Acoustic Monitoring Downtime	**67:18**

4.4. SIMULTANEOUS VISUAL AND ACOUSTIC MONITORING SUMMARY

While visual observations began on 23 March 2012, acoustic observations began on 29 March 2012, due to the hydrophone cable needing to be deployed after the airgun arrays to avoid entanglement. Of the total observation effort performed by PSOs during this survey, visual monitoring accounted for 71% (298 hours 14 minutes) while acoustic monitoring accounted for 29% (120 hours 32 minutes). As displayed in Figure 7 there were 70 hours 06 minutes of simultaneous visual and acoustic observations conducted during this survey. Simultaneous visual and acoustic monitoring accounted for 58% of total acoustic monitoring and 24% of the total visual observation.

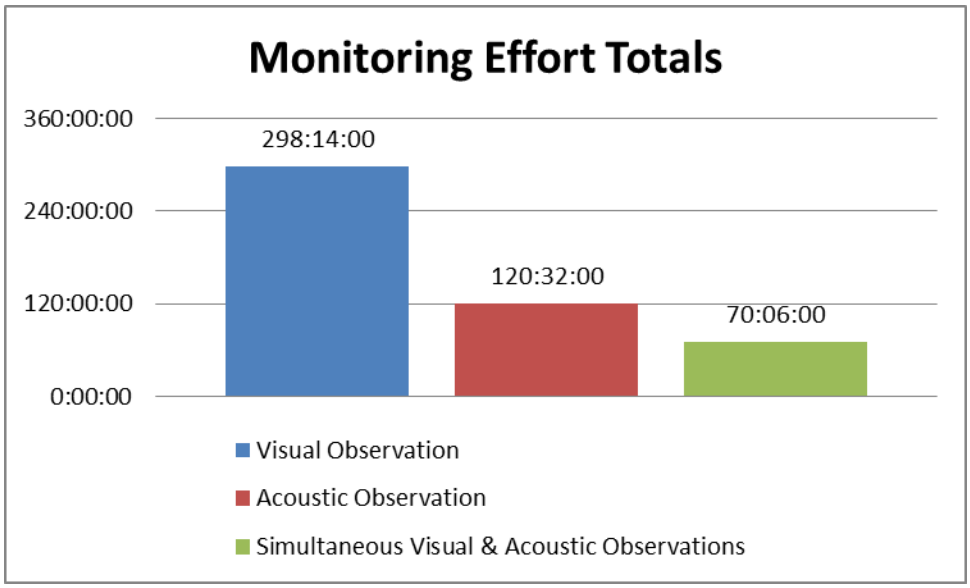

Figure 7. Total acoustic and visual monitoring effort (Hours:Minutes).

4.5. ENVIRONMENTAL CONDITIONS

A majority of visual monitoring effort was conducted during moderate observations conditions. During the first week of the project the rain and cloud cover was the most evident. There were a few brief periods where visibility was obscured by precipitation and fog, as well as general cloud cover. The safety radii were almost always visible, with the exception of just a couple hours on a few days during both weeks 2 and 3. Visibility remained clear, 6 kilometers or more, for the majority of the survey.

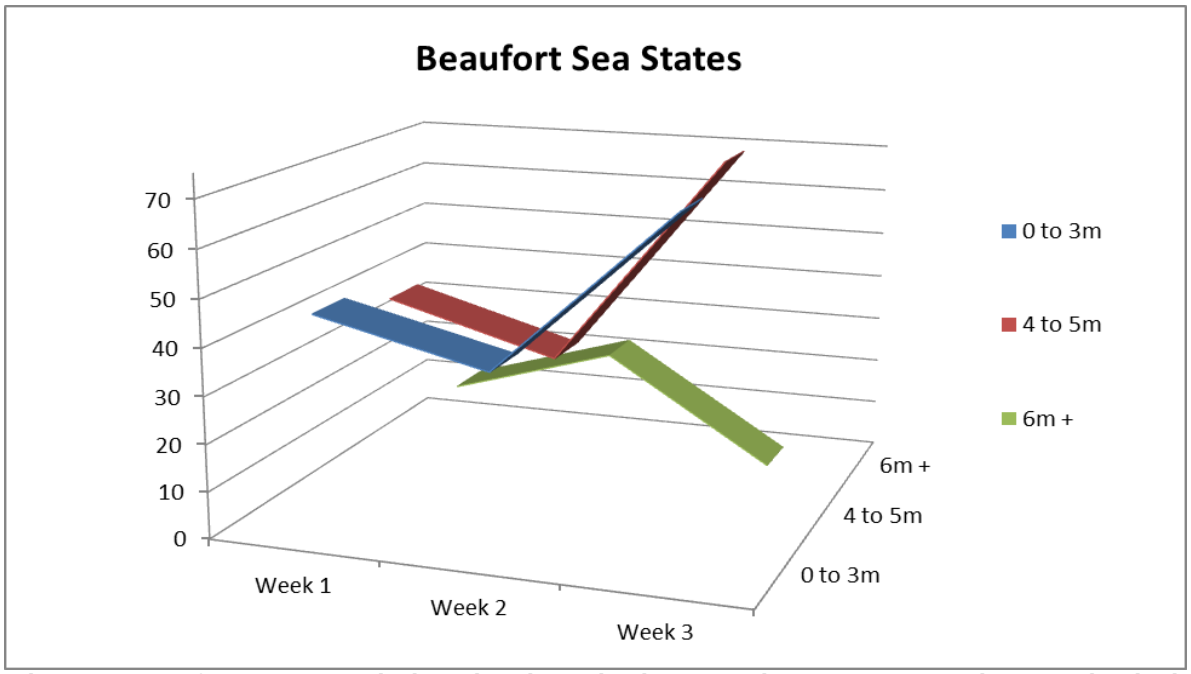

Figure 8. Beaufort sea state during visual monitoring over the Korenaga marine geophysical survey.

Periods of light to heavy rain were frequent throughout the survey and did at times affect visual observations. A total of 30 hours of precipitation was recorded. The Beaufort Sea states ranged from levels 1 through 8 but remained between a level 1 and level 5 for a total of 304 hours, while only reaching a level of 6 or more for 34 hours (Figure 8).

Wind forces remained relatively stable throughout the survey with a minimum of 1 knot during the first week to a maximum of 38 knots during the second week. Forces from 10-21 knots were the average during the cruise totalling 198 hours (Figure 9).

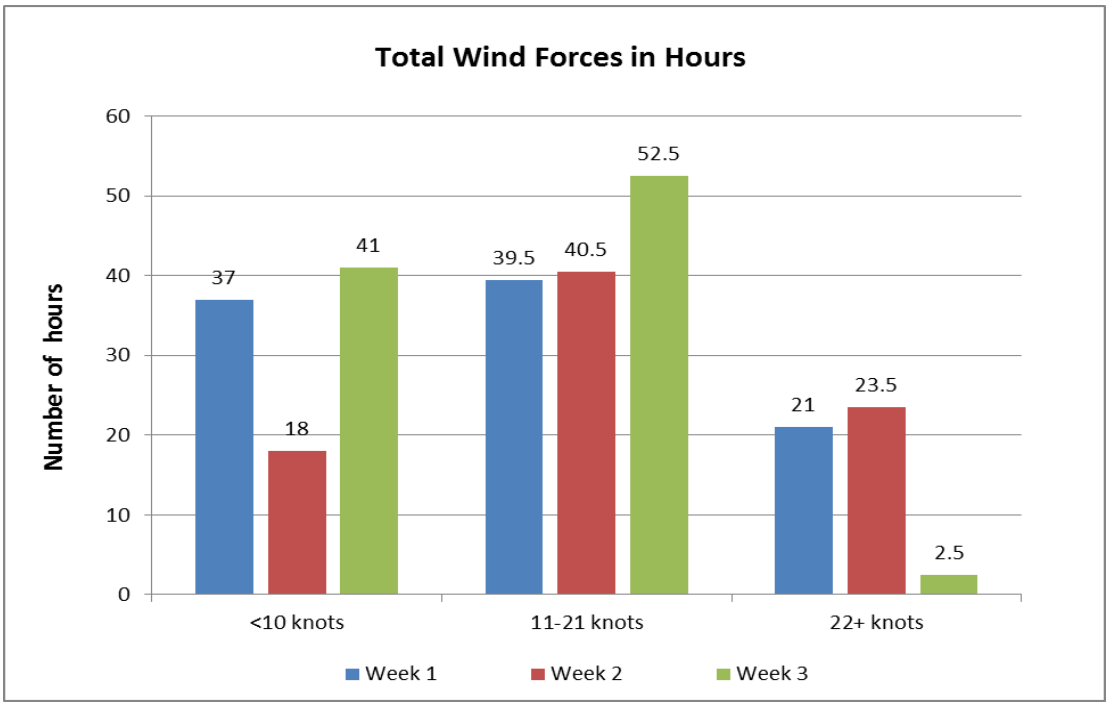

Figure 9. Average wind force each week during visual monitoring.

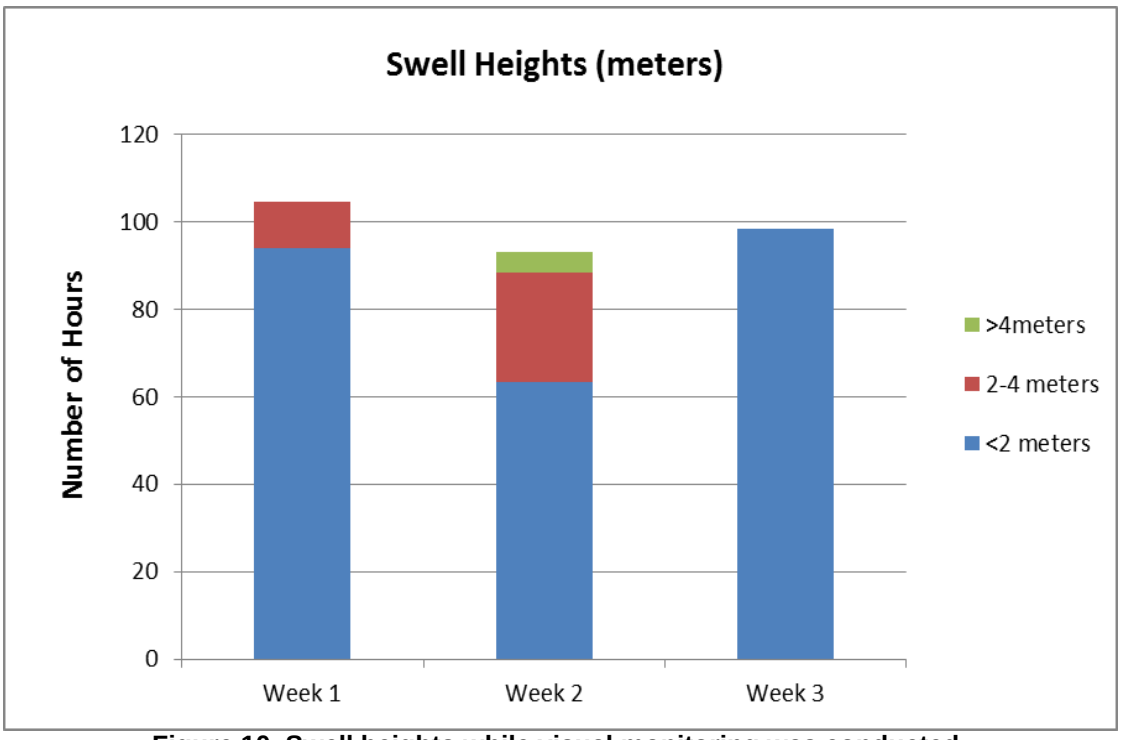

Figure 10. Swell heights while visual monitoring was conducted.

5. MONITORING AND DETECTION RESULTS

5.1. VISUAL DETECTIONS

Visual monitoring conducted during the Korenaga marine geophysical survey resulted in the collection of nine records of detection for protected species (summarized in Appendix F). Three species of marine mammal were positively identified, along with two unidentified baleen whales, three unidentified large cetaceans, and one detection of unidentified small cetaceans. The total number of detection events and total number of animals recorded by species is described in Table 7.

A complete list of bird species 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 G.

Table 7. Number of visual detection records collected for each protected species.

	Total Number of Detection Records	Total Number of Animals Recorded
Cetaceans		
Unidentifiable whale	3	5
Unidentifiable cetacean	1	3
Mysticetes		
Humpback whale	1	1
Unidentifiable baleen whale	2	3
Odontocetes		
Sperm whale	1	8
Pinnipeds		
Northern fur seal	1	1
TOTAL	**9**	**21**

There were few sightings of protected species during the Korenaga survey and it was common to go multiple days without detections of protected species (Figure 11). The most detections occurred on 8 April when there were three detections of protected species totalling six animals. Two of these detections occurred within 20 minutes as the *Langseth* passed near a seamount while in transit to Honolulu.

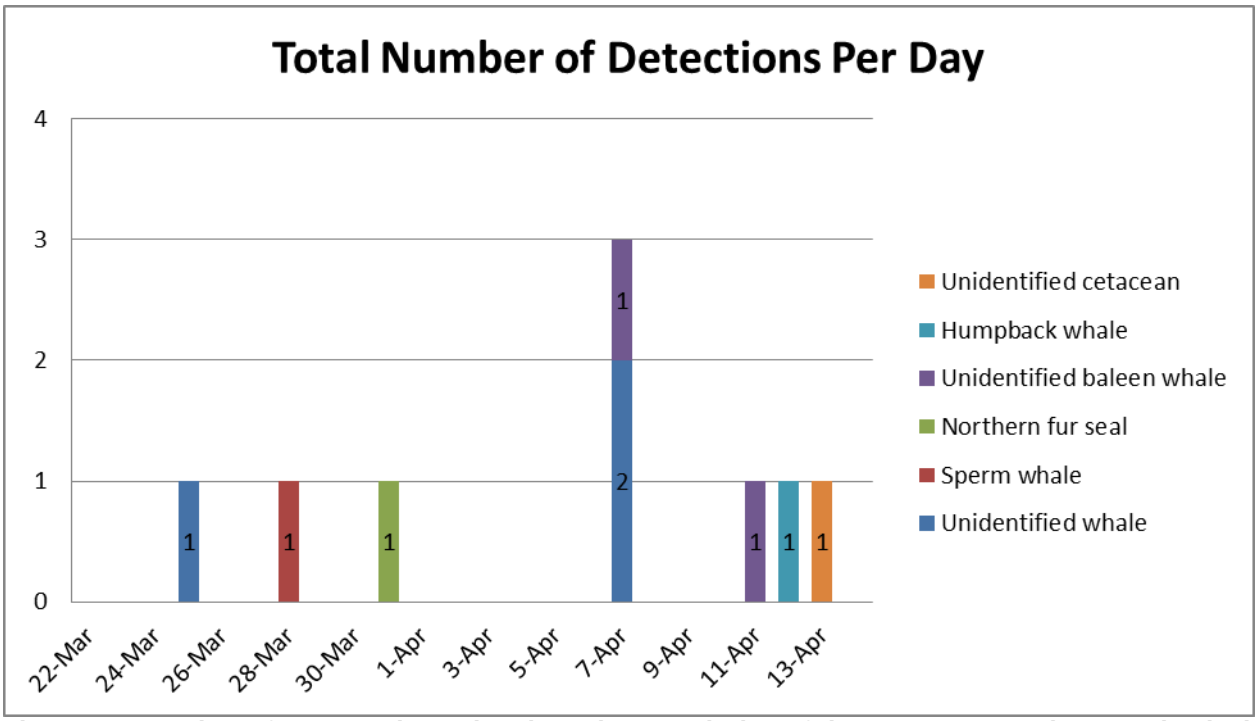

Figure 11. Number of protected species detections each day of the Korenaga marine geophysical survey.

Of the nine protected species detection events during the Korenaga marine geophysical survey, two detections (22%) occurred while the acoustic source was active and seven detections (78%) occurred while the acoustic source was silent. Figure 12 demonstrates the species detected compared to airgun activity.

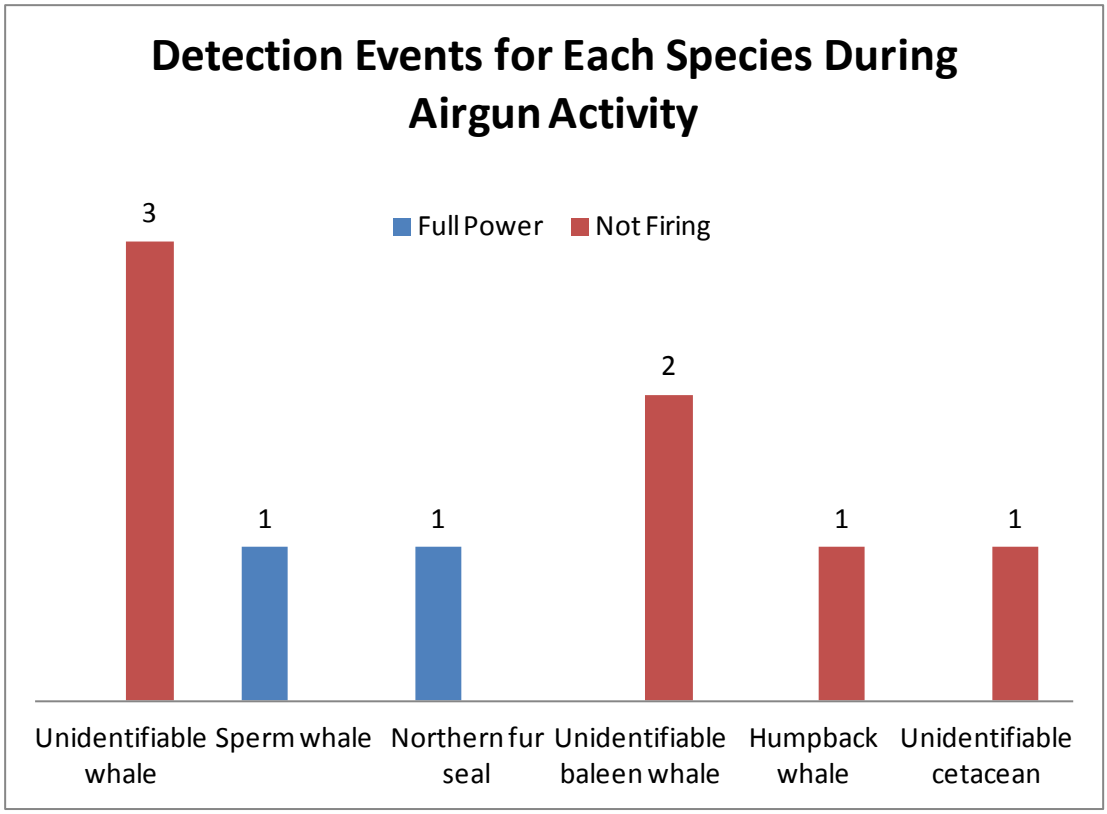

Figure 12. Species detected compared to airgun activity.

Table 8 demonstrates the average closest approach of protected species to the source at various volumes.

Table 8. Average closest approach of protected species to the acoustic source at various volumes.

Species Detected	Full Power (6140-6600 in³)		Single Airgun 40 in³		Ramp-up / Other Reduced Volume		Not Firing	
	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)
Unidentified whale	-	-	-	-	-	-	3	1417
Unidentified baleen whale	-	-	-	-	-	-	2	1350
Unidentified cetacean	-	-	-	-	-	-	1	600
Humpback whale	-	-	-	-	-	-	1	260
Sperm whale	1	1300	-	-	-	-	-	-
Northern fur seal	1	230	-	-	-	-	-	-

Cetaceans were detected most frequently, consisting of 89% (8 detection records) of the total records. Figure 13 demonstrates the total number of animals observed, per species, during the detection events. Sperm whales were the most abundant positively identified protected species accounting for one visual detection of eight animals.

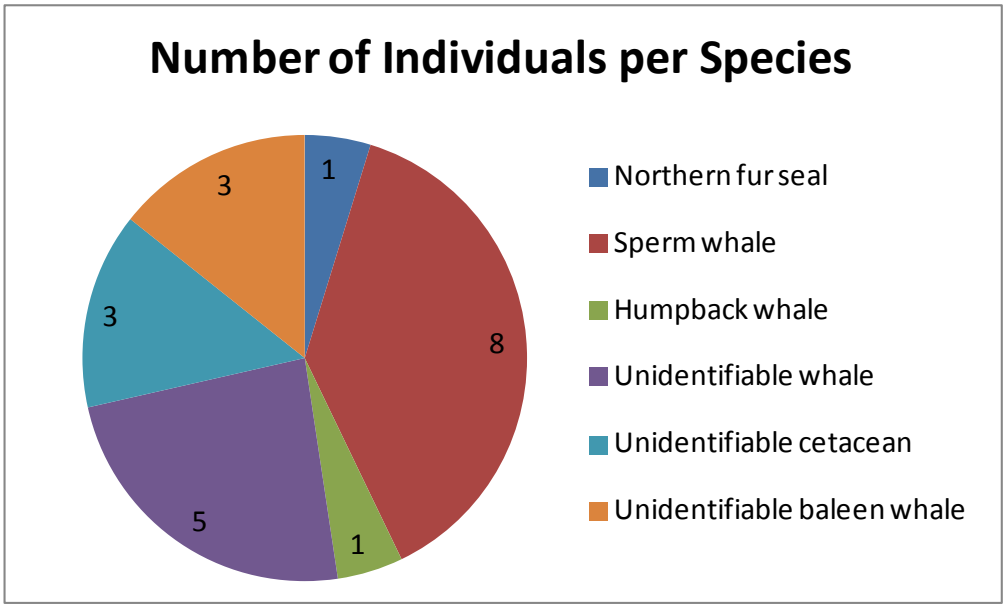

Figure 13. Number of individuals per species detection.

The spatial distribution of marine mammal detections can be seen in Figure 14.

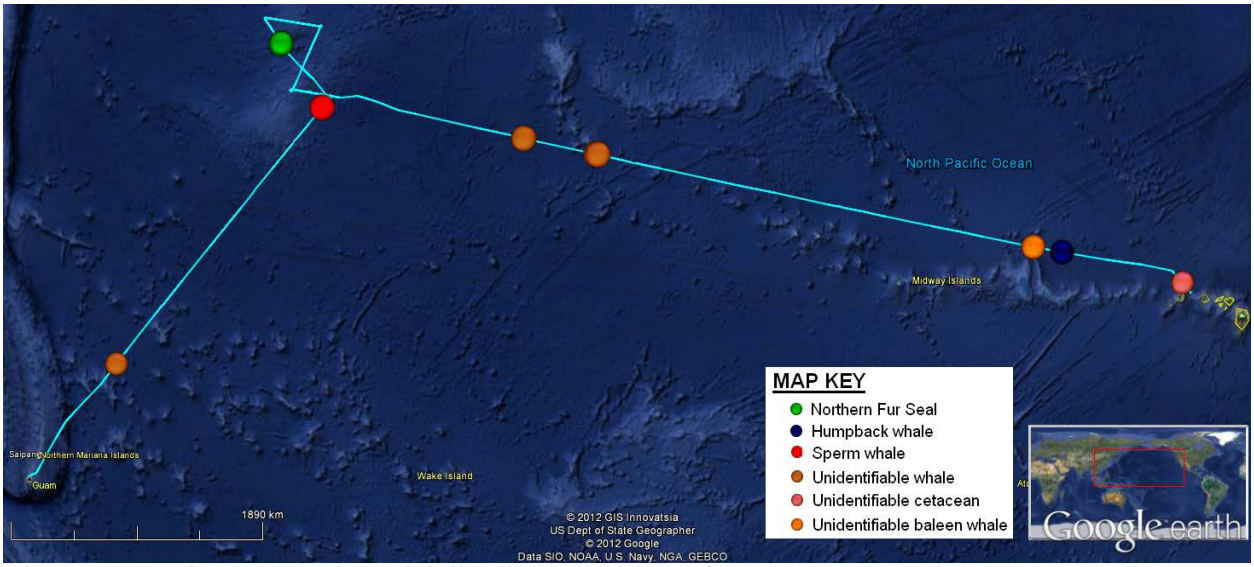

Figure 14. Marine mammal spatial distribution of detections from 23 March 2012 - 15 April 2012 on board the *Langseth*.

5.1.1. Cetacean Detections

5.1.1.1. Unidentified whale

On 26 March at 03:12 UTC an unidentified whale was observed 1000 meters off the port bow of the vessel. The closest distance of the animal to the vessel was 800 meters. As the vessel was in transit, no mitigation actions were required.

On 8 April at 4:24 UTC there was a sighting of an unidentifiable whale. The detection was brief and consisted of the observation of two low bushy blows ~800m off the starboard bow of the vessel. This detection occurred while the vessel was in transit to Honolulu.

On 8 April at 18:59 UTC the blows from three unidentified whales were observed ~2.5km off the starboard side of the vessel. The blows were bushy and appeared to be at an angle, so it is likely they were sperm whales (*Physter macrocephalus*). This detection occurred while passing a seamount in transit to Honolulu.

5.1.1.2. Sperm whale

On 29 March at 22:29 UTC a group of sperm whales was observed 1980 meters from port bow. A total of eight sperm whales appeared to be positioned in a line perpendicular to the ship's course. The animals were seen logging, then moving towards the vessel, 1143 meters at the closest approach, and then moving away from the vessel. No mitigation action was required. . These whales were exposed to sound pressure levels greater than 160 dB re: 1 μPa (rms), constituting Level-B takes.

5.1.1.3. Unidentified baleen whale

On 8 April at 18:41 UTC two unidentified baleen whales were observed ~1000m off the starboard bow of the vessel, traveling quickly away from the vessel. The whales were likely sei whales (*Balaenoptera borealis*), but could also have possibly been Bryde's whales (*Balaenoptera edeni*). This detection occurred while the vessel was in transit and passing near a seamount. The water depth ranged from ~1900m-4900m in a short period of time.

On 12 April at 19:26 UTC two blows were observed from an unidentifiable baleen whale approximately 1400 meters off the port side of the vessel. The blows were tall and appeared split down the middle in a slight V-shape. This was possibly a humpback whale (*Megaptera novaeangliae*).

5.1.1.4. Humpback whale

On 12 April at 03:30 UTC a humpback whale was observed 500 meters, at 15 degrees, from starboard bow. The whale then dove for 6 to 7 minutes, reappearing 450 meters directly behind vessel. Vessel was in transit, no mitigation action was required.

5.1.1.5. Unidentified cetacean

On April 14 at 20:59 UTC three unidentified cetaceans were spotted 600 meters from port side of vessel. Animals were detected while observing multiple birds feeding. Three falcate dorsal fins broke the surface of the water briefly. No mitigation action was required.

5.1.2. Pinniped Detections

5.1.2.1. Northern fur seal

On 1 April at 07:33 UTC a Northern fur seal was observed approximately 50 meters off the port bow of the vessel. As the vessel passed the seal came within 10 meters of the vessel and its closest observed distance to the acoustic source was 230 meters. This detection resulted in a power down of the acoustic source. The seal was exposed to sound pressure levels greater than 190 dB re: 1 μPa (rms), constituting a Level-B take.

6. MITIGATION ACTION SUMMARY

There was one mitigation action implemented during the Korenaga marine geophysical survey. It constituted of a power-down of the acoustic source for protected species inside the 190 dB safety radii. No shut-downs or delays to ramp-up were required or implemented. The total duration of down time caused by mitigation actions (including required ramp up) was 1 hour 02 minutes during the survey. The number and duration of mitigation actions is summarized in Table 9.

Table 9. Number and duration of mitigation actions implemented during the Korenaga marine geophysical survey.

Mitigation Action	Cetaceans	
	Number	Duration
Delayed Ramp-up	0	0:00
Power-down	1	1:02
Shut-down	0	0:00
Total	**1**	**1:02**

On 1 April a Northern fur seal was detected just off the port bow of the vessel, inside the 190 dB safety radius. This occurred while the acoustic source was firing full power while in production and resulted in a power-down of the acoustic source. The seas were very rough and the seal was last seen at while still inside the safety radius, resulting in a 15 minute wait before a ramp up was conducted to resume production. This was the only mitigation action implemented during the Korenaga survey and accounts for 100% of mitigation downtime (Table 10).

Table 10. Power-downs and downtime duration by species.

Species	Number of Power-downs	Duration of Downtime	Percentage of Mitigation Downtime
Northern fur seal	1	1:02	**100%**

Each mitigation action that was implemented during the survey is summarized in Table 11.

Table 11. Summary of each mitigation action implemented during the Korenaga marine geophysical survey.

Date	Visual Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Firing Source/Power Level	Mitigation Action	Total Duration of Mitigation Event
1-Apr	3	Northern fur seal	1	Firing full power	230m / 40 in³	Power down	1:02

6.1. MARINE MAMMALS KNOWN TO HAVE BEEN EXPOSED TO 160 DB OF RECEIVED SOUND LEVELS

NMFS granted an IHA to L-DEO for a marine seismic survey allowing Level B harassment takes (exposure to sound pressure levels greater than or equal to 160 dB re: 1 µPa (rms)) for 30 marine mammal species: seven mysticetes and 23 odontocete species, and one pinniped species. Direct visual observations recorded by PSOs of one species of marine mammals for

which takes were granted in the IHA provide a minimum estimate of the actual number of cetaceans exposed to received sound levels or 180/190 dB and 160 dB.

During the Korenaga marine geophysical survey one northern fur seal was observed within the 190 dB safety radius and eight sperm whales were observed within the 160 dB safety radius, where Level B harassment is expected to occur, while the acoustic source was active (Table 12).

Table 12. Level B Harassment Takes authorized by NMFS IHA for the Korenaga marine geophysical and number of known individuals exposed to 160 dB and 180/190 dB through visual observations.

Species	IHA Authorized Takes	Number of animals exposed to 180/190 dB	Number of animals exposed to 160 dB
Mysticetes			
North Pacific right whale	2	0	0
Humpback whale	5	0	0
Minke whale	29	0	0
Bryde's whale	6	0	0
Sei whale	21	0	0
Fin whale	9	0	0
Blue whale	4	0	0
Odontocetes			
Sperm whale	12	0	8
Pygmy sperm whale	37	0	0
Dwarf sperm whale	90	0	0
Cuvier's beaked whale	78	0	0
Baird's beaked whale	10	0	0
Longman's beaked whale	18	0	0
Blainville's beaked whale	15	0	0
Rough-toothed dolphin	36	0	0
Bottlenose dolphin	277	0	0
Pantropical spotted dolphin	812	0	0
Spinner dolphin	32	0	0
Striped dolphin	1,374	0	0
Fraser's dolphin	286	0	0
Short-beaked common dolphins	3,569	0	0
Pacific white-sided dolphins	420	0	0
Northern right whale dolphin	5	0	0
Risso's dolphin	125	0	0
Melon-headed whale	89	0	0
False killer whale	24	0	0
Killer whale	73	0	0
Short-finned pilot whale	65	0	0
Dall's porpoise	253	0	0
Pinnipeds			
Northern fur seal	21	1	1

These numbers are likely to be an underestimate and provide the absolute minimum number of animals actually exposed. There were multiple days with high winds making it difficult to observe the 160 dB radius. Additionally, there were a couple days with dense fog obscuring the safety radii. It is also possible that estimated numbers of animals recorded during each sighting

event were underestimates, due to some animals not being seen or having moved away before they were observed. Table 13 describes the behavior of all animals, including unidentified species, which were exposed to 160 dB for the duration they were observed.

Table 13. Behavior of species exposed to 160 dB.

Species	Detection No.	No. of Animals	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
Sperm whale	2	8	Logging	Parallel vessel, same direction	Rolling, Diving	Towards vessel, Away from vessel
Northern fur seal	3	1	Swimming at surface	Unknown	Diving	Away from vessel

6.1.1. Sperm Whale

Sperm whales were the only observed odontocete exposed to noise levels constituting Level-B harassment during the Korenaga survey. One sighting event totalling a minimum of eight animals were observed within the 160 dB safety radius while the acoustic source was active. The whales did not enter the 180 dB safety radius and no mitigation actions were implemented.

On 29 March (detection 2) a single blow was detected 1980m from port bow, followed by multiple blows. The animals appeared to be in a line parallel to ships course. The animals logging, then the group split in two with some animals moving towards the ship then the groups merged again moving away from the vessel. The airguns were firing full power and the whales' closest observed distance to the airguns was 1300 meters. There were at least two juveniles in the group. All eight whales were exposed to received sound pressure levels greater than 160 dB.

6.1.2. Northern Fur Seal

A Northern fur seal was the only observed pinniped exposed to noise levels constituting Level-B harassment during the Korenaga survey. There was one sighting event of one animal that was observed within the 190 dB safety radius while the acoustic source was active. This detection resulted in the implementation of a power down of the acoustic source.

On 1 April (detection 3) a Northern fur seal was observed approximately 50 meters off the port bow of the vessel. As the vessel passed the seal came within 10 meters of the vessel and its closest observed distance to the acoustic source was 230 meters. The animals original heading relative to the vessel was unknown and as the vessel passed the seal swam away.

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

In order to minimize the Level-B incidental taking of marine mammals and sea turtles during the Korenaga marine geophysical survey, mitigation measures were implemented whenever these protected species were seen near or within the safety radii designated in the IHA. Very few mitigation actions were necessary during this survey with only one power down occurring that was implemented for a Northern fur seal observed within the 190 dB safety radius.

7. ACKNOWLEDGEMENTS

The Protected Species Observers on board Langseth during the Korenaga marine geophysical survey on the Shatsky Rise in the central Pacific Ocean would like to thank the National Science Foundation and Lamont-Doherty Earth Observatory for the opportunity to work on this project. It was a pleasure to work with Dr. Jun Korenaga, as well as Meagan Cummings, the Marine Environmental Safety Coordinator for L-DEO. We would also like to thank the marine crew and science team on board the *R/V Langseth* for their assistance and hospitality.

We would like to thank the following individuals for their considerable help in making the program a success.

- Meagan Cummings and Jeff Rupert from L-DEO and Holly Smith and Olivia Lee from NSF for their assistance, planning and preparation for the cruise.
- Rebecca Snyder from RPS for her support and installation of the PAM system.
- Matthew Dellinger from RPS for providing logistical support for the project.
- We also thank Anne Unietis and Meagan Cummings for reviewing this report.

We would like to extend our sincere thanks and gratitude to everyone who helped support this project as it would not have been possible without the efforts and assistance of the many individuals and organizations involved.

8. LITERATURE CITED

LGL Ltd., Environmental Research Associates, 2012. “Environmental Assessment of a Marine Geophysical Survey by the R/V Marcus G. Langseth on the Shatsky Rise in the Northwest Pacific Ocean, March – April 2012” <http://www.nsf.gov/geo/oce/envcomp/attachment_1_shatsky_rise_ea.pdf>.

APPENDIX A: Incidental Harassment Authorization for the Korenaga marine geophysical survey

DEPARTMENT OF
COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION NATIONAL MARINE FISHERIES SERVICE

Incidental Harassment
Authorization

The Lamont-Doherty Earth Observatory (L-DEO), Columbia University, P.O. Box 1000, 61 Route 9W, Palisades, New York 10964-8000, is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107, to harass small numbers of marine mammals incidental to a marine geophysical survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) in the northwest Pacific Ocean, March through May,
2012.

1. This Authorization is valid from March 24, 2012 through May 7, 2012.

2. This Authorization is valid only for specified activities associated with the R/V *Marcus G. Langseth*'s (*Langseth*) seismic operations as specified in L-DEO's Incidental Harassment Authorization (IHA) application and environmental analysis in the following specified geographic area:

   (a) In the northwest Pacific Ocean in international waters, bounded by approximately 33.5 - 36° North by 156 - 161° East.

3. Species Authorized and Level of Takes

   (a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in international waters in the northwestern Pacific Ocean:

   (i) Mysticetes – see Table 2 (attached) for authorized species and take numbers.

   (ii) Odontocetes – see Table 2 (attached) for authorized species and take numbers.

(iii) If any marine mammal species are encountered during seismic activities that are not listed in Table 2 (attached) for authorized taking and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 dB re 1 μPa (rms), then the Holder of this Authorization must alter speed or course, power-down or shut-down the airguns to avoid take.

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

(c) The methods authorized for taking by Level B harassment is limited to the following acoustic sources without an amendment to this Authorization:

(i) an 36-airgun array that may range in size from 40 to 360 cubic inches (in^3) with a total volume of approximately 6,600 cubic inches (in^3) as an energy source;

(ii) a multi-beam echosounder; and

(iii) a sub-bottom profiler.

4. The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, National Marine Fisheries Service (NMFS), at 301-427-8401.

5. The Holder of this Authorization is required to cooperate with NMFS and any other Federal, state or local agency monitoring the impacts of the activity on marine mammals.

6. Mitigation and Monitoring Requirements

The Holder of this Authorization is required to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable adverse impact on affected marine mammal species or stocks:

(a) Utilize two, NMFS-qualified, vessel-based Protected Species Visual Observers (PSVOs) (except during meal times and restroom breaks, when at least one PSVO will be on watch) to visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from civil twilight-dawn to civil twilight-dusk) and before and during start-ups of airguns day or night. The *Langseth*'s vessel crew will also assist in detecting marine mammals, when practicable. PSVOs will have access to reticle binoculars (7x50 Fujinon), big-eye binoculars (25x150), and night vision devices. PSVO shifts will last no longer than 4 hours at a time. PSVOs will also make observations during daytime periods when the seismic system is not operating for comparison of animal abundance and behavior, when feasible.

(b) PSVOs will conduct monitoring while the airgun array and streamers are being deployed or recovered from the water.

(c) Record the following information when a marine mammal is sighted:

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

(ii) time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or power-down), sea state, visibility, and sun glare; and

(iii) the data listed under 6(c)(ii) will also be recorded at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

(d) Utilize the passive acoustic monitoring (PAM) system, to the maximum extent practicable, to detect and allow some localization of marine mammals around the *Langseth* during all airgun operations and during most periods when airguns are not operating. One PSVO and/or bioacoustician will monitor the PAM at all times in shifts no longer than 6 hours. A bioacoustician shall design and set up the PAM system and be present to operate or oversee PAM, and available when technical issues occur during the survey.

(e) Do and record the following when an animal is detected by the PAM:

(i) notify the PSVO immediately of a vocalizing marine mammal so a power-down or shut-down can be initiated, if required;

(ii) enter the information regarding the vocalization into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position, and water depth when first detected, bearing if determinable, species or species group (e.g., unidentified dolphin, sperm whale), types and nature of sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information.

(f) Visually observe the entire extent of the exclusion zone (180 dB for cetaceans; see Table 1 [attached] for distances) using NMFS-qualified PSVOs, for at least 30 minutes prior to starting the airgun (day or night). If the PSVO finds a marine mammal within the exclusion zone, L-DEO must delay the seismic survey until the marine mammal(s) has left the area. If the PSVO sees a marine mammal that surfaces, then dives below the surface, the observer shall wait 30 minutes. If the PSVO sees no marine mammals during that time, they should assume that the animal has moved beyond the exclusion zone. If for any reason the entire radius cannot be seen for the entire 30 minutes (min) (i.e., rough seas, fog, darkness), or if

marine mammals are near, approaching, or in the exclusion zone, the airguns may not be

started up. If one airgun is already running at a source level of at least 180 dB, L-DEO may start the second gun without observing the entire exclusion zone for 30 min prior, provided no marine mammals are known to be near the exclusion zone (in accordance with condition 6(h) below).

(g) Establish a 180-dB exclusion zone for marine mammals before the 36-airgun array (6,600 in^3) is in operation; and a 180-dB exclusion zone before a single airgun (40 in^3) is in operation, respectively. See Table 1 (attached) for distances and safety radii.

(h) Implement a "ramp-up" procedure when starting up at the beginning of seismic operations or anytime after the entire array has been shutdown for more than 8 min, which means start the smallest gun first and add airguns in a sequence such that the source level of the array will increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-up, the PSVOs will monitor the exclusion zone, and if marine mammals are sighted, a course/speed alteration, power-down, or shutdown will be implemented as though the full array were operational. Therefore, initiation of ramp-up procedures from shut-down requires that the PSVOs be able to view the full exclusion zone as described in 6(f) (above).

(i) Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant exclusion zone. If speed or course alteration is not safe or practicable, or if after alteration the marine mammal still appears likely to enter the exclusion zone, further mitigation measures, such as power-down or shut-down, will be taken.

(j) Power-down or shutdown the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 1, attached). A shut-down means all operating airguns are shut-down. A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun, which reduces the exclusion zone to the degree that the animal(s) is outside of it.

(k) Following a power-down, if the marine mammal approaches the smaller designated exclusion zone, the airguns must then be completely shut-down. Airgun activity will not resume until the PSVO has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or has not been seen within the exclusion zone for 15 min for species with shorter dive durations (small odontocetes) or 30 min for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales).

(l) Following a power-down or shut-down and subsequent animal departure, airgun operations may resume following ramp-up procedures described in 6(h).

(m) Marine geophysical surveys may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire relevant exclusion zones are visible and can be effectively monitored.

(n) No initiation of airgun array operations is permitted from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the entire relevant exclusion zone cannot be effectively monitored by the PSVOs on duty.

(o) If a North Pacific right whale (*Eubalaena japonica*) is visually sighted, the airgun array will be shut-down regardless of the distance of the animal(s) to the sound source. The array will not resume firing until 30 min after the last documented whale visual sighting.

(p) To the maximum extent practicable, schedule seismic operations (i.e., shooting airguns) during daylight hours.

7. Reporting Requirements

The Holder of this Authorization is required to:

(a) Submit a draft report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *Langseth*'s northwest Pacific ocean cruise. This report must contain and summarize the following information:

(i) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings;

(ii) Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (number of power-downs and shut-downs), observed throughout all monitoring activities.

(iii) An estimate of the number (by species) of marine mammals that: (A) are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re: 1 μPa (rms) and/or 180 dB re 1 μPa (rms) with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on modeling results) to the seismic activity at received levels greater than or equal to 160 dB re: 1 μPa (rms) and/or 180 dB re: 1 μPa (rms) with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

(iv) A description of the implementation and effectiveness of the: (A) terms and conditions of the Biological Opinion's Incidental Take Statement (ITS) (attached); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report will confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on Endangered Species Act listed marine mammals.

(b) Submit a final report to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, within 30 days after receiving comments from NMFS on the draft report. If NMFS decides that the draft report needs no comments, the draft report will be considered to be the final report.

8. Reporting Prohibited Take

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the IHA (if issued), such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), L-DEO shall immediately cease the specified activities and immediately report the incident to the Acting Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov and the Pacific Islands Regional Stranding Coordinator at 808-944-2269 (David.Schofield@noaa.gov).

The report must include the following information:

- Time, date, and location (latitude/longitude) of the incident;
- Name and type of vessel involved;
- Vessel's speed during and leading up to the incident;
- Description of the incident;
- Status of all sound source use in the 24 hours preceding the incident;
- Water depth;
- Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

Activities will not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with L-DEO to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. L-DEO may not resume their activities until notified by NMFS via letter, email, or telephone.

9. Reporting an Injured or Dead Marine Mammal with an Unknown Cause of Death

In the event that L-DEO discovers an injured or dead marine mammal, and the lead PSVO determines that the cause ofthe injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), L- DEO will immediately report the incident to the Acting Chief of the Pem1its and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov and the Pacific Islands Regional Stranding Coordinator at 808-944-2269 (David.Schofield@noaa.gov).

The report must include the same information identified in the paragraph above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with L-DEO to determine whether modifications in the activities are appropriate.

10. Reporting an Injured or Dead Marine Mammal not Related to L-DEO Activities

In the event that L-DEO discovers an injured or dead marine mammal, and the lead PSVO determines that the injury or death is not associated with or related to the activities authorized in the IHA (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), L-DEO will report the incident to the Acting Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov and the Pacific Islands Regional Stranding Coordinator at 808-944-2269 (David.Schofield@noaa.gov), within 24 hours ofthe discovery. L-DEO will provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS.

11. L-DEO is required to comply with the Terms and Conditions of the Incidental Take Statement (ITS) corresponding to NMFS' Biological Opinion issued to both NSF and NMFS' Office of Protected Resources (attached).

12. A copy of this Authorization and the ITS must be in the possession of all contractors and protected species observers operating under the authority of this Incidental Harassment Authorization.

James H. Lecky

Director
Office of Protected Resources
National Marine Fisheries Service

Attachments

3/23/i_l_ ,

Date

Attachment

Table 1. Measured (array) or predicted (single airgun) distances to which sound levels greater than or equal to 160 and 180 dB re: 1 μPa_{rms} that could be received in deep water using a 36-airgun array, as well as a single airgun towed at a depth of 9 m (29.5 ft) during the proposed survey in the northwest Pacific Ocean, during March - May, 2012. [Distances are based on model results provided by L–DEO.]

Source and Volume	**Water Depth**	**Predicted RMS Distances (m)**		
		160 dB	**180 dB**	**19 dB**
Single Bolt airgun	Deep (> 1,000 m)	385	40	12
36-Airgun Array		3,850	940	400

Table 2. Authorized Level B take for L-DEO's seismic survey in the northwestern Pacific Ocean, during March through May, 2012.

Species	**Requested or Adjusted Take Authorization**
North Pacific right whale	2
Humpback whale	5
Minke whale	29
Bryde's whale	6
Sei whale	21
Fin whale	9
Blue whale	4
Sperm whale	12
Pygmy sperm whale	37
Dwarf sperm whale	90
Cuvier's beaked whale	78
Baird's beaked whale	10
Longman's beaked whale	18
Blainville's beaked whale	15
Rough-toothed dolphin	36
Bottlenose dolphin	277
Pantropical spotted dolphin	812
Spinner dolphin	32
Striped dolphin	1,374
Fraser's dolphin	286
Short-beaked common dolphin	3,569
Pacific white-sided dolphin	420
Northern right whale dolphin	5
Risso's dolphin	125
Melon-headed whale	89
False killer whale	24
Killer whale	73
Short-finned pilot whale	65
Dall's porpoise	253
Northern fur seal	21

Incidental take statement

Section 9 of the ESA and federal regulation pursuant to Section 4(d) of the ESA prohibit the "take" of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the NMFS as an act which actually kills or injures wildlife, which may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Sections 7(b)(4) and 7(o)(2), taking that is incidental and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken by the NSF and the Permits and Conservation Division so that they become binding conditions for L-DEO for the exemption in Section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with Section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of listed species, the NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures and terms and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of Section 9(a), pursuant to Section 7(o) of the ESA.

Section 7(b)(4)(C) of the ESA specifies that in order to provide an incidental take statement for an endangered or threatened species of marine mammal, the taking must be authorized under Section 101(a)(5) of the MMPA. One of the federal actions considered in this Opinion is the Permits and Conservation Division's proposed authorization of the incidental taking of fin, blue, sei, humpback, North Pacific right, and sperm whales pursuant to Section 101(a)(5)(D) of the MMPA. With this authorization, the incidental take of listed whales is exempt from the taking prohibition of Section 9(a), pursuant to Section 7(o) of the ESA.

Amount or extent of take

The NMFS anticipates the proposed seismic survey in the Pacific Ocean over the Shatsky Rise might result in the incidental take of listed species. The proposed action is expected to take four blue, nine fin, 21 sei, five humpback, two North Pacific right, and 12 sperm whales by exposing individuals to received seismic sound levels greater than 160 dB re 1 μPa by harassment. These estimates are based on the best available information of whale densities in the area to be ensonified above 160 dB re 1 μPa during the proposed activities. This incidental take would result primarily from exposure to acoustic energy during seismic operations and would be in the form of harassment, and is not expected to result in the death or injury of any individuals that are exposed.

We expect the proposed action will also take individual sea turtles as a result of exposure to

acoustic energy during seismic studies, and we expect this take would also be in the form of harassment, with no death or injury expected for individuals exposed. Harassment of sea turtles is expected to occur at received levels above 166 dB re 1 μPa. As we cannot determine the number of individuals to which harassment will occur, we expect the extent of exposure will occur within the 166 dB isopleth of the *Langseth's* airgun array.

Harassment of blue, fin, humpback, North Pacific right, sei, and sperm whales exposed to seismic studies at levels less than 160 dB re 1 μPa, or of green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles at levels less than 166 dB re 1 μPa, is not expected. If overt adverse reactions (for example, startle responses, dive reactions, or rapid departures from the area) by listed whales or sea turtles are observed outside of the 160 dB or 166 dB re 1 μPa isopleths, respectively, while airguns are operating, incidental take may be exceeded. If such reactions by listed species are observed while airguns, multibeam echosounder, or sub-bottom profiler are in operation, this may constitute take that is not covered in this Incidental Take Statement. The NSF and the Permits and Conservation Division must contact the Endangered Species Act Interagency Cooperation Division to determine whether reinitiation of consultation is required because of such operations.

Any incidental take of blue, fin, humpback whales, North Pacific right, sei whales, sperm whales, or green sea turtles, hawksbill sea turtles, leatherback sea turtles, loggerhead sea turtles, and olive ridley sea turtles is restricted to the permitted action as proposed. If the actual incidental take meets or exceeds the predicted level, the NSF and Permits and Conservation Division must reinitiate consultation. All anticipated takes would be "takes by harassment", as described previously, involving temporary changes in behavior.

Reasonable and prudent measures

The NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impact of incidental take of listed whales and sea turtles resulting from the proposed action. These measures are non-discretionary and must be binding conditions of the NSF funding of the proposed seismic studies and the NMFS' authorization for the exemption in Section 7(o)(2) to apply. If the NSF or the NMFS fail to ensure compliance with these terms and conditions, the protective coverage of Section 7(o)(2) may lapse.

1. For listed sea turtle and marine mammal species these measures include the following: immediate shutdown of all seismic sources in the event a North Pacific right whale is detected; vessel-based visual monitoring by marine mammal and sea turtle observers; real-time passive acoustic monitoring by marine mammal and sea turtle observers; speed or course alteration as practicable; implementation of a marine mammal and sea turtle exclusion zone within the 180 dB re 1 μPa_{rms} isopleth for power-down and shut-down procedures; emergency shutdown procedures in the event of an injury or mortality of a listed marine mammal or sea turtle; and ramp-up procedures when starting up the array. The measures for marine mammals are required to be implemented through the terms of the IHA issued under section 101(a)(5)(D) and 50 CFR 216.107.
2. The implementation and effectiveness of mitigation measures incorporated as part of the Reasonable and Prudent Measure mentioned above and the associated Terms and

Conditions must be monitored.

Terms and conditions

In order to be exempt from the prohibitions of Section 9 of the ESA, the NSF, Permits and Conservation Division, and L-DEO must comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above. These terms and conditions are non-discretionary.

To implement the Reasonable and Prudent Measures, the NSF and the NMFS shall ensure that

1. L-DEO implements the mitigation, monitoring, and reporting conditions contained in the IHA and this Opinion.
2. The Chief of the Endangered Species Act Interagency Cooperation Division is immediately informed of any changes or deletions to any portions of the monitoring plan or IHA.
3. L-DEO immediately reports all sightings and locations of injured or dead endangered and threatened species to the Permits and Conservation Division and NSF.
4. The NSF and the Permits and Conservation Division provide a summary of the implementation and effectiveness of the terms of the IHA to the Chief of the Endangered Species Act Interagency Cooperation Division. This report shall confirm the implementation of each term and summarize the effectiveness of the terms for minimizing the adverse effects of the project on listed whales and sea turtles.

Conservation recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

We recommend the following conservation recommendations, which would provide information for future consultations involving seismic surveys and the issuance of incidental harassment authorizations that may affect endangered large whales and endangered or threatened sea turtles

1. *Effects of seismic noise on sea turtles.* The NSF should promote and fund research examining the potential effects of seismic surveys on listed sea turtle species.

In order for the Endangered Species Act Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting ESA-listed species or their habitats, the Permits and Conservation Division should notify the Endangered Species Act Interagency Cooperation Division of any conservation recommendations they implement in their final action.

Reinitiation notice

This concludes formal consultation on the proposed seismic source survey to be funded by the NSF and conducted by the L-DEO on board the *R/V Langseth* in the Pacific Ocean over the Shatsky Rise, and the issuance of an incidental harassment authorization for the proposed studies

pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA). As provided in 50 CFR §402.16, consultation must be reinitiated if control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of authorized take is exceeded, Section 7 consultation must be reinitiated immediately.

APPENDIX B: Basic Summary Data Form

BASIC DATA FORM				
LDEO Project Number		MGL1206		
Seismic Contractor		Lamont-Doherty Earth Observatory of Columbia University		
Area Surveyed During Reporting Period		Shatsky Rise in the Northwest Pacific Ocean		
		Approximately between 33.5 to 36°N and 156 to 161°E		
Survey Type		2D marine seismic		
Vessel and/or Rig Name		*R/V Marcus G. Langseth*		
Permit Number		IHA granted by NMFS on 23 March 2012		
Location / Distance of Airgun Deployment		232 meters aft of PSO tower		
Water Depth	**Min**	~3000m		
	Max	~5000m		
Dates of project		23 March 2012	THROUGH	15 April 2012
Total time airguns operating – all power levels:		186 hours 17 minutes		
Time airguns operating at full power on survey lines:		174 hours 45 minutes		
Time airguns operating at partial power on survey lines:		1 hour 33 minutes		
Time airguns operating at full/partial power on line changes:		9 hours 59 minutes		
Amount of time mitigation gun (40 in³) operations:		18 minutes		
Amount of time in ramp-up:		1 hour 15 minutes		
Number daytime ramp-ups:		2		
Number of night time ramp-ups:		0		
Number of ramp-ups from mitigation source:		1		
Amount of time conducted in airgun testing:		None		
Duration of visual observations:		298 hours 14 minute		
Duration of observations while airguns firing:		104 hours 46 minutes		
Duration of observation during airgun silence:		193 hours 28 minutes		
Duration of acoustic monitoring:		120 hours 32 minutes		
Duration of acoustic monitoring while airguns firing:		120 hours 03 minutes		
Duration of acoustic monitoring during airgun silence:		29 minutes		
Duration of simultaneous acoustic and visual monitoring:		70 hours 06 minutes		
Lead Protected Species Observer:		Heidi Ingram		
Protected Species Observers:		Meghan Piercy		
		Marina Olson		
		Tatiana Moreno		
Acoustic Observer:		Emily Ellis		
Number of Marine Mammals Visually Detected:		9		
Number of Marine Mammals Acoustically Detected:		0		
Number of acoustic detections confirmed by visual sighting:		0		
Number of visual sighting confirmed by acoustic detection:		0		
Number of Sea Turtles detected:		0		
List Mitigation Actions (eg. Power-downs, shut-downs, ramp-up delays)		1 Power-down (1 April, detection #4)		
Duration of operational downtime due to mitigation:		1 hour 02 minutes		

APPENDIX C: Passive Acoustic Monitoring System Specifications

Passive Acoustic Monitoring System Specifications

Main cable and spare cable:

Mechanical Information

Length 250m			
Diameter	14mm over cable	32mm over mouldings	64mm over connectors
Weight 60kg			
Connector	CEEP 39 pin		

Hydrophone elements

Hydrophone 1	Sphere 1	Broad band	2 kHz to 200 kHz	(3dB points)
Hydrophone 2	Sphere 2	Broad band	2 kHz to 200 kHz	(3dB points)
Hydrophone 3	Sphere 3	Broad band	2 kHz to 200 kHz	(3dB points)
Hydrophone 4	Sphere 4	Low frequency	75Hz to 30 kHz	(3dB points)

Depth Capability 100m

Spacing between elements 1 & 2 (for HF detection)	0.25m	0.16mSecs
Spacing between elements 2 & 3 (for HF detection)	1.2m	0.8mSecs
Spacing between elements 3 & 4 (for LF detection)	1.2m	0.8mSecs

Interface unit Array 1 outputs

Broad band channel sensitivity	-166dB re 1V/uPa
Low frequency channel sensitivity	-157dB re 1V/uPa

Deck cable specification

Length	100m
Diameter	14mm
Connectors	39 pin ITT female
Flying lead for onboard connection	
Connector Diameter	64mm

Inboard Deck Cable

Deck cable specification

Length	1m
Diameter	14mm
Connectors	39 pin ITT male
Flying lead for onboard connection	
Connector Diameter	64mm

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

PAM hydrophone deployment and retrieval procedure on the *R/V Marcus G. Langseth*

The hydrophone deployment procedure is a "living" document and may be altered at any time to reflect changes in deployment over time.

Overview

The research vessel *Langseth* is equipped with a towed PAM array system comprised of a low frequency laptop, a high frequency laptop, a data processing unit, a 100m deck cable, and a 250m linear hydrophone cable with 4 hydrophones and a depth gauge at the last 5m of the cable (Figure D.14). The system is capable of detected a broad range of marine mammal vocalizations due to three of the hydrophone elements having a broadband frequency range of 2 to 200kHz while the fourth hydrophone has a shorter frequency range of 75 to 30kHz for lower frequency detections and all four hydrophones having preamplifiers.

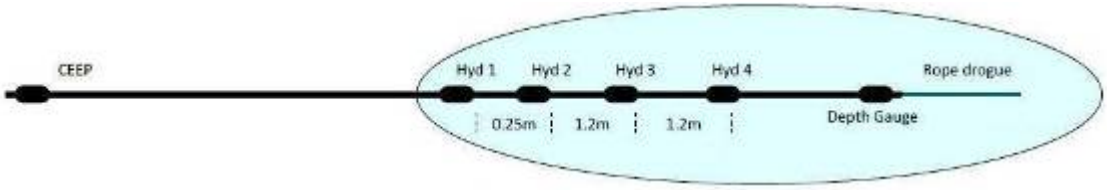

Figure D.16: Diagram of Linear Hydrophone Array.

The two laptops and data processing unit are set up in the main lab with a GPS cable feed (INGGA string) directly from the ship's navigation system to the low frequency laptop (Figure D. 15). The data processing unit connects to the 250m hydrophone cable through a 100m deck cable that is run from the main lab out to the gun deck. Both the deck cable in use and the spare are run from the main lab out to out to the gun deck just in case one failed because the cable had to be run through the bulk head which can only be done while in port. The 250m hydrophone cable is wound on a section of a deckhead winch on the port side of the gun deck (Figure D. 16). From the winch the hydrophone cable is fed astern and pulled further port by a line secured by a yale grip to the port sponson. (Figure D.17). An 8m rope drogue was secured to the end of the hydrophone cable with zip ties with a 9kg shackle secured to the end of the rope drogue with a knot and tape (Figure D.18). Second four lengths of chain weighing approximately 2.5kg each were secured on the cable with tape, 3m, 45m, 96, and 132m up from the depth gauge (Figure D.19). The hydrophone is deployed approximately 150m from the stern and 50m before the center of string. Being that the hydrophone cable is free and independent of the guns the cable is always retrieved before port gun strings are moved.

Figure D.17: PAM Laptops and data processing unit setup.

Figure D.18: Hydrophone cable on winch.

Figure D.19: Hydrophone cable secured by a yale grip to the port sponson.

Figure D.20: Rope drogue and first chain weight secured near hydrophone elements.

Figure D.21: One of the four lengths of chain used to weigh down the cable.

Deployment

- Make sure the data processing unit is off.
- Make sure the deck cable is disconnected from the hydrophone cable.
- Make sure chains on the hydrophone cable are secure.
- Lower the rope drogue and end of the hydrophone cable over the stern and on the port side of the yellow umbilicals and the spreader rope (rope through stern chock) making sure the elements don't hit against the vessel.
- Feed out the hydrophone from the winch.
- Shut off winch controls, connect hydrophone cable to deck cable, turn on data processing unit.

Retrieval

- Make sure data processing unit is off.
- Make sure the deck cable is disconnected to the hydrophone cable.
- Retrieval is the opposite of deployment.
- Make sure the hydrophone elements don't hit against the stern and store them loosely around the winch.

HSE

All PPE required while on gun deck, including coveralls, hardhat, steel toe boots, safety glasses and gloves. Working close to the side, pinch points at the winch, trip hazards, and potential for jellyfish tentacles on the cable upon retrieval are potential hazards.

APPENDIX E: Passive Acoustic Monitoring Downtime

Passive Acoustic Monitoring Downtime

Date	Monitoring Suspended	Date	Monitoring Resumed	Duration acoustic monitoring suspended	Comments
2012-03-30	03:27	2012-03-30	19:05	15:38	Hydrophone cable retrieved due to shallow depth and risk of entanglement with the seismic gear. Remained on board until environmental conditions improved.
2012-03-31	03:49	2012-03-31	05:18	1:29	Hydrophone cable retrieved in order to retrieve seismic arrays 3 and 4 for maintenance.
2012-03-31	19:27	2012-04-01	23:42	28:15	Hydrophone cable retrieved due to shallow depth and risk of entanglement with the seismic gear. Cable remained on board due to high seas and side swells.
2012-04-04	04:56	2012-04-05	02:52	21:56	Hydrophone cable retrieved due to shallow depth and risk of entanglement with the seismic gear. Cable remained on board until environmental conditions improved.

APPENDIX F: **Summary of visual detections of protected species during the Korenaga marine geophysical survey.**

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
1	26-Mar	03:12	Unidentifiable whale	1	21.24528°N 150.84972°E	Not Firing	ST	SB DI	1000m Not Firing	None	Whale observed while in transit to survey site. All seismic gear on board.
2	29-Mar	22:29	Sperm whale	8	33.04955°N 160.60488°E	Firing Full Power	PV/SD AV	BA R DI	1300m Full Power	None	All whales (including two juveniles) exposed to received sound levels greater than 160 dB.
3	1-Apr	07:33	Northern fur seal	1	35.25308°N 158.15242°E	Firing full power	NS	DI AV	230m / Mitigation firing	Power down	Seal last seen inside safety radius. Ramp up required to resume production.
4	8-Apr	4:24	Unidentified whale	1	32.36495°N 170.01348°E	Not firing	UN	SB	750m Not firing	None	Observed while in transit, all seismic gear on board.
5	8-Apr	18:41	Unidentified baleen whale	2	31.78767°N 173.20765°E	Not firing	AV	FT DI	1200m Not firing	None	Likely sei whales, but possibly Bryde's whales. Observed while in transit, all seismic gear on board.
6	8-Apr	18:59	Unidentified whale	3	31.77315°N 173.27585°E	Not firing	ST	SB	2500m Not firing	None	Likely sperm whales. Observed while in transit, all seismic gear on board.
7	12-Apr	19:26	Unidentified baleen whale	1	26.26305°N 167.39888°W	Not firing	UN	SB	1500m Not firing	None	Possibly a humpback whale. Observed while in transit, all seismic gear on board.
8	13-Apr	3:30	Humpback whale	1	25.73450°N 165.95942°W	Not firing	TV	DF	260m Not firing	None	Observed while in transit, all seismic gear on board.
9	14-Apr	20:59	Unidentifiable cetaceans	3	22.65792°N 159.33633°W	Not firing	MI	UN	600m Not firing	None	Observed while in transit, all seismic gear on board. Kauai visible on horizon.

APPENDIX G: Species of birds and other wildlife observed during the Korenaga marine geophysical survey

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
Sooty Tern	Laridae	*Sterna*	*fuscata*	23	4
Brown Noddy	Laridae	*Anous*	*stolidus*	75	1
White Tern	Laridae	*Gygis*	*alba*	28	4
Red-footed Booby	Pelecaniformidae	*Sula*	*sula*	38	6
Masked Booby	Pelecaniformidae	*Sula*	*dactylatra*	5	2
Brown Booby	Pelecaniformidae	*Sula*	*leucogaster*	1	1
Red-tailed Tropicbird	Phaethontidae	Phaethon	*rubricauda*	3	3
White-tailed Tropicbird	Phaethontidae	Phaethon	*lepturus*	2	2
Black-footed Albatross	Diomedeidae	*Phoebastra*	*nigripes*	134	20
Laysan Albatross	Diomedeidae	*Diomedea*	*immutabliis*	124	18
Great Frigatebird	Fregatidae	*Frigata*	*minor*	1	1
Sooty Shearwater	Procellariidae	*Puffinus*	*griseus*	1	1
Townsend's Shearwater	Procellariidae	*Puffinus*	*auricularis*	3	2
Hawaiian Petrel	Procellariidae	*Pterodroma*	*sandwichensis*	2	1
Bonin Petrel	Procellariidae	*Pterodroma*	*hypoleuca*	27	3
Leach's Storm Petrel	Hydrobatidae	*Oceanodroma*	*leucorhoa*	4	3
Black-legged Kittiwake	Laridae	*Larus*	*tridactyla*	5	3
Tufted Puffin	Alcidae	*Fratercula*	*cirrhata*	4	1
Barn Swallow	Hirundinidae	*Hirundo*	*rustica*	4	2
Unidentified shearwater	Procellariidae			17	7
Unidentified Petrel	Procellariidae			30	4
Unidentified storm petrel	Hydrobatidae			19	5
Unidentified Tern	Laridae			9	3
Unidentified Albatross	Diomedeidae			21	2
Unidentified Jaeger	Laridae			2	2
Unidentified shorebird				46	4

Unidentified Booby	Pelecaniformidae			1	1

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
Flying Fish	Exocoetidae			553	11
Mahi mahi	Coryphaenidae	*Coryphenus*	*hippurus*	5	2
Yellowfin Tuna	Scombridae	*Thunnini*	*thunnus*	1	1
Manta Ray	Mobulidae	*Manta*	*birostris*	2	2
Unidentified Fish				52	4
Portuguese Man-O-War	Physaliidae	*Physalia*	*physalis*	1	1
Barnacles				1000+	5