Protected Species Mitigation and Monitoring Report

United States Extended Continental Shelf Survey

United States Geological Service's
DUTCH ECS Survey
Central-western Bering Sea

8 August 2011- 2 September 2011

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, was contracted to conduct the United States Geological Survey (USGS) Extended Continental Shelf (ECS) two-dimensional (2D) marine seismic program in the central-west Bering Sea. The survey was conducted to delineate the United States (U.S.) ECS. The *Langseth*, left Dutch Harbor on 8 August 2011 and began the survey on 11 August 2011. The survey was completed on 30 August 2011 and the *Langseth* returned to Dutch Harbor on 2 September 2011.

The USGS 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 5 August 2011 (Appendix A) with several mitigation measures that stipulated harassment to marine mammals. Mitigation measures were implemented to minimize potential impacts to marine mammals, sea turtles and protected seabirds 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 and USGS to provide continuous protected species observation coverage and to fulfill the environmental regulatory requirements and reporting mandated by NMFS in the IHA. Four PSOs and one dedicated 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 362 hours 54 minutes of visual observations and 237 hours 23 minutes of acoustic monitoring over the course of the survey.

This visual monitoring effort produced a project total of 57 protected species detection records all of marine mammals: 43 cetacean records, 13 pinniped records, and one fissiped record. Of the 43 cetacean records collected, 18 consisted of mysticetes, 24 records were collected for odontocetes, and one record for an unidentified large cetacean. There were no sightings of sea turtles during the survey. All detections were made visually. There were no acoustic detections made using the PAM system.

Detections of protected species resulted in a total of nine mitigation actions being implemented, of which were all power-downs of the acoustic source. Mitigation measures were to be applied to sightings of short-tailed albatross flocks of more than nine birds however there were no sightings of flocks of this size during the survey.

A known 42 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 two humpback whale takes and 35 Dall's porpoise takes. Additionally, five unidentified baleen whales and one unidentified pinniped were observed within the 160 dB safety radius.

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 USGS DUTCH ECS two-dimensional marine seismic survey on board the *R/V Langseth* from 8 August to 2 September, 2011 in the central-western Bering Sea.

This document serves to meet the reporting requirements dictated in the IHA issued to the USGS by NMFS on 5 August 2011. 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.

The Endangered Species Act (ESA) identifies avian species which are afforded protection and identifies the short-tailed albatross (*Phoebastria albatrus*) as a species that was expected to occur in the survey prospect area. Due to a lack of available scientific research documenting the application of mitigation radii for these endangered birds during seismic survey and due to the request from the U.S. Fish and Wildlife Service, USGS applied the 190dB safety radii to power-down upon encountering flocks of more than nine short-tailed albatross foraging or resting in the water.

2.1. PROJECT OVERVIEW AND LOCATION

The survey occurred in the central western Bering Sea, between approximately 350 and 800 km offshore, in the area 55 to 58.5° North, 177° West to 175° East (Figure 1). The seismic survey took place in water depths greater than 3,000 meters. The survey plan included 14 survey lines of the multi-channel survey (MCS) and three Ocean-bottom seismometer (OBSs) refraction lines. The *R/V Langseth* was the source/acquisition vessel used throughout the USGS DUTCH ECS marine seismic survey. The *Langseth*'s cruising speed is 10 knots but seismic survey speed varied between 3.5 and 5 knots. Acquisition began on 11 August 2011 and continued until 30 August 2011. All of the planned transect lines were completed allowing the *Langseth* to acquire one partial contingency survey line. The *Langseth* acquired a total of approximately 2,468 kilometres of survey lines over the course of the USGS DUTCH ECS marine seismic survey program.

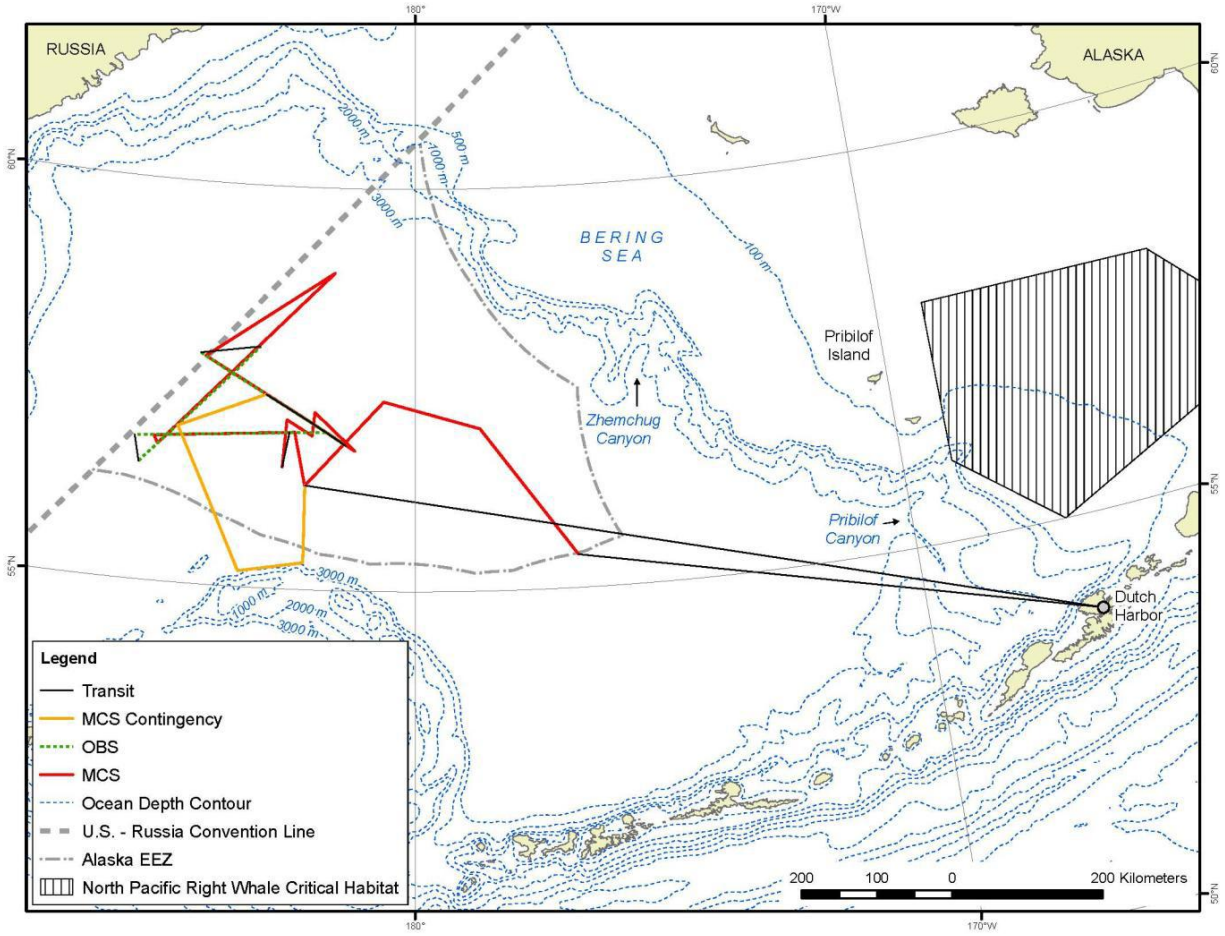

Figure 1. Location of the USGS DUTCH ECS Survey in the Bering Sea (LGL EA 2011).

The primary purpose of the survey was to collect seismic reflection and refraction profiles to be used to delineate the U.S. extended continental shelf in the central-western Bering Sea. The ECS is that region beyond 200 nautical miles (n.mi.) where a nation can show that it satisfies the conditions of Article 76 of the United Nations Convention on the Law of the Sea. One of the conditions in Article 76 is a function of sediment thickness. The seismic profiles are designed to identify the stratigraphic "basement" and to map the thickness of the overlying sediments. Acoustic velocities (required to convert measured travel times to true depth) were measured directly using sonobuoys and ocean-bottom seismometers, as well as by analysis of hydrophone streamer data.

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 181 meters astern of the vessel. This placed the source arrays 224.4 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 in^3 to 360 in^3. 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 in^3. The full power source of four sub-arrays (36 airguns) had a total discharge volume of 6,600 in^3 and a pressure of 1900 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 22 seconds at typical survey speed, but was increased to 150 meters during the acquisition of the three OBS refraction survey lines, or approximately 66 seconds at typical survey speed. The sound signal receiving system during the acquisition of the MCS transect lines consisted of a single eight kilometer long hydrophone streamer, which received the returning acoustic signals and transferred the data to the processing system located onboard 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.

Acquisition of the OBS refraction survey lines utilized 17 Scripp's Institute of Oceanography LC4X4 OBSs as the receiving system. Each OBS, with a volume of 1 $meter^3$, was deployed along the seafloor with an anchor and retrieved by an acoustic trigger where the OBS was released to float to the surface and be retrieved. All 17 of the OBSs deployed were successfully retrieved.

Sonobuoys were also deployed up to four times per day during seismic operations on both MCS and OBS survey line acquisition. A total of 35 sonobuoys were launched, each consisting of a hydrophone, electronics, and a radio transmitter that measured the seismic signal then transmitted the data back to the ship, for up to eight hours before sinking to the ocean bottom.
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 are 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 USGS by NMFS including both monitoring and mitigation objectives. Additional mitigation measures were implemented voluntarily by USGS after consultation with U.S. Department of Fish & Wildlife Service. 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 Passive Acoustic Monitoring 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 achieving 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 onboard were NMFS-approved and held certifications from a recognized Joint Nature Conservation Committee (JNCC) course and/or approved Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) 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 be used 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 MMO, but most often two MMOs, 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 07:30 to 09:08 local time, while end of observation times ranged from 22:30 to 00:20 local time.

A visual monitoring schedule was established by the PSOs where each person completed visual observations watches which varied in length between one hour to four hours, two to four times a day, for a total of five to seven 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 twice each day for lunch and dinner.

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 indicating the possible presence of a protected species.

Observers were also conducting visual observations for groups of short-tailed albatross to report sightings of more than two birds to the U.S. Department of Fish & Wildlife as well as to initiate mitigation procedures for flocks of birds on the surface in groups containing more than nine birds. No short-tailed albatross were sighted throughout the survey.

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, sea turtle, or short-tailed albatross) 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 what 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 to be made for possible analysis later 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)	Shut-down EZ for Pinnipeds 190 dB (m)	Shut-down EZ for Cetaceans 180 dB (m)	Level-B Harassment Zone 160 dB (m)
Single bolt airgun (40 in^3)	9	Deep (>1,000)	12	40	385
4 strings 36 airguns (6600 in^3)	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 224.4m 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 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 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 a 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 one to six hours maximum. 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 half 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 below can be found in Appendix D.

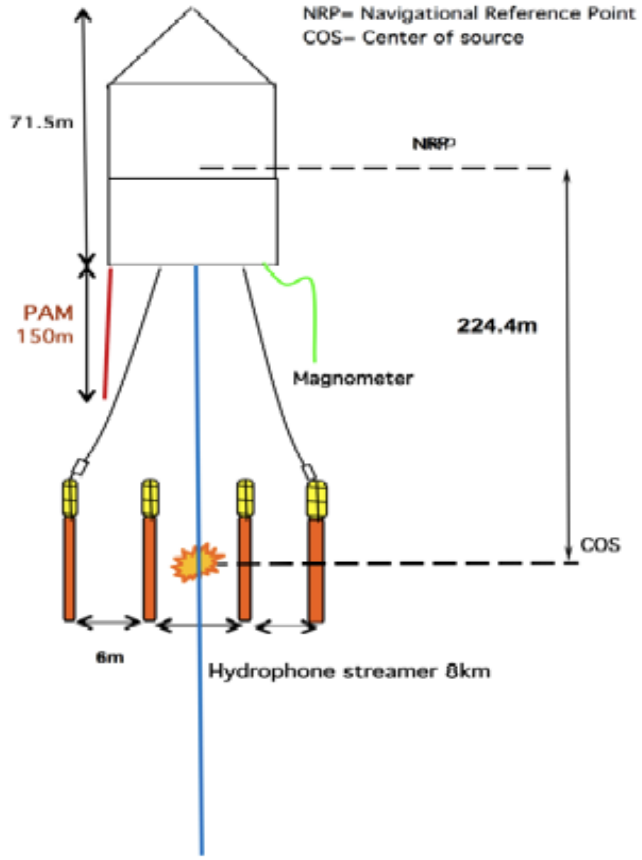

Figure 3. Location of the hydrophone deployment.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

The *R/V Langseth* departed the port of Dutch Harbor for the seismic survey site at 20:35 UTC on 8 August 2011. The seismic gear was deployed on 10 August 2011 as the *Langseth* neared the first survey line. Use of the acoustic source commenced at 23:33 UTC on 10 August 2011. Acquisition began on the first survey line began at 00:30 UTC on 11 August 2011. Table 2 outlines the dates and times of acquisition for each survey line.

Acquisition of the multi-channel seismic portion of the survey was completed at 03:23 on 21 August 2011. At this time the seismic gear was brought on board and the next day was spent deploying 17 ocean-bottom seismometers. Acquisition on the first OBS survey line began at 02:10 UTC on 23 August 2011. The final OBS line was completed at 15:59 UTC on 26 August and the vessel again retrieved the seismic gear to return and retrieve the OBS's. At 17:26 UTC on 30 August the vessel began acquisition on part of one of the contingency MCS survey lines. The USGS DUTCH ECS was completed with the acquisition of the final part of the survey line at 22:59 UTC on 30 August 2011. The vessel returned to the dock in Dutch Harbor at 16:30 UTC on 2 September 2011.

Table 2. USGS DUTCH ECS multi-channel seismic and ocean-bottom seismometer survey lines acquired.

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
MGL1111MCS01SEQ1	11-Aug-2011	00:30	11-Aug-2011	16:06
MGL1111MCS01ASEQ2	11-Aug-2011	16:08	12-Aug-2011	04:53
MGL1111MCS02SEQ3	12-Aug-2011	04:56	12-Aug-2011	17:58
MGL1111MCS03SEQ4	12-Aug-2011	20:47	13-Aug-2011	14:45
MGL1111MCS04SEQ5	13-Aug-2011	15:49	14-Aug-2011	00:29
MGL1111TRN05SEQ6	14-Aug-2011	00:50	14-Aug-2011	02:41
MGL1111MCS05SEQ7	14-Aug-2011	03:31	15-Aug-2011	04:19
MGL1111MCS07SEQ8	15-Aug-2011	06:03	16-Aug-2011	16:10
MGL1111MCS08SEQ9	16-Aug-2011	16:20	17-Aug-2011	13:37
MGL1111MCS09SEQ10	17-Aug-2011	13:40	18-Aug-2011	07:00
MGL1111MCS09ASEQ11	18-Aug-2011	07:04	18-Aug-2011	16:26
MGL1111MCS10SEQ12	18-Aug-2011	16:51	19-Aug-2011	02:00
MGL1111TRN11SEQ13	19-Aug-2011	02:51	19-Aug-2011	07:35
MGL1111MCS11SEQ14	19-Aug-2011	07:58	19-Aug-2011	23:45
MGL1111TRN12SEQ15	20-Aug-2011	00:40	20-Aug-2011	02:41
MGL1111MCS12SEQ16	20-Aug-2011	02:45	20-Aug-2011	16:25
MGL1111MCS13SEQ17	20-Aug-2011	16:28	21-Aug-2011	03:23
MGL1111OBS01SEQ18	23-Aug-2011	02:10	23-Aug-2011	15:37
MGL1111OBS01BSEQ19	24-Aug-2011	07:27	24-Aug-2011	22:51
MGL1111OBS02ASEQ20	25-Aug-2011	00:14	25-Aug-2011	11:13
MGL1111OBS02SEQ21	25-Aug-2011	11:18	26-Aug-2011	15:59
MGL1111MCS14SEQ22	30-Aug-2011	17:26	30-Aug-2011	22:59

The acoustic source was active throughout the survey, with a few periods of source silence, for a total of 325 hours 44 minutes of source activity. This includes ramping-up of the airguns, full

power and partial power firing both online and during line changes, and operation of a single 40 in^3 mitigation airgun (Figure 4). The mitigation source was active during mitigation power-downs initiated for protected species inside the safety radius as well as for mechanical/technical reasons for a total of 10 hours 30 minutes during the survey. Full power source operations accounted for 88% (287 hours 59 minutes) of airgun activity during the project. Line changes were often shot at full or partial power, totalling 12 hours 13 minutes of array activity. Also because the data was still usable while shooting at partial power (volume ranging from 3,020 in^3 to 4,950 in^3) portions of survey lines were sometimes shot using partial power while maintenance was performed on an array, accounting for 8 hours 22 minutes of array activity. Additionally, the full volume of the acoustic source (36 airguns firing) ranged from 5880 in^3 to 6600 in^3, caused by various guns of different sizes being changed out on the arrays. Due to two airguns on the array being changed out for smaller ones, 37 airguns were fired at a volume of 6,240 in^3 for 18 minutes on 17 August 2011. Once noticed, the volume was changed back to 6,200 in^3 from 36 airguns.

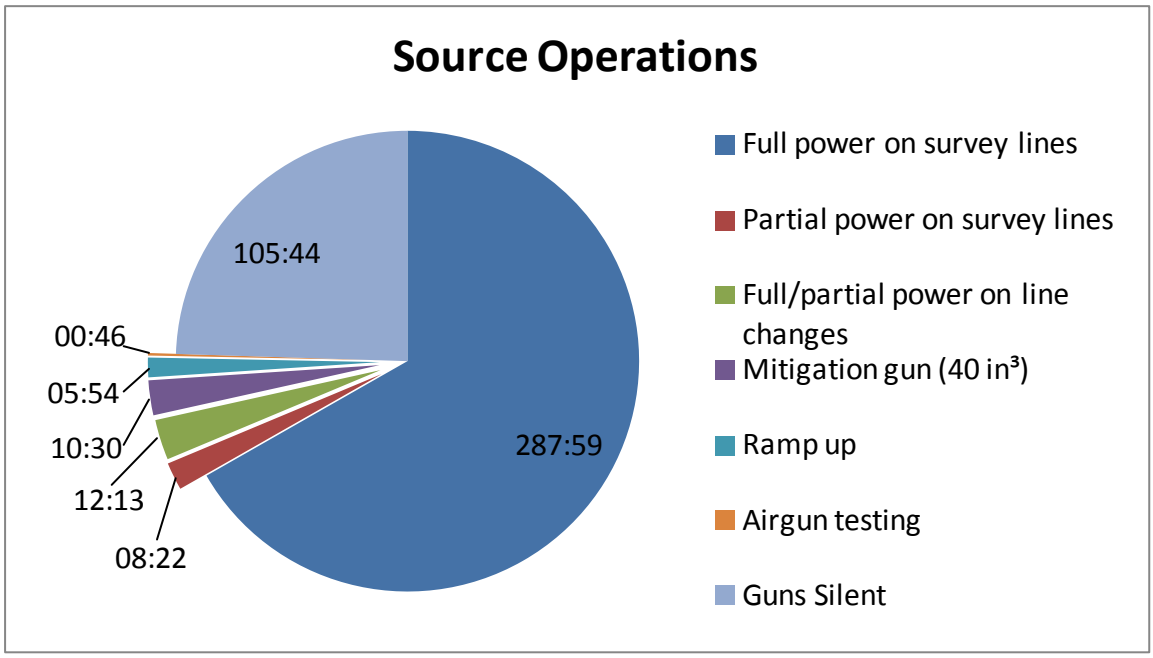

Figure 4. Total acoustic source operations.

The acoustic source was ramped up a total of ten times over the course of the survey in order to commence full power survey operations in compliance with the IHA (Table 3). Each ramp-up was conducted over 31 to 38 minutes, where the NMFS approved automated gun controller program DigiShot added guns sequentially to achieve full source over the required period of time. All ramps ups were 20 to 40 minutes in duration with the exception of one ramp-up on 20 August 2011 that lasted 45 minutes. The 45 minute ramp-up was caused by a timing error with the DigiShot program. 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. Ramp-ups were only conducted during daylight hours during the USGS DUTCH ECS survey project. No ramp-ups were conducted at night. Three daytime ramp-ups were conducted from airgun silence during the survey. The remaining seven daytime ramp-ups were initiated with a mitigation source already active.

Table 3. Total acoustic source operations during USGS DUTCH ECS survey.

Acoustic Source Operations	Number	Duration (hh:mm)
Gun Tests		**00:46**
Ramp-up	**10**	**5:54**
Day time ramp-ups from silence	**3**	
Day time ramp-ups from mitigation	**7**	
Night time ramp-ups from mitigation	**0**	
Full power survey acquisition		**287:59**
Partial power survey acquisition		**8:23**
Full/partial power line changes		**12:13**
Single airgun (40 in³)		**10:30**
Total time acoustic source was active		**325:44**

4.2. VISUAL MONITORING SURVEY SUMMARY

The Protected Species Observers (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 20:35 UTC on 8 August 2011 and continued until 06:30 UTC on 2 September 2011 when the vessel returned to Dutch Harbor at the completion of the survey project. Visual monitoring was over a period of about 26 days and a total of approximately 209440.5 km of visual effort was completed. 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 15 hours of visual observations per day. Visual observations were suspended from 19:00 UTC on 23 August 2011 until 04:00 UTC and on 24 August 2011 due to severe weather, when the seismic gear was brought on board and the vessel moved away from the survey area to wait for the weather to improve. Visual observations were suspended again while in transit back to port on 1 September 2011 at 03:55 UTC due to severe weather.

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 immediately return to assist.

The acoustic source was active during the majority of visual (57%) and during all acoustic monitoring, as shown in Figure 5. Once the survey began the acoustic source was only disabled a few time while deploying and retrieving the OBSs, and due to severe weather.

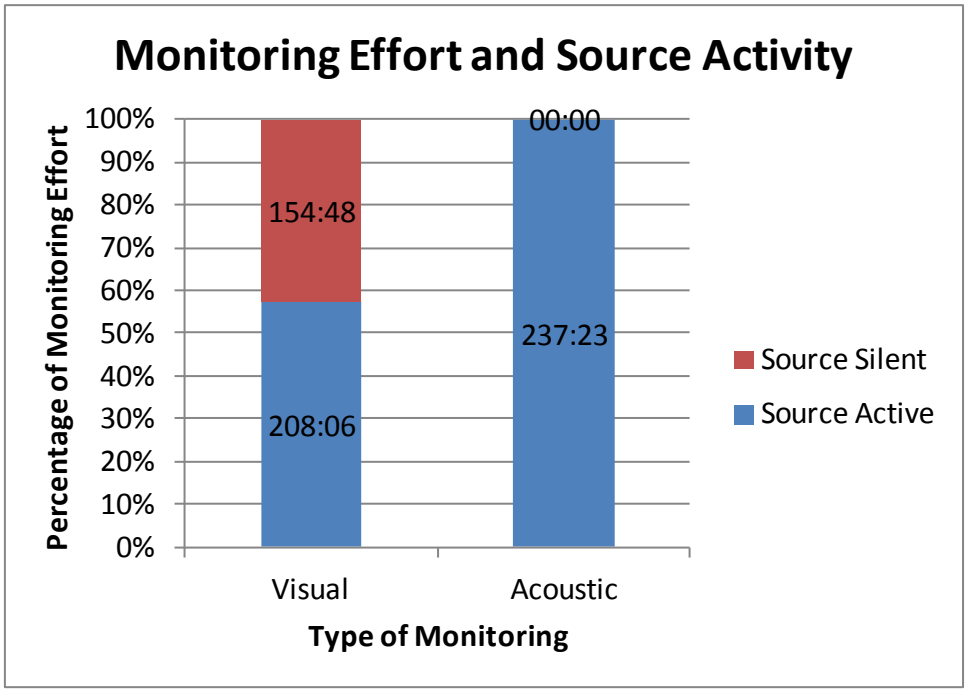

Figure 5. Duration of visual and acoustic monitoring effort while the acoustic source was active vs. silent.

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	**208:06**
Total monitoring while acoustic source silent	**154:48**
Total monitoring effort	**362:54**

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 83% of visual monitoring was conducted from the PSO tower during the USGS DUTCH ECS survey.

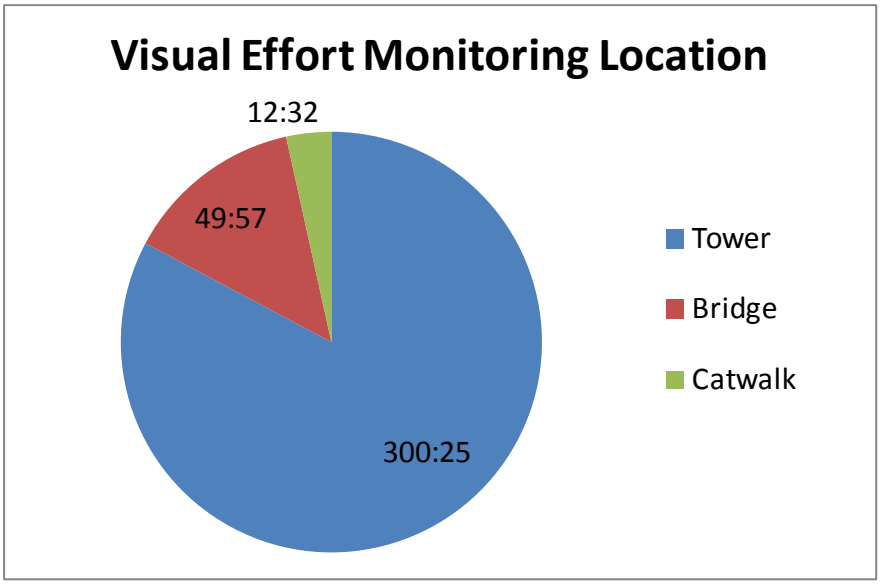

Figure 6. Total visual effort from observation locations on board the R/V Langseth.

4.3. ACOUSTIC MONITORING SURVEY SUMMARY

The hydrophone cable was deployed for the first time on 11 August 2011 after the vessel had completed deployment of the seismic equipment. Acoustic monitoring began immediately at 01:30 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 22:55 UTC on 30 August 2011 when acquisition of the final survey line was completed and the hydrophone cable was retrieved in preparation for the retrieval of the seismic equipment. Over the course of the project, PSOs conducted 237 hours and 23 minutes of acoustic monitoring, all of which 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	**85:04**
Total day time monitoring	**148:52**
Total monitoring while acoustic source active	**237:23**
Total monitoring while acoustic source silent	**00:00**
Total acoustic monitoring	**237:23**

There were several periods of acoustic monitoring downtime (243 hours and 30 minutes) that accumulated throughout the project. Acoustic monitoring was suspended and the cable retrieved for numerous instances of seismic repairs/maintenance to avoid a potential entanglement when the seismic equipment was retrieved. Downtime was attributed to seismic equipment when it related to repairs, maintenance or malfunctioning of streamers, airguns or compressors (Table 6) and accounted for 7 hours and 27 minutes of the total acoustic monitoring downtime of the project. Acoustic monitoring downtown can also be attributed to weather when the cable was retrieved several times due to entanglement with the seismic equipment or to prevent entanglement. The cable would remain on board until the sea state

had decreased to a sufficient level to make it safe to deploy the cable without risk on entanglement. Weather and entanglement accounted for 36 hours and 41 minutes of acoustic monitoring downtown. The largest portion of acoustic monitoring downtime was attributed to the deployment and retrieval of the OBSs. 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)
Seismic equipment repairs	**07:27**
OBS Deployment & Retrieval	**199:22**
PAM cable entanglement/Weather	**36:41**
Total Passive Acoustic Monitoring Downtime	**243:30**

4.4. SIMULTANEOUS VISUAL AND ACOUSTIC MONITORING SUMMARY

While visual observations began on 8 August acoustic observations began on 11 August, 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 60% (362 hours 54 minutes) while acoustic monitoring accounted for 40% (237 hours 23 minutes). As displayed in Figure 7 there were 148 hours 52 minutes of simultaneous visual and acoustic observations conducted during this survey. Simultaneous visual and acoustic monitoring accounted for 63% of total acoustic monitoring and 41% of the total visual observation.

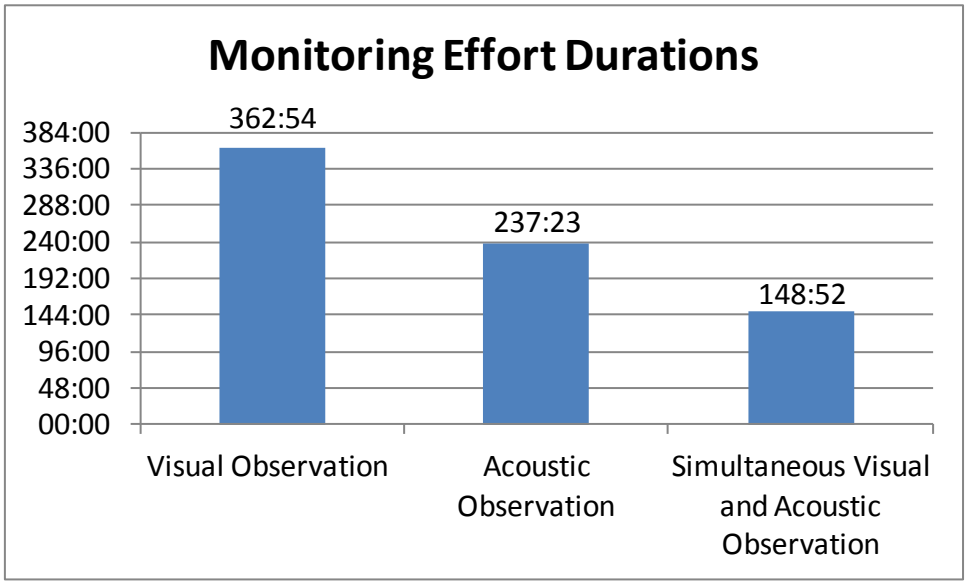

Figure 7. Total PAM and visual monitoring effort.

4.5. ENVIRONMENTAL CONDITIONS

A majority of visual monitoring effort was conducted during average observations conditions with regular periods of high winds (greater than 20 knots) which could last hours or days at a time. There were brief periods where visibility was obscured/hindered by rain or fog and the safety radii were not visible. These conditions were present for a total of 45 hours for the cruise.

Visibility remained clear, 5 kilometers or more, for a total of 164.5 hours (Figure 8). Temperatures were moderate averaging at or around 11^{0}C.

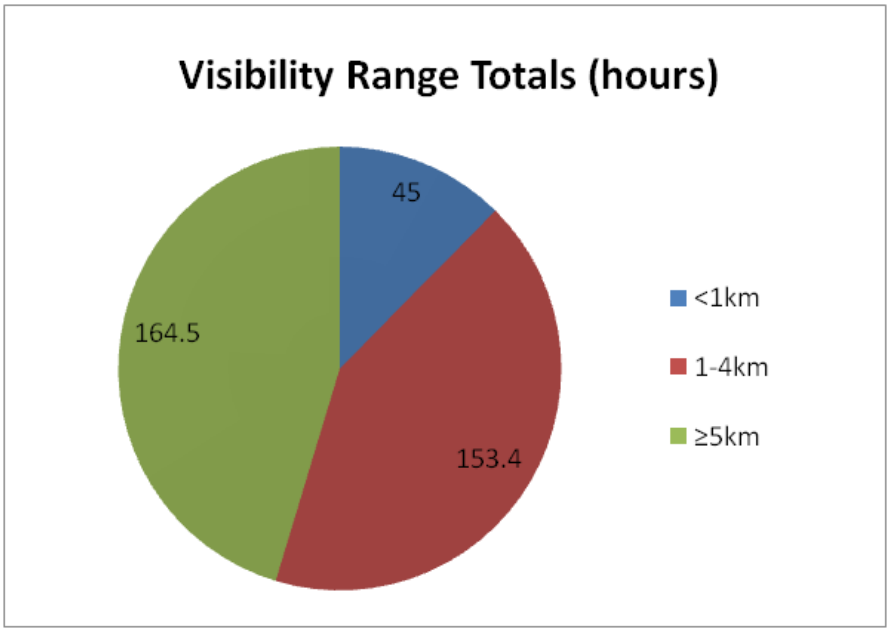

Figure 8. Visibility during visual monitoring over the USGS DUTCH ECS Survey.

Wind forces varied greatly throughout the cruise with a minimum of less than 1 knot to a maximum of 35 knots. For the beginning of the cruise, winds often remained less than 11 knots but gradually picked up towards the end of the survey. Most days the wind speed ranged from 11 to 20 knots though, there were 94 hours with high winds (greater than 20 knots) (Figure 9).

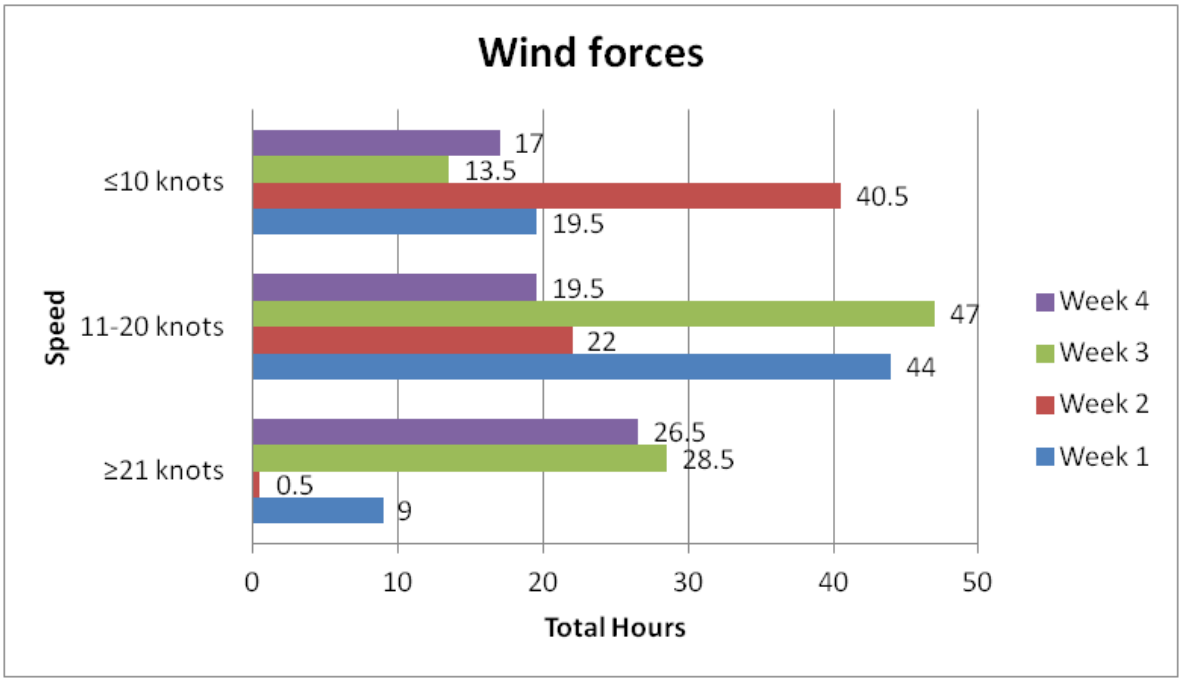

Figure 9. Average wind force each week during visual monitoring.

Rain and fog were intermittent throughout the cruise but did not often obscure visibility (Figure 10). Rain was present, in a light to moderate level, for a total of 102.5 hours and fog was present for a total of 97 hours. The Beaufort sea state ranged from levels 1 through 8 but generally remained between a level 3 and level 6.

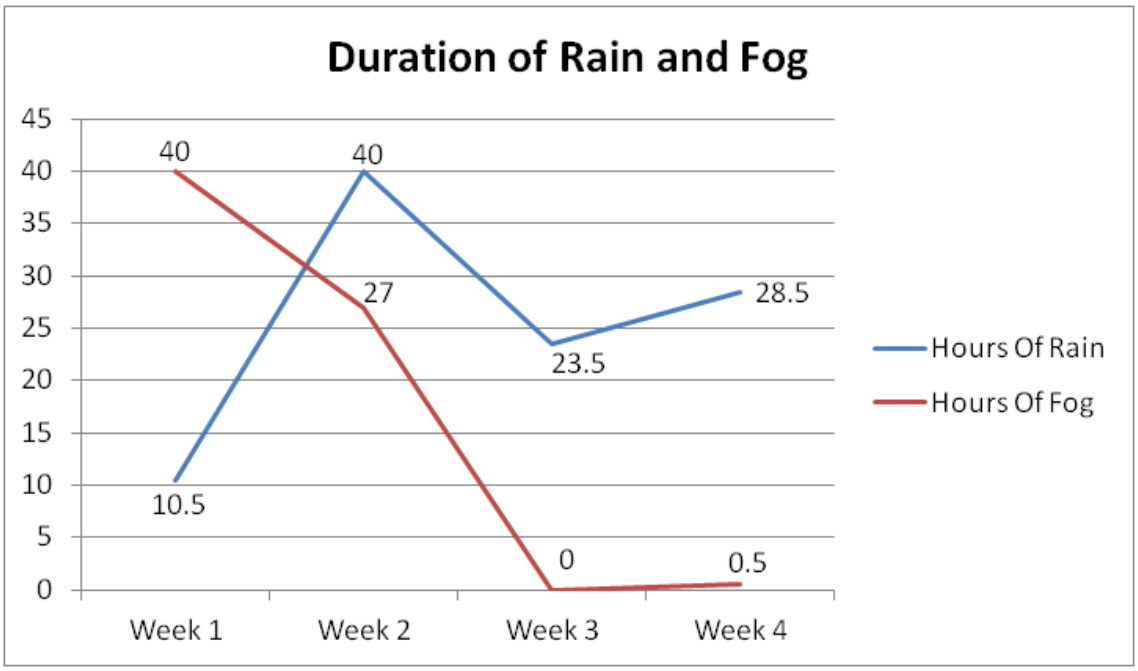

Figure 10. Duration of rain and fog while visual monitoring was conducted.

5. MONITORING AND DETECTION RESULTS

5.1. VISUAL DETECTIONS

Visual monitoring conducted during the USGS DUCTH ECS marine seismic survey resulted in the collection of 57 records of detection for protected species (summarized in Appendix F). Six species of marine mammals, three cetaceans, two pinnipeds, and one fissiped were identified in addition to several unidentified baleen whales, unidentified whale and one unidentified pinniped. The total number of detection events and total number of animals recorded by species is described in Table 7.

No short-tailed albatross were sighted throughout the survey. 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 detection records collected for each protected species.

	Total Number of Detection Records	Total Number of Animals Recorded
Cetaceans		
Unidentifiable whale	1	1
Mysticetes		
Humpback whale	4	11
Fin whale	2	3
Unidentifiable baleen whale	12	15
Odontocetes		
Dall's porpoise	24	244
Pinnipeds		
Steller sea lion	2	2
Northern fur seal	8	67
Unidentifiable pinniped	3	4
Fissipeds		
Sea Otter	1	15
TOTAL	**57**	**362**

The number of protected species detections each day varied greatly over the course of the survey (Figure 11). Including several days where no protected species were observed. The greatest number of detections in one day occurred on 9 August 2011 with 13 records of detection. This was shortly after leaving the Dutch Harbor.

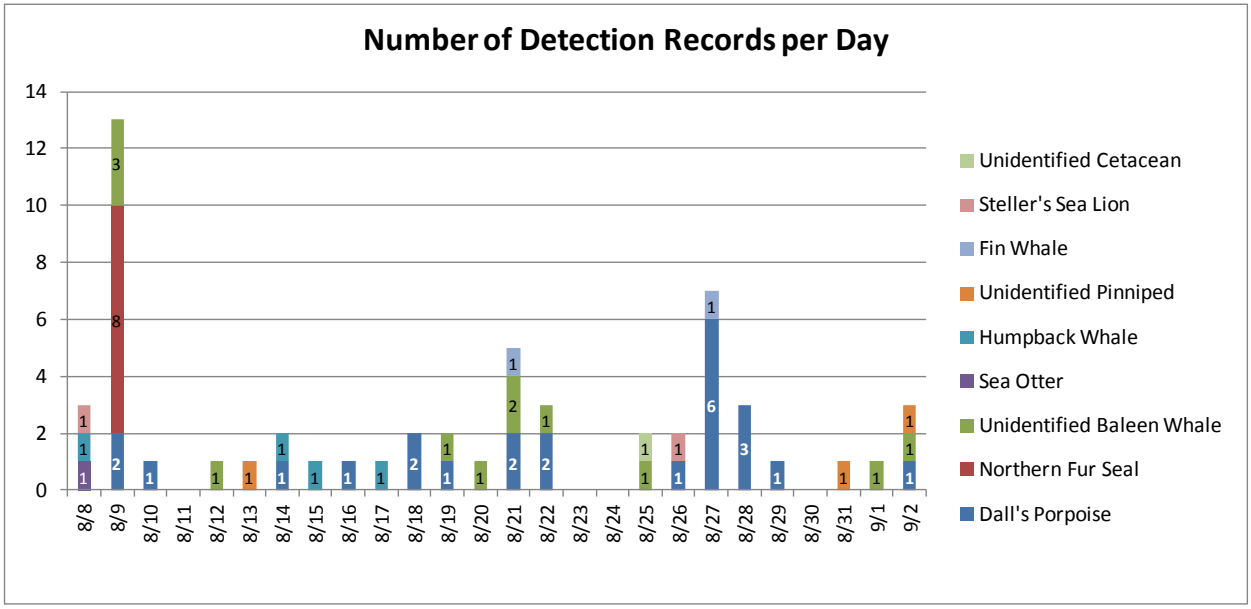

Figure 11. Number of protected species detections each day of the USGS DUTCH ECS Survey.

Of the 57 protected species detection events during the USGS DUTCH ECS survey, 15 detections (26%) occurred while the acoustic source was active and 42 detections (74%) occurred while the acoustic source was silent. 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 (5880-6600 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)
Humpback whale	3	2537	0	-	0	-	1	845
Fin whale	0	-	0	-	0	-	2	950
Unidentifiable baleen whale	4	1018	0	-	0	-	8	2158
Unidentifiable whale	1	3900	0	-	0	-	0	-
Dall's porpoise	5	646	0	-	1	220	18	1826
Steller sea lion	0	-	0	-	0	-	2	350
Northern fur seal	0	-	0	-	0	-	8	110
Unidentifiable pinniped	1	215	0	-	0	-	2	28
Sea otter	0	-	0	-	0	-	1	100

Cetaceans were detected most frequently, consisting of 75% (43 detection records) of the total records. Figure 12 demonstrates the total number of animals observed, per species, during the detection events. Dall's porpoises were the most commonly detected protected species during the survey, accounting for 24 detection events and totaling 244 animals. The next most common positively identified species was the Northern fur seal, accounting for eight detection events and 67 individual animals.

The spatial distribution of marine mammal detections can be seen in Figure 13.

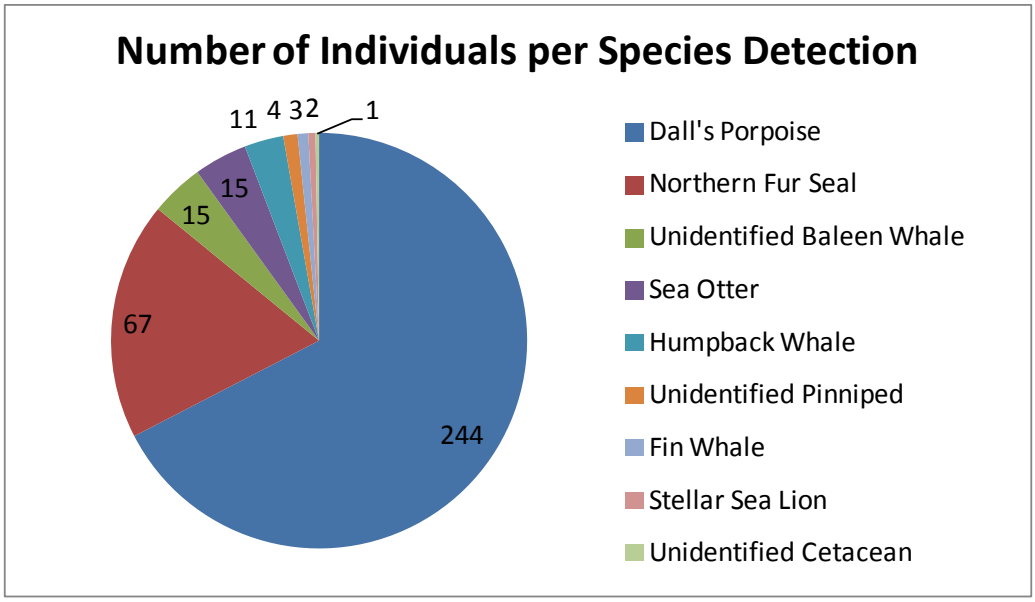

Figure 12. Number of individuals per species detection.

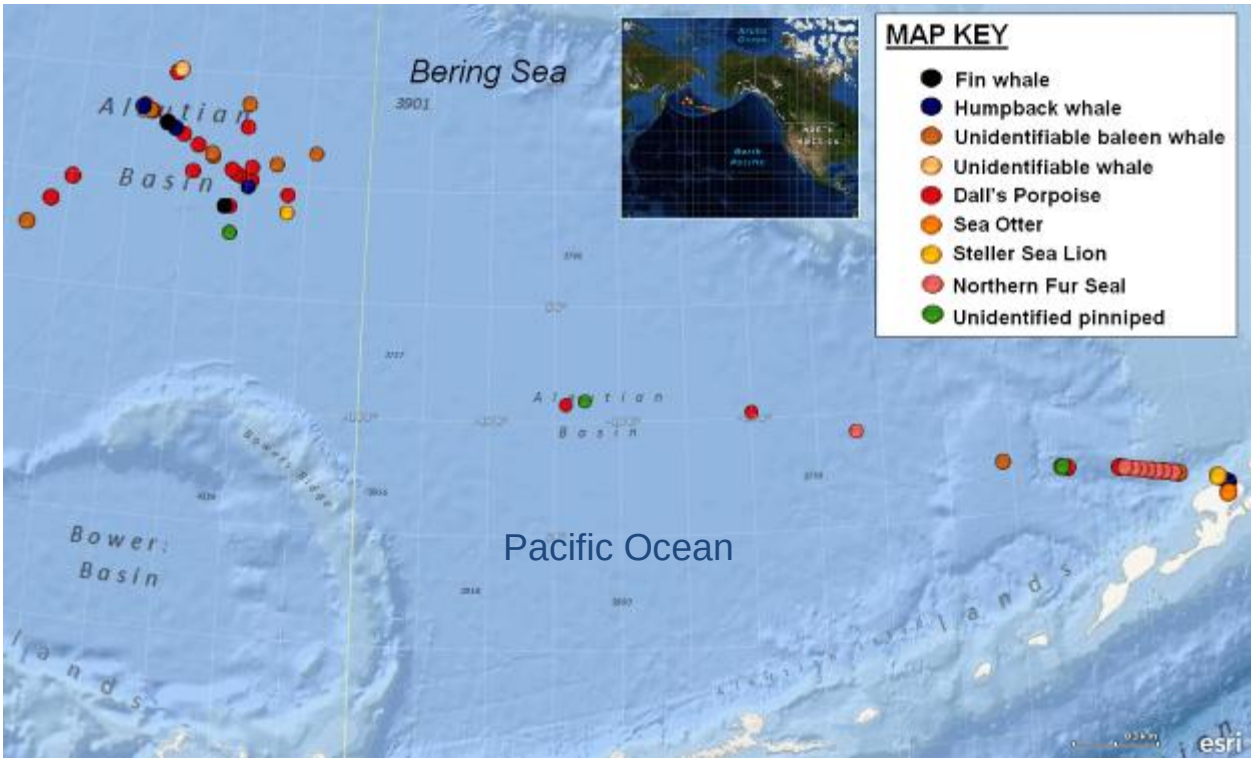

Figure 13: Marine mammal spatial distribution of detections during the USGS DUTCH ECS survey.

5.1.1. Cetacean Detections

5.1.1.1. Humpback whale

There were four sightings of humpback whales (*Megaptera novaeangliae).* The first sighting, which occurred on 8 August, involved seven whales and occurred while the *Langseth* was underway to the survey sight. The remaining three sightings, involving one, two and

one whale respectively, occurred while the airguns were firing. However, only one sighting of a single whale resulted in a power-down on 14 August 2011.

5.1.1.2. Fin whale

Two sightings of fin whales *(Balaenoptera borealis)* occurred during the survey cruise. The airguns were not firing during either sighting, thus none of the whales were exposed to received sound levels. The first sighting involved two whales on 21 August 2011 and the second sighting involved one whale on 27 August 2011.

5.1.1.3. Dall's porpoise

There were 244 individual Dall's porpoises *(Phocoenoides dalli)* observed in 24 sightings. Five of these sightings resulted in power-downs causing 45% of mitigation down time. Of the five power-downs, one occurred while the airgun arrays were ramping-up. All but one remaining sightings occurred when the sound source was silent. On 18 August 2011, a group of two individuals came within the 160dB radius, but did not enter the 180dB and therefore the sighting did not result in mitigation action. Group sizes ranged from 2 - 25 individuals.

5.1.1.4. Unidentified baleen whale

There were a total of 12 detections of unidentified baleen whales during the cruise with an estimated total of 15 unidentified mysticetes. The larger clusters of detections, totalling four each, occurred in weeks one and three. During these periods, visual conditions were hindered by rain and fog thus preventing the observers from making a definite identification. Four detections occurred when the airguns were firing and two resulted in a power-down until the cetaceans were considered outside the safety radii. The baleen detections occurring on August 12 and 19 were exposed to 160 dB and the remaining two on August 20 and 25 were exposed to greater than 180 dB.

5.1.1.5. Unidentified whale

There was a detection of an unidentified cetacean on August 25, 2011. The guns were firing at full power during this time. No mitigation actions were necessary as the cetacean was sighted outside the 160 dB safety radius.

5.1.2. Pinniped Detections

5.1.2.1. Northern fur seal

Northern fur seals (*Callorhinus ursinus*) were positivity identified on nine occasions; with a total of 67 individuals observed. All of these detections occurred the first week of the cruise, during the transit to the survey area. Therefore all Northern fur seals were seen when all seismic equipment was on board and no sound source active. The seals were noted to be in depths ranging from 1374 to 3508 meters, and noted as close as 30 to as far 400 meters distance from the vessel.

5.1.2.2. Steller's sea lion

Two lone Steller's sea lions (*Eumetopias jubatus)* were observed during the research cruise. The first sighting occurred in transit to the survey site, and the second during retrieval of the seismic gear. On neither of these occasions was the sound source active. The sea lions' closest approach to the vessel was 300 meters.

5.1.2.3. Unidentified pinniped

Unidentified pinnipeds were observed on three occasions. The first detection resulted in a power-down during full volume production. The single mammal sighted was lost in fog, and the sound source was repowered after a 15-minute mitigation period. On the second and third sighting, the unidentified pinniped was observed when no sound source was active and therefore no mitigation was required.

5.1.3. Fissiped Detections

5.1.3.1. Sea otter

Sea Otters (*Enhydra lutris*) were sighted only once during the acquisition of the USGS DUTCH ECS survey. A group of 15 sea otters were observed feeding and basking in the kelp as the *R/V Marcus G. Langseth* was leaving Dutch Harbor on 8 August 2011. The sea otters were observed within the safety radii, though they were not exposed to the sound source due to the gun arrays being on board for the transit to the survey site.

6. MITIGATION ACTION SUMMARY

There were nine mitigation actions implemented during the USGS DUTCH ECS survey. All mitigation actions were a power-down of the acoustic source for protected species inside the 180/190 dB safety radii. No shut-downs or delays to ramp-up were required or implemented. Mitigation actions caused a total duration of downtime of 6 hours 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 USGS DUTCH ECS survey.

Mitigation Action	Cetaceans		Pinnipeds		Total	
	Number	Duration	Number	Duration	Number	Duration
Delayed Ramp-up	0	0:00	0	0:00	**0**	**0:00**
Power-down	8	5:05	1	0:57	**9**	**6:02**
Shut-down	0	0:00	0	0:00	**0**	**0:00**
Total	**8**	**5:05**	**1**	**0:57**	**9**	**6:02**

The majority of mitigation actions implemented during the survey were for Dall's porpoises. Dall's porpoise detections resulted in five power-downs which caused in 2 hours and 44 minutes of downtime. The average downtime caused by the five power-downs from Dall's porpoises was approximately 33 minutes. Unidentified baleen whales resulted in two power-downs which caused 1 hour and 23 minutes of downtime. The average downtime caused by the two power-downs from unidentified baleen whales was approximately 42 minutes. A humpback whale and unidentified pinniped each caused a power-down which together resulted in 1 hour and 55 minutes of downtime (Table 10).

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

Species	Number of Power-downs	Duration of Downtime	Percentage of Mitigation Downtime
Dall's Porpoise	5	2:44	45%
Humpback Whale	1	0:58	16%
Unidentified Baleen whale	2	1:23	23%
Unidentified Pinniped	1	0:57	16%

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

Table 11. Summary of each mitigation action implemented during the USGS DUTCH ECS 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	Comments
10-Aug	17	Dall's porpoise	8	Ramp-up	220m / 3300 in^3	Power-down	0:40	Porpoises last seen at 23:44, power down implemented 23:50. Ramp-up began 23:59, 15 minutes after last sighting of porpoises.
13-Aug	19	Unid. pinniped	1	Full power	215m / 6300 in^3	Power-down	0:57	Pinniped last seen 18:46, power down implemented 18:46, ramp-up began 19:03, 17 minutes after last sighting of pinniped.
14-Aug	20	Dall's porpoise	8	Full power	600m / 6320 in^3	Power-down	0:04	Porpoises observed leaving safety radius, airguns return to full power.
14-Aug	21	Humpback whale	1	Full power	900m / 6320 in^3	Power-down	0:58	PSOs saw whale leave EZ at 4:18 and mistakenly waited 15 minutes before allowing operations to continue making a ramp-up necessary.
16-Aug	23	Dall's porpoise	5	Full power	300m / 5920 in^3	Power-down	0:04	Porpoises observed leaving safety radius, airguns return to full power.
18-Aug	25	Dall's porpoise	4	Full power	800m / 5880 in^3	Power-down	0:59	Porpoises last seen at 18:34 inside safety radius.
19-Aug	28	Dall's porpoise	8	Full power	280m / 5880 in^3	Power-down	0:57	Porpoises last seen at 17:54 inside safety radius. Ramp-up began at 18:10.
20-Aug	29	Unid. mysticete	1	Full power	425m / 5880 in^3	Power-down	1:15	Whale last seen inside safety radius at 16:33. Ramp-up began 17:03.
25-Aug	39	Unid. mysticete	2	Full power	845m / 6250 in^3	Power-down	0:08	Whales last seen in safety radius at 19:26. Return to full power 19:28.

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

NMFS granted an IHA to the USGS for a marine seismic survey allowing Level B harassment takes (exposure to 160 dB received sound) for 12 marine mammal species: four mysticetes, five odontocete species, and three pinniped species. Direct visual observations recorded by PSOs of two species of marine mammals for which takes were granted in the IHA provide a minimum estimate of the actual number of animals exposed to received sound levels or 180 dB (cetaceans) / 190 dB (pinnipeds) and 160 dB.

During the USGS GOA ECS survey two humpback whales and 35 Dall's porpoises were observed within the 160 dB predicted distances 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 USGS DUTCH ECS and number of known individuals exposed to 160 dB and 180 dB/190 dB through visual observations.

Species	IHA Authorized Takes	Number of animals exposed to 180 dB (Cetaceans) / 190 dB (Pinnipeds)	Number of animals exposed to 160 dB
Mysticetes			
Northern Pacific right whale	0	0	0
Bowhead whale	0	0	0
Gray whale	0	0	0
Humpback whale	6	2	2
Minke whale	19	0	0
Sei whale	1	0	0
Fin whale	61	0	0
Blue whale	0	0	0
Unidentified mysticete	N/A	0	5
Odontocetes			
Sperm whale	1	0	0
Cuvier's beaked whale	0	0	0
Baird's beaked whale	5	0	0
Stejneger's beaked whale	2	0	0
Pacific white-sided dolphins	0	0	0
Killer whale	44	0	0
Dall's porpoise	137	33	35
Pinnipeds			
Northern fur seal	441	0	0
Ribbon seal	674	0	0
Steller sea lion	42	0	0
Spotted seal	0	0	0
Ringed Seal	0	0	0
Unidentified pinniped	N/A	0	1

These numbers are very likely to be an underestimate and provide the absolute minimum number of animals actually exposed. Also during a large portion of the visual observations held by the PSOs the 3,850m level-B harassment radius was not visible due to fog. It is very likely during these periods of dense fog that animals could have entered the radius without being detected by the PSOs. It is also possible that estimated numbers of animals recorded during each sighting event were underestimates, 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	Final behavior	Final direction in relation to vessel
Dall's porpoise	17	8	Fast swimming	Towards vessel	Bowriding	Unknown
	20	8	Fast swimming	Towards vessel	Fast swimming	Away from vessel
	23	5	Fast swimming	Parallel, same direction	Fast swimming	Away from vessel
	25	4	Fast swimming	Parallel, same direction	Fast swimming	Parallel, same direction
	26	2	Fast swimming	Parallel, same direction	Fast swimming	Parallel, same direction
	28	8	Fast swimming	Away from vessel	Fast swimming	Away from vessel
Humpback whale	21	1	Blowing	Parallel, opposite direction	Blowing	Away from vessel
	24	1	Blowing	Parallel, same direction	Diving	Parallel, same direction
Unidentified baleen whale	18	1	Blowing	Away from vessel	Blowing	Away from vessel
	27	1	Blowing	Away from vessel	Blowing	Away from vessel
	29	1	Blowing	Unknown	Unknown	Unknown
	39	2	Blowing	Unknown	Blowing	Away from vessel
Unidentified pinniped	19	1	Milling	Milling	Fast swimming	Away from vessel

6.1.1. Humpback Whale

Humpback whales were the only positively identified large mysticetes exposed to noise levels constituting Level-B harassment during the USGS DUTCH ECS Survey. Two sighting events of humpback whales totalling a minimum total of two animals were observed within the 160 dB safety radius while the acoustic source was active. Only one of these whales was also exposed to received sound levels of 180 dB from the acoustic source, resulting in the implementation of a mitigation power-down.

On 14 August (detection 21) a humpback whale was observed blowing approximately 900m from the acoustic source, while it was firing at full power (6,320 in^3). The whale was initially observed swimming parallel in the opposite direction of the vessel. During the five minutes the whale was observed it continued blowing and turning away from the vessel.

On 17 August (detection 24) a humpback whales was briefly observed blowing, while swimming parallel in the same direction as the vessel. It was located 2614m from the acoustic source while it was firing full power (5,880 in^3). During the brief one minute sighting the whale it continued to blow before diving, keeping the same heading.

6.1.2. Dall's Porpoise

Dall's porpoises were the only odontocetes exposed to noise levels constituting Level-B harassment during the survey. Six detection events of Dall's porpoises totalling a minimum of 35 animals were observed within the 160 dB safety radius while the acoustic source was active. Of these 35 porpoises, 33 were exposed to received sound levels of 180 dB from the acoustic source, resulting in the implementation of mitigation power-downs.

On 10 August (detection 17) a pod of eight porpoises was observed 220m from the acoustic source while it was being ramped-up. The pod proceeded to swim quickly towards the vessel and "bow-ride" before the PSOs lost sight of them.

On 14 August (detection 20) a pod of eight porpoises was observed approximately 600m from the acoustic source while it was firing full power (6,320 in^3). The pod was initially observed swimming quickly towards the vessel and last seen swimming quickly away from the vessel.

On 16 August (detection 23) a pod of five porpoises was observed approximately 300m from the acoustic source while it was firing full power (5,920 in^3). The pod was initially observed swimming quickly parallel to and in the same direction as the vessel and was last seen swimming quickly away from the vessel.

On 18 August (detection 25) a pod of four porpoises was observed approximately 800m from the acoustic source while it was firing full power (5,880 in^3). During the duration the pod was observed they were swimming quickly parallel to and in the same direction as the vessel. Later in the day two porpoises (detection 26) were observed approximately 1250m from the acoustic source while it was firing full power. They were also travelling parallel to and in the same direction of the vessel.

On 19 August (detection 28) a pod of eight porpoises was observed approximately 280m from the acoustic source while it was firing full power (5,880 in^3). The pod was initially sighted swimming quickly away from the vessel and continued away from the vessel when last observed.

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 USGS marine seismic survey, mitigation measures were implemented whenever these protected species were seen near or within the safety radii designated in the IHA. Power-downs were implemented for pinnipeds, mysticetes, and odontocetes.

Additional mitigation measures specific to the USGS survey required that if a North Pacific right whale (*Eubalaena japonica*) or a blue whale (*Balaenoptera musculus*) were sighted, the airgun array would be shut-down regardless of the distance of the animal(s) to the sound source and that the array would not resume firing until 30 minutes after the last documented sighting of the whale. While none of these species were positively identified during the USGS survey, numerous large unidentified baleen whales were observed. Therefore these species may have been in the area without their respective mitigation implemented because of the uncertainty of identification.

The IHA also mandated that concentrations of humpback whales *(Megaptera novaeangliae)*, fin whales *(Balaenoptera physalus),* and killer whales *(Orcinus orca)* be “avoided if possible” and that the “array be powered-down if necessary”. A concentration of these species was defined as three or more individuals sighted that did not appear to be travelling (e.g. feeding, socializing). There was only one sighting of a group of seven humpback whales. This occurred just while leaving Dutch Harbor so there was no seismic gear in the water or required mitigation actions.

7. ACKNOWLEDGEMENTS

The Protected Species Observers on board Langseth during the USGS DUTCH ECS survey in Central-western Bering Sea would like to thank the National Science Foundation, Lamont-Doherty Earth Observatory, and United States Geological Survey for the opportunity to work on this project. It was a pleasure to work with Drs. Jonathan Childs and Ginger Barth from USGS, and Meagan Cummings, 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, and Dr. Jonathan Childs from USGS 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 Meagan Cummings and Anne Unietis 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, 2011. “Environmental Assessment of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Central-Western Bering Sea, August 2011”.

APPENDIX A: Incidental Harassment Authorization for USGS GOA ECS Marine Seismic Survey

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

Incidental Harassment Authorization

U.S. Geological Survey, Pacific Coastal and Marine Science Center, Mail Stop 999, 345 Middlefield Road, Menlo Park, California 94025, is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)), to harass small numbers of marine mammals incidental to a marine geophysical (seismic) survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) in the central-western Bering Sea, August 2011:

1. This Authorization is valid from August 7 through October 1, 2011.

2. This Authorization is valid only for the *Langseth*'s activities associated with seismic survey operations that shall occur in the following specified geographic area:

> Between approximately 350 to 800 kilometers (km) (189 to 432 nautical miles [nmi]) offshore, in the area 55 to 58.5° North, 177° West to 175° East within the Exclusive Economic Zone of the United States and adjacent International Waters, as specified in USGS's Incidental Harassment Authorization application and associated Environmental Assessment.

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 the waters of the central-western Bering Sea:
>
> > (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) Pinnipeds – see Table 2 (attached) for authorized species and take numbers.
> >
> > (iv) 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 Condition 3(a) above 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.

4. The methods authorized for taking by Level B harassment are limited to the following acoustic sources without an amendment to this Authorization:

(i) A 36 Bolt airgun array with a total capacity of 6,600 in^3 (or smaller);
(ii) A multi-beam echosounder;
(iii) A sub-bottom profiler; and
(iv) An acoustic release transponder used to communicate with ocean bottom seismometers (OBS).

5. 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.

6. 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.

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

(b) PSVOs shall conduct monitoring while the airgun array and streamer(s) 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), Beaufort sea state and wind force, visibility, and sun glare; and

(iii) The data listed under Condition 7(c)(ii) shall 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 NMFS-qualified Protected Species Observer (PSO) and/or expert bioacoustician (i.e., Protected Species Acoustic Observer [PSAO]) shall monitor the PAM at all times in shifts no longer than 6 hours. An expert 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 on-duty PSVO(s) 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 (EZ) (180 dB re 1 μPa [rms] for cetaceans and 190 dB re 1 μPa [rms] for pinnipeds; see Table 1 [attached] for distances) using NMFS-qualified PSVOs, for at least 30 minutes (min) prior to starting the airgun array (day or night). If the PSVO finds a marine mammal within the EZ, USGS 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 PSVO shall wait 30 min. If the PSVO sees no marine mammals during that time, they should assume that the animal has moved beyond the EZ. If for any reason the entire radius cannot be seen for the entire 30 min (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or in the EZ, the airguns may not be ramped-up. If one airgun is already running at a source level of at least 180 dB re 1 μPa (rms), USGS may start the second airgun without observing the entire EZ for 30 min prior, provided no marine mammals are known to be near the EZ (in accordance with Condition 7(h) below).

(g) Establish a 180 dB re 1 μPa (rms) and 190 dB re 1 μPa (rms) EZ for marine mammals before the 4-string airgun array (6,600 in^3) is in operation; and a 180 dB re 1 μPa (rms) and 190 dB re 1 μPa (rms) EZ before a single airgun (40 in^3) is in operation, respectively. See Table 1 (attached) for distances and EZs.

(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 shall increase in steps not exceeding approximately 6 dB per 5-min period. During ramp-up, the PSVOs shall monitor the EZ, and if marine mammals are sighted, a power-down, or shut-down shall 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 EZ as described in Condition 7(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 EZ. If speed or course alteration is not safe or practicable, or if after alteration the marine mammal still appears likely to enter the EZ, further mitigation measures, such as a power-down or shut-down, shall be taken.

(j) Power-down or shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant EZ (as defined in Table 1, attached). A shut-down means all operating airguns are shut-down (i.e., turned off). A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun, which reduces the EZ to the degree that the animal(s) is no longer in or about to enter it.

(k) Following a power-down, if the marine mammal approaches the smaller designated EZ, the airguns must then be completely shut-down. Airgun activity shall not resume until the PSVO has visually observed the marine mammal(s) exiting the EZ and is not likely to return, or has not been seen within the EZ for 15 min for species with shorter dive durations (small odontocetes and pinnipeds) 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 Condition 7(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 EZs 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 EZ cannot be effectively monitored by the PSVO(s) on duty.

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

(p) Concentrations of humpback (*Megaptera novaeangliae*), fin (*Balaenoptera physalus*), and/or killer (*Orcinus orca*) whales shall be avoided, if possible, and the array shall be powered-down if necessary. A concentration or group of whales shall consist of when three or more individuals are visually sighted that do not appear to be traveling (e.g., feeding, socializing, etc.).

(q) To the maximum extent practicable, schedule seismic operations (i.e., shooting airguns) during daylight hours and OBS operations (i.e., deploy/retrieve) to nighttime hours.

8. 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* central-western Bering Sea 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) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on reported and corrected empirical values for the 36 airgun array and modeling measurements for the single airgun) 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) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds 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 shall 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, Conservation, and Education 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 shall be considered to be the final report.

9. In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), USGS shall immediately cease the specified activities and immediately report the incident to the Chief of the Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Michael.Payne@noaa.gov and Brian.D.Hopper@noaa.gov, and the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barabara.Mahoney@noaa.gov). The report must include the following information:

(a) Time, date, and location (latitude/longitude) of the incident; the name and type of vessel involved; the 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 marine mammal observations in the 24 hours preceding the incident; species identification or description of the animal(s) involved; the fate of the animal(s); and photographs or video footage of the animal (if equipment is available).

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

In the event that USGS discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the 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), USGS will immediately report the incident to the Chief of the Permits Conservation, and Education Division, Office of Protected Resources, NMFS, at 301-427-8401, and the NMFS Alaska

Stranding Hotline (1-877-925-7773) and/or by email to the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barabara.Mahoney@noaa.gov). The report must include the same information identified in the Condition 9(a) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with USGS to determine whether modifications in the activities are appropriate.

In the event that USGS discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), USGS shall report the incident to the Chief of the Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, at 301-713-2289, and the NMFS Alaska Stranding Hotline (1-877-925-7773) and/or by email to the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barbara.Mahoney@noaa.gov), within 24 hours of the discovery. USGS shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network.

10. USGS is required to comply with the Terms and Conditions of the ITS corresponding to NMFS's Biological Opinion issued to both USGS and NMFS's Office of Protected Resources (attached).

11. A copy of this Authorization and the ITS must be in the possession of all contractors and PSOs operating under the authority of this Incidental Harassment Authorization.

AUG 05 2011

James H. Lecky
Director
Office of Protected Resources
National Marine Fisheries Service

Date

Attachments

Attachment

Table 1. Exclusion Zone Radii for Triggering Mitigation.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Distances (m)		
			Shut-down EZ for Pinnipeds 190 dB	Shut-down EZ for Cetaceans 180 dB	Level-B Harassment Zone 160 dB
Single Bolt airgun 40 in^3	9	Deep (>1,000)	12	40	385
4 strings 36 airguns 6,600 in^3	9	Deep (>1,000)	400	940	3,850

Table 2. Authorized Take Numbers for Each Marine Mammal Species in the Central-Western Bering Sea.

Species	Authorized Take in the Central-Western Bering Sea Study Area
Mysticetes	
North Pacific right whale (*Eubalaena japonica*)	0
Bowhead whale (*Balaena mysticetus*)	0
Gray whale (*Eschrichtius robustus*)	0
Humpback whale (*Megaptera novaeangliae*)	6
Minke whale (*Balaenoptera acutorostrata*)	19
Sei whale (*Balaenoptera physalus*)	1
Fin whale (*Balaenoptera borealis*)	61
Blue whale (*Balaenoptera musculus*)	0
Odontocetes	
Sperm whale (*Physeter macrocephalus*)	1
Cuvier's beaked whale (*Ziphius cavirostris*)	0
Baird's beaked whale (*Berardius bairdii*)	5
Stejneger's beaked whale (*Mesoplodon stejnegeri*)	2
Pacific white-sided dolphins (*Lagenorhynchus obliquedens*)	0
Killer whale (*Orcinus orca*)	44
Dall's porpoise (*Phocoenoides dalli*)	137
Pinnipeds	
Northern fur seal (*Callorhinus ursinus*)	441
Ribbon seal (*Histriophoca fasciata*)	674
Steller sea lion (*Eumetopias jubatus*)	42
Spotted seal (*Phoca largha*)	0
Ringed seal (*Pusa hispida*)	0

APPENDIX B: Basic Summary Data Form

BASIC DATA FORM				
LDEO Project Number		MGL1111		
Seismic Contractor		Lamont-Doherty Earth Observatory of Columbia University		
Client		United States Geological Survey		
Area Surveyed During Reporting Period		Central-western Bering Sea		
		Approximately between 55 to 58.5°N and 177°W to 175°E		
Survey Type		2D marine seismic		
Vessel and/or Rig Name		*R/V Marcus G. Langseth*		
Permit Number		IHA granted by NMFS on 5 August 2011		
Location / Distance of Airgun Deployment		181m astern of vessel		
Water Depth	**Min**	3000m		
	Max	3900m		
Dates of project		8 August 2011	THROUGH	2 September 2011
Total time airguns operating – all power levels:		325 hours 44 minutes		
Time airguns operating at full power on survey lines:		287 hours 59 minutes		
Time airguns operating at partial power on survey lines:		8 hours 22 minutes		
Time airguns operating at full/partial power on line changes:		12 hours 13 minutes		
Amount of time mitigation gun (40 in³) operations:		10 hours 30 minutes		
Amount of time in ramp-up:		5 hours 54 minutes		
Number daytime ramp-ups:		10		
Number of night time ramp-ups:		0		
Number of ramp-ups from mitigation source:		7		
Amount of time conducted in airgun testing:		46 minutes		
Duration of visual observations:		362 hours 54 minutes		
Duration of observations while airguns firing:		208 hours 06 minutes		
Duration of observation during airgun silence:		154 hours 48 minutes		
Duration of acoustic monitoring:		237 hours 23 minutes		
Duration of acoustic monitoring while airguns firing:		237 hours 23 minutes		
Duration of acoustic monitoring during airgun silence:		None		
Duration of simultaneous acoustic and visual monitoring:		148 hours 52 minutes		
Lead Protected Species Observer:		Heidi Ingram		
Protected Species Observers:		Dara Cameron		
		Amanda Harrison		
		Meghan Piercy		
Acoustic Observer:		Emily Ellis		
Number of Marine Mammals Visually Detected:		57		
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)		9 power-downs		
Duration of operational downtime due to mitigation:		6 hours 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.

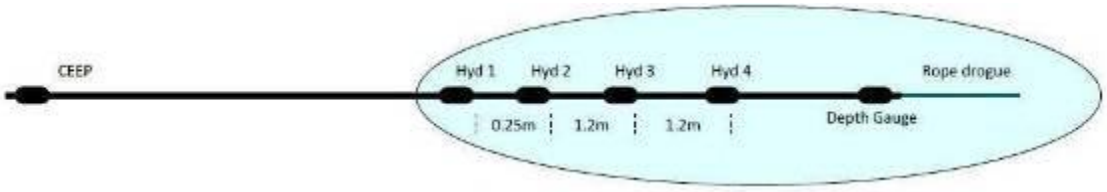

Figure D.14: Diagram of Linear Hydrophone Array.

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.15: PAM Laptops and data processing unit setup.

Figure D.16: Hydrophone cable on winch.

Figure D.17: Hydrophone cable secured by a yale grip to the port sponson.

Figure D.18: Rope drogue and first chain weight secured near hydrophone elements.

Figure D.19: 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
08-11-11	17:20	8-12-11	22:46	29:26	PAM cable tangled in gun string. Kept on deck after untangling due to high swells.
08-14-11	00:09	08-14-11	04:00	03:51	PAM cable brought aboard to perform maintenance on arrays.
08-16-11	15:44	08-16-11	19:20	03:36	PAM cable brought aboard to perform maintenance on arrays.
08-17-11	10:40	08-17-11	17:55	07:15	PAM cable tangled in gun strings. Kept on deck after untangling due to high swells and gun maintenance needed at end of line.
08-21-11	3:18	08-24-11	09:36	78:18	PAM cable brought aboard to retrieve seismic equipment to prepare for OBS deployment. Cable remained on board due to high swells.
08-25-11	17:41	08-30-11	18:45	121:04	PAM cable brought aboard to retrieve seismic gear for OBS retrieval.
08-30-11	22:55				End of production.

APPENDIX F: Summary of detections of protected species during USGS DUTCH ECS survey

Detections of protected species during USGS DUTCH ECS 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	8-Aug	20:35	Sea otter	15	53.89700°N 166.50578°W	Not Firing	OM	FF BA	100 Not Firing	None	Vessel in transit to survey site
2	8-Aug	21:10	Humpback whale	7	53.99350°N 166.49167°W	Not Firing	PV/SD	R SB	845 Not Firing	None	Vessel in transit to survey site
3	8-Aug	21:57	Steller sea lion	1	54.06100°N 166.64783°W	Not Firing	ST PV/SD	FL NS	400 Not Firing	None	Vessel in transit to survey site
4	9-Aug	00:22	Unid. baleen whale	1	54.14950°N 167.29683°W	Not Firing	PV/OD	SB ST	100 Not Firing	None	Vessel in transit to survey site
5	9-Aug	00:39	Northern fur seal	2	54.16217°N 167.39117°W	Not Firing	MI	NS MI	50 Not Firing	None	Vessel in transit to survey site
6	9-Aug	01:10	Unid. baleen whale	1	54.18250°N 167.53983°W	Not Firing	PV/OD	SB ST	3500 Not Firing	None	Vessel in transit to survey site
7	9-Aug	01:12	Northern fur seal	2	54.18250°N 167.53983°W	Not Firing	MI	MI ST	30 Not Firing	None	Vessel in transit to survey site
8	9-Aug	01:25	Northern fur seal	50	54.20000°N 167.66767°W	Not Firing	MI	MI ST	100 Not Firing	None	Vessel in transit to survey site
9	9-Aug	01:52	Unid. baleen whale	1	54.20917°N 167.73482°W	Not Firing	PV/OD	SB NS	2614 Not Firing	None	Vessel in transit to survey site
10	9-Aug	02:02	Northern fur seal	3	54.21817°N 167.80117°W	Not Firing	MI	SA NS	50 Not Firing	None	Vessel in transit to survey site
11	9-Aug	02:27	Northern fur seal	1	54.23537°N 167.92133°W	Not Firing	MI	MI ST	70 Not Firing	None	Vessel in transit to survey site

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
12	9-Aug	02:47	Northern fur seal	2	54.25057°N 168.04082°W	Not Firing	MI	MI NS	400 Not Firing	None	Vessel in transit to survey site
13	9-Aug	03:13	Northern fur seal	6	54.26950°N 168.17900°W	Not Firing	MI	FL NS	150 Not Firing	None	Vessel in transit to survey site
14	9-Aug	03:29	Dall's porpoise	20	54.28155°N 168.26745°W	Not Firing	PE/BH	FT PO	350 Not Firing	None	Vessel in transit to survey site
15	9-Aug	17:50	Northern fur seal	1	54.83790°N 172.39092°W	Not Firing	ST	BA	30 Not Firing	None	Vessel in transit to survey site
16	9-Aug	23:17	Dall's porpoise	6	55.05162°N 173.99062°W	Not Firing	TV	FT	300 Not Firing	None	Vessel in transit to survey site
17	10-Aug	23:36	Dall's porpoise	8	55.14675°N 176.82108°W	Ramp-up	TV	FT BR	220 Ramp-up	Power-down	Porpoises entered 180 dB EZ during ramp-up. Ramp-up required to resume operations.
18	12-Aug	19:59	Unid. baleen whale	1	57.30178°N 179.10565°E	Full power	AV	SB	1100 Full power	None	Blow sighted 1100m from source, 3 minutes later blow sighted 2000m from source.
19	13-Aug	18:45	Unid. pinniped	1	56.55917°N 177.77583°E	Full power	MI	PO AV	215 Full power	Power-down	Pinniped entered 190 dB EZ while arrays were firing full power. Ramp-up required to resume operations.
20	14-Aug	02:02	Dall's porpoise	8	57.03842°N 178.07002°E	Full power	TV	FT AV	600m Full power	Power-down	Porpoises observed leaving safety radii at 02:06 UTC. Airguns return to full power 02:07 UTC.
21	14-Aug	04:13	Humpback whale	1	56.97782°N 178.01373°E	Full power	PV/OD	SB AV	900m Full power	Power-down	PSOs observed whale leaving safety radii at 04:18 UTC and mistakenly waited 15 min. before allowing operations to continue making a ramp-up necessary.
22	15-Aug	21:34	Humpback whale	2	57.64067°N 176.09083°E	Full power	PV/OD	SA DF	4096m Full power	None	Humpback observed for 25 minutes, always remaining outside of safety radii.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
23	16-Aug	02:53	Dall's porpoise	5	57.97083°N 176.61653°E	Full power	PV/SD	FT	300m Full power	Power-down	Porpoises observed leaving safety radius at 02:56 UTC. Airguns return to full power 02:58 UTC.
24	17-Aug	22:59	Humpback whale	1	57.46347°N 176.69617°E	Full power	PV/SD	DI	2614m Full power	None	Humpback briefly observed within 160 dB safety radius. No mitigation actions were necessary.
25	18-Aug	18:31	Dall's porpoise	4	56.92213°N 178.68500°E	Full power	PV/SD	FT SV	800m Full power	Power-down	Porpoises last seen inside 180 dB safety radius. Ramp-up necessary to resume operations.
26	18-Aug	23:58	Dall's porpoise	2	57.15257°N 178.05687°E	Full Power	PV/SD	FT SV	1250m Full power	None	Porpoises briefly sighted within 160 dB safety radius. No mitigation actions were necessary.
27	19-Aug	07:27	Unid. baleen whale	1	57.19042°N 178.46437°E	Full power	AV	SB	1700m Full power	None	Unidentifiable whale observed within 160 dB safety radius. No mitigation actions were necessary.
28	19-Aug	17:50	Dall's porpoise	8	57.08868°N 177.06858°E	Full power	AV	FT	280m Full power	Power-down	Porpoises last seen within 180 dB safety radius. Ramp-up necessary to resume operations.
29	20-Aug	16:33	Unid. baleen whale	1	57.71885°N 177.91657°E	Full power	n/a	SB	425m Full power	Power-down	Whale last seen inside 180 dB safety radius. Ramp-up necessary to resume operations.
30	21-Aug	05:29	Dall's porpoise	5	56.79471°N 177.73623°E	Not firing	TV	FT BR	200m Not firing	None	Detected during OBS deployment.
31	21-Aug	06:17	Dall's porpoise	9	56.79397°N 177.67325°E	Not firing	PV/OD	FT SV	3417m Not firing	None	Detected during OBS deployment
32	21-Aug	06:43	Fin whale	2	56.79317°N 177.64815°E	Not firing	TV	FF MI	1500m Not firing	None	Detected during OBS deployment.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
33	21-Aug	17:05	Unid. baleen whale	2	57.23330°N 177.38377°E	Not firing	PV/OD	SB	2614m Not firing	None	Detected during OBS deployment.
34	21-Aug	17:34	Unid. baleen whale	1	57.25928°N 177.36403°E	Not firing	UN	SB	1932m Not firing	None	Detected during OBS deployment.
35	22-Aug	07:53	Dall's porpoise	15	57.51075°N 177.92867°E	Not firing	TV	FT	200m Not firing	None	Detected during CTG deployment.
36	22-Aug	17:40	Dall's porpoise	12	56.73933°N 174.70375°E	Not firing	AV	FT SV	150m Not firing	None	Detected during OBS deployment.
37	22-Aug	19:36	Unid. baleen whale	2	56.50432°N 174.34485°E	Not firing	TV	SB	2000m Not firing	None	
38	25-Aug	00:45	Unid. whale	1	58.00315°N 176.68355°E	Full power	UN	SB	3900m Full power	None	Whale detected outside of 160 dB safety radius.
39	25-Aug	19:00	Unid. baleen whale	2	57.60890°N 176.22530°E	Full power	UN	SB AV	845m Full power	Power-down	Whales observed inside 180 dB safety radius at 19:20 UTC. Whales observed outside of safety radius at 19:26 UTC.
40	26-Aug	17:11	Steller sea lion	1	56.76468°N 178.68793°E	Not firing	AV	NS	300m Not firing	None	Detected while retrieving airguns.
41	26-Aug	21:46	Dall's porpoise	2	57.01915°N 178.01817°E	Not firing	PV/OD	FT SV	300m Not firing	None	
42	27-Aug	00:02	Dall's porpoise	9	57.07340°N 177.85947°E	Not firing	PV/OD	FT PO	2490m Not firing	None	Detected while retrieving OBS.
43	27-Aug	00:19	Dall's porpoise	4	57.09082°N 177.80027°E	Not firing	UN	FT SV	4700m Not firing	None	Detected while retrieving OBS.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
44	27-Aug	04:20	Dall's porpoise	13	57.12327°N 177.72295°E	Not firing	UN	FT SV	1000m Not firing	None	Detected while retrieving OBS.
45	27-Aug	17:02	Dall's porpoise	25	57.32462°N 177.11520°E	Not firing	PV/SD	PO BR FT	0m Not firing	None	Detected while retrieving OBS.
46	27-Aug	19:43	Dall's porpoise	15	57.41403°N 176.84837°E	Not firing	PV/SD	PO BR FT	0m Not firing	None	Detected while retrieving OBS.
47	27-Aug	21:04	Fin whale	1	57.50767°N 176.54933°E	Not firing	PV/SD	SB DI FT	400m Not firing	None	
48	27-Aug	23:27	Dall's porpoise	17	57.51175°N 176.54460°E	Not firing	TV	BR FT	100m Not firing	None	Detected while retrieving OBS.
49	28-Aug	01:22	Dall's porpoise	25	57.60750°N 176.25917°E	Not firing	PV/OD	PO BR FT	200m Not Firing	None	Observed during OBS retrieval.
50	28-Aug	03:02	Dall's porpoise	10	57.64963°N 176.12002°E	Not firing	PV/SD	BR FT	250m Not firing	None	Observed during OBS retrieval.
51	28-Aug	03:42	Dall's porpoise	5	57.64877°N 176.11942°E	Not firing	TV	FT	100m Not firing	None	Observed during OBS retrieval.
52	29-Aug	03:44	Dall's porpoise	13	56.95567°N 175.02583°E	Not firing	TV	FT	50m Not firing	None	Observed during OBS retrieval.
53	31-Aug	22:50	Unid. pinniped	1	55.17872°N 176.53278°W	Not firing	MI	NS DI	30m Not firing	None	Observed while in transit to port.
54	1-Sep	22:00	Unid. baleen whale	1	54.45750°N 170.13377°W	Not firing	UN	SB	3000m Not firing	None	Observed while in transit to port.
55	2-Sep	02:10	Unid. baleen whale	1	54.35321°N 169.21244°W	Not firing	PV/OD	PE/BH	1500m Not firing	None	Observed while in transit to port.
56	2-Sep	02:23	Unid. pinniped	2	54.35057°N 169.19332°W	Not firing	MI	MI	25m Not firing	None	Observed while in transit to port.
57	2-Sep	02:49	Dall's porpoise	4	54.34070°N 169.10657°W	Not firing	PV/OD	FT SV	800m Not firing	None	Observed while in transit to port.

APPENDIX G: Species of birds observed during the USGS DUTCH ECS survey

Species of birds observed during the survey

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
Northern Fulmar	Procellariidae	*Fulmarus*	*glacialis*	2117	25
Tufted Puffin	Alcidae	*Fratercula*	*cirrhata*	337	24
Horned Puffin	Alcidae	*Fratercula*	*corniculata*	1	1
Common Murre	Alcidae	*Uria*	*aalge*	89	14
Red-legged Kittiwake	Laridae	*Rissa*	*brevirostris*	42	3
Black-legged Kittiwake	Laridae	*Larus*	*tridactyla*	506	23
Arctic Tern	*Sternidae*	*Sterna*	*paradisaea*	14	4
Pomarine Jaeger	Stercorariidae	*Stercorarius*	*pomarinus*	8	5
Long-tailed Jaeger	Stercorariidae	*Stercorarius*	*longicaudus*	2	2
Parasitic jaeger	Stercorariidae	*Stercorarius*	*parasiticus*	20	12
Forked-tailed Storm Petrel	Hydrobatidae	*Oceanodroma*	*furcata*	31	3
Mottled Petrel	Procellariidae	*Pterodroma*	*inexpectata*	117	11
Laysan Albatross	Diomedeidae	*Phoebastria*	*immutuabilis*	43	20
Black-footed Albatross	Diomedeidae	*Phoebastria*	*nigripes*	19	11
Ancient Murrelet	Alcidae	*Synthliboramphus*	*antiquus*	3	3
Sooty Shearwater	Procellariidae	*Puffinus*	*griseus*	153	8
Short-tailed Shearwater	Procellariidae	*Puffinus*	*tenuirostris*	259	15
Glaucous-winged Gull	Laridae	*Larus*	*glaucescens*	1	1
Sabine's Gull	Laridae	*Xema*	*sabini*	2	2
Ruddy Turnstone	Scolopacidae	*Arenaria*	*interpres*	4	3
Harlequin Duck	Anatidae	*Histrionicus*	*histrionicus*	3	2
Red-necked Phalarope	Scolopacidae	*Phalaropus*	*lobatus*	1	1
Unidentified Passerine				2	1
Unidentified Shorebird				5	3