Protected Species Mitigation and Monitoring Report

Plate boundaries around the Chukchi borderland: An integrated geophysics cruise to test models for the formation of the Canada Basin.

Coakley Marine Geophysical Survey in the Arctic Ocean

8 September 2011- 9 October 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 working with the University of Alaska Geophysics Institute (UAGI) and Dr. Bernard Coakley to conduct a marine seismic survey in the Arctic Ocean. The project collected seismic reflection data across the transition from the Chukchi Shelf to the Chukchi Borderland to image the structures that separate these two large continental blocks. The *Langseth* left Dutch Harbor on 8 September 2011 and began the survey on 13 September 2011. The survey was completed on 5 October 2011 and the *Langseth* returned to Dutch Harbor on 9 October 2011.

The UAGI 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 26 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 to provide continuous protected species observation coverage and to fulfill the environmental regulatory requirements and reporting mandated by NMFS in the IHA. Four PSOs, one dedicated PAM Operator, and one Native Alaskan North slope resident 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 406 hours and 55 minutes of visual observations and 526 hours and 20 minutes of acoustic monitoring over the course of the survey.

This visual monitoring effort produced a project total of 42 protected species detection records of marine mammals: seven cetacean records and 35 pinniped records. Of the seven cetacean records collected, two consisted of mysticetes, one record was collected for odontocetes, and four records for unidentified cetaceans. There was also one sighting of what was believed to be a pinniped carcass that was showing signs of advanced decay. All detections were made visually. There were no acoustic detections made using the PAM system. There were no sightings of sea turtles during the survey.

Detections of protected species resulted in a total of five mitigation actions being implemented, all of which were power downs of the acoustic source. A known 24 pinnipeds were exposed to received sound levels greater than 160 dB of sound from the acoustic source, constituting a level B harassment take as defined by NMFS. Pinniped Level B harassment takes included three spotted seals (*Phoca largha*), seven bearded seals (*Erignathus barbarus*), four Pacific walrus (*Odobenus rosmarus divergens*), five ringed seals (*Phoca/Pusa hispida*), and an additional five unidentified pinnipeds.

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 Coakley two-dimensional (2D) marine geophysical survey on board the *R/V Langseth* from 8 September 2011 to 9 October 2011 in the Arctic Ocean.

This document serves to meet the reporting requirements dictated in the IHA issued to UAGI by NMFS on 26 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 effects.

Additional mitigation measures were implemented voluntarily by UAGI after consultation with Alaska Department of Fish & Wildlife Service for Pacific walrus (*Odobenus rosmarus* divergens) and polar bears (*Ursus maritimus*). The 190 dB safety radius was to be applied for both species and they were to be given an 800 meter buffer zone from the vessel when possible. Airgun operations were also to be suspended if subsistence hunting was actively occurring within 5 km of the *R/V Langseth.*

2.1. PROJECT OVERVIEW AND LOCATION

The survey occurred in Arctic Ocean, greater than 200 km offshore, in the area 72° to 77° North, 160° to 175° West (Figure 1). The seismic survey took place in water depths ranging from 30 meters to 3800 meters. The survey plan included 17 multi-channel survey (MCS) lines. Acquisition began on 13 September 2011 and continued until 5 October 2011. All of the planned transect lines were completed allowing the *Langseth* to acquire some contingency lines. The *Langseth* acquired a total of approximately 5300 kilometres of survey lines over the course of the Coakley 2D marine geophysical survey.

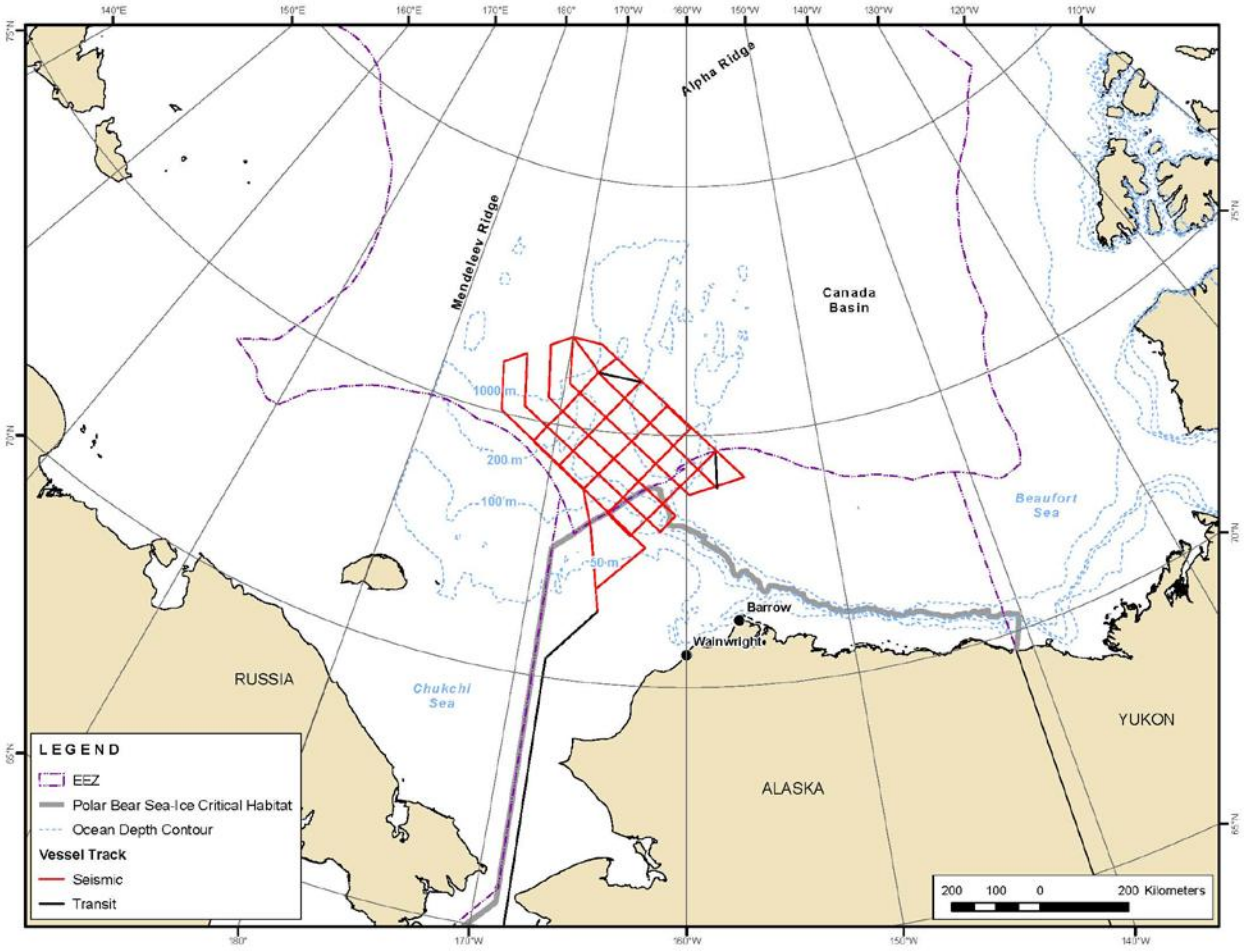

Figure 1. Location of the Coakley marine geophysical survey in the Arctic Ocean (LGL EA, 2011).

The purpose of the study is to collect seismic reflection data across the transition from the Chukchi Shelf to the Chukchi Borderland to image the structures that separate these two large continental blocks. The data from this study will be used to test existing tectonic models and develop new constraints on the development of the Amerasian Basin, and will substantially advance the knowledge about the Mesozoic history of this basin. In addition, the seismic data collected will enable the formulation of new tectonic models for the history of this region, which will be used to improve our understanding of the surrounding continents.

2.1.1. Energy Source

The acoustic source used during the Coakley 2D marine geophysical survey in the Arctic Ocean consisted of one towed airgun array and one hydrophone streamer cable. The array was deployed centrally astern of the vessel. While only one array was firing at a time, two arrays were interchanged when maintenance was needed so that production could continue. The airguns arrays were towed at a depth of six meters and were situated either 83.3 meters or 103.3 meters from the Navigational Reference Point (NRP), which was located on the PSO observation tower. Whenever the arrays were exchanged the PAM operator would notify the visual PSOs so that they were always aware of the safety radii. The first acoustic source array that was deployed was being towed at a depth of nine meters, however it was noticed that the IHA was granted for an array towed at six meters depth and the array was switched out at 20:45 UTC on 15 September 2011 for an array towed at six meters depth.

The 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. The array contained ten airguns, with the first and last spaced 16 meters apart. All ten airguns on the array were firing during survey acquisition. The total volume of the array was 1830 in^3 and a pressure of 1950 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 interval for the MCS survey was 15 seconds. The sound signal receiving system during the acquisition of the MCS transect lines consisted of a single six kilometer long hydrophone streamer, which received the returning acoustic signals and transferred the data to the processing system located 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.

Sonobuoys were also deployed up to four times per day (occasionally more if a sonobuoy failed) during seismic operations on MCS line acquisition. A total of 108 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* simultaneously with the airgun array.

3. MITIGATION AND MONITORING METHODS

The PSO monitoring system on the *Langseth* was established to meet the IHA requirements that were issued to the UAGI by NMFS including both monitoring and mitigation objectives. Additional mitigation measures were implemented voluntarily by UAGI after consultation with Alaska Department of Fish & Wildlife Service. The survey mitigation program was produced to minimize potential impacts of the *Langseth*'s seismic program on 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 and one Native Alaskan North Slope resident aboard to conduct monitoring for marine mammals, record and report on observations, and request mitigation actions in accordance to the IHA. The PSOs onboard were NMFS-qualified 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 the ship's bridge (Figure 2) located 12.8 meters above the water surface which afforded the PSOs a 360 degree viewpoint around the acoustic source.

Figure 2. The R/V Marcus G. Langseth showing location of bridge (12.8m asl) and MMO tower (18.9m asl), where observations were conducted.

Due to the temperature being at or below freezing and frequent snow during the majority of survey most of the observations were held from the bridge (12.8m asl), however when the weather was warmer observations were held from the PSO tower (18.9m asl). The PSO tower was equipped with Fujinon 7x50 binoculars and 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. For the duration that observations were held from the bridge the laptop, binoculars, field guides, etc. were moved into the bridge. Night Quest NQ2200 Night Vision Viewers 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 PSO, but most often two PSOs, watched for marine mammals at all times while airguns operated during daylight periods and whenever the vessel was underway but 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 09:30 local time, while end of observation times ranged from 20:20 to 23:00 local time.

A visual monitoring schedule was established by the PSOs where each person completed visual observations watches varying in length between one hour and four hours, two to four times a

day for a total of five to seven hours of visual monitoring per day. The Native Alaskan North slope observer contributed two to four hours of visual observation a 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. This occurred twice each day for lunch and dinner and solo watches lasted less than 40 minutes.

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, ice flows and other sighting cues indicating the possible presence of a protected species.

Upon the visual detection of a protected species, PSOs would first identify the animals range to the acoustic source (if firing) while identifying the observed animal (cetacean, pinniped, polar bear) to determine which safety radius applies 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, 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 further analysis to be conducted later by one of the more experienced acoustic operators.

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

Source and Volume	Array Tow Depth (m)	Water Depth (m)	Shut-down EZ for Pinnipeds, Polar Bears 190 dB (m)	Shut-down EZ for Cetaceans 180 dB (m)	Level-B Harassment Zone 160 dB (m)
Single bolt airgun (40 in^3)	6	Shallow (<100)	150	296	1,050
		Intermediate (100-1,000)	18	60	578
		Deep (>1,000)	12	40	385
1 string 10 airguns (1830 in^3)	6	Shallow (<200)	190	1,870	14,370
		Intermediate (200-1,000)	130	1,400	13,980
		Deep (>1,000)	130	425	14,070

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 83.3m or 103.3m 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. Times when photographs were not taken were due to the brevity of a sighting. The camera used was a Canon EOS 60D with a 300 millimeter telephoto lens. Marine mammal identification manuals were consulted and photos were examined during visual watch breaks to confirm identifications.

During or immediately after each sighting event PSOs recorded the position, time at first and last sighting, number of animals present (adults and juveniles), the initial and any subsequent behaviors observed, the initial range, bearing and movement of the animal(s), the source activity at the initial and final detections and any mitigation measures that were applied. Specific information regarding the animal(s) closest approach to the vessel, acoustic source and the acoustic source output at the closest approach were recorded to determine if the animals had been exposed to 160 dB and/or 180/190 dB of sound from the source during the sighting event. Additionally, the vessel position, water depth, vessel heading and speed, the wind speed and direction, Beaufort sea state, swell level, visibility and glare were recorded every half an hour at minimum or every time conditions (environment, vessel or seismic activity) changed. Each sighting event was linked to an entry on this datasheet such that environmental conditions were available for each sighting event.

3.1.1. FLIR (Forward Looking InfraRed) Camera

While in port a FLIR (Forward Looking InfraRed) thermal imaging camera was installed on the mast with a live feed monitor located in the bridge. It was to be used for navigation in low light conditions as well as to possibly detect marine mammals. To test this idea, once a marine mammal was observed visually the PSOs would then try to see if the animal could be seen on the monitor, using the FLIR camera. This was difficult due to brief sightings and the limited range of the FLIR (approximately 1500m). Throughout the survey only one marine mammal was detected on the FLIR monitor. On 9 September 2011 one blow from a humpback whale (detection no. 13), approximately 1 km from the vessel was observed with the FLIR camera.

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.

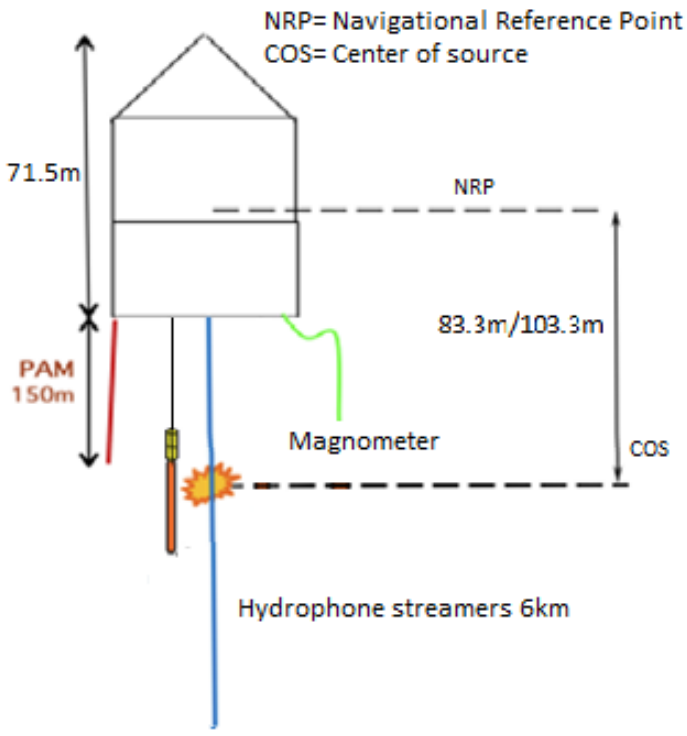

Figure 3. Location of the hydrophone deployment.

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 15:15 UTC on 8 September 2011. The seismic gear was deployed on 12 September 2011 as the *Langseth* neared the first survey line. Use of the acoustic source commenced at 00:13 UTC on 13 September 2011. Acquisition began on the first survey line began at 12:13 UTC on 13 September 2011. Table 2 outlines the dates and times of acquisition for each survey line.

Acquisition of the multi-channel seismic survey lines was completed at 04:41 UTC on 5 October 2011 and the seismic gear was brought on board for the transit back to port. The vessel returned to Dutch Harbor at 17:30 UTC on 9 October 2011.

Table 2. Multi-channel seismic and ocean-bottom seismometer survey lines acquired.

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
MGL1112MCS01A Seq1	13-Sep-2011	12:13	13-Sep-2011	13:02
MGL1112MCS02T Seq2	13-Sep-2011	13:57	13-Sep-2011	14:34
MGL1112MCS01AR Seq3	13-Sep-2011	15:46	13-Sep-2011	22:01
MGL1112MCS01B Seq4	13-Sep-2011	22:12	14-Sep-2011	11:16
MGL1112MCS01C Seq5	14-Sep-2011	11:18	15-Sep-2011	20:45
MGL1112MCS01D Seq6	15-Sep-2011	20:57	16-Sep-2011	00:48
MGL1112MCS03T Seq7	16-Sep-2011	01:22	16-Sep-2011	05:20
MGL1112MCS01E Seq8	16-Sep-2011	05:23	17-Sep-2011	02:48
MGL1112MCS01EA Seq9	17-Sep-2011	02:50	17-Sep-2011	15:44
MGL1112MCS01T Seq10	17-Sep-2011	15:46	17-Sep-2011	21:35
MGL1112MCS02 Seq11	17-Sep-2011	21:37	19-Sep-2011	09:55
MGL1112MCST2 Seq12	19-Sep-2011	10:05	19-Sep-2011	12:47
MGL1112MCST5 Seq13	19-Sep-2011	13:51	19-Sep-2011	15:01
MGL1112MCST6 Seq14	19-Sep-2011	17:14	19-Sep-2011	20:16
MGL1112MCS03B Seq15	19-Sep-2011	20:18	19-Sep-2011	20:54
MGL1112MCS03BA Seq16	19-Sep-2011	20:56	21-Sep-2011	04:49
MGL1112MCS03T Seq17	21-Sep-2011	05:25	21-Sep-2011	11:03
MGL1112MCS04 Seq18	21-Sep-2011	11:03	22-Sep-2011	14:52
MGL1112MCS04A Seq19	22-Sep-2011	15:01	22-Sep-2011	16:38
MGL1112MCS04B Seq20	22-Sep-2011	17:02	22-Sep-2011	21:40
MGL1112MCS04T Seq21	22-Sep-2011	23:08	23-Sep-2011	05:12
MGL1112MCS05 Seq22	23-Sep-2011	05:44	23-Sep-2011	05:47
MGL1112MCS05A Seq23	23-Sep-2011	05:52	23-Sep-2011	13:50
MGL1112MCS05B Seq24	23-Sep-2011	13:56	23-Sep-2011	14:38
MGL1112MCS05C Seq25	23-Sep-2011	14:40	23-Sep-2011	17:57
MGL1112MCS05D Seq26	23-Sep-2011	18:00	23-Sep-2011	21:27

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
MGL1112MCS05E Seq27	23-Sep-2011	21:39	24-Sep-2011	10:16
MGL1112MCS05T Seq28	24-Sep-2011	10:31	24-Sep-2011	14:45
MGL1112MCS06 Seq29	24-Sep-2011	14:59	25-Sep-2011	13:42
MGL1112MCS06A Seq30	25-Sep-2011	13:44	25-Sep-2011	18:54
MGL1112MCS06T Seq31	25-Sep-2011	19:07	25-Sep-2011	23:20
MGL1112MCS07 Seq32	25-Sep-2011	23:34	26-Sep-2011	00:30
MGL1112MCS07A Seq33	26-Sep-2011	00:31	26-Sep-2011	02:52
MGL1112MCS07B Seq34	26-Sep-2011	02:53	27-Sep-2011	03:25
MGL1112MCS07T Seq35	27-Sep-2011	03:41	27-Sep-2011	04:52
MGL1112MCS07TA Seq36	27-Sep-2011	04:54	27-Sep-2011	07:35
MGL1112MCS08 Seq37	27-Sep-2011	07:48	28-Sep-2011	02:01
MGL1112MCS08A Seq38	28-Sep-2011	02:04	28-Sep-2011	02:23
MGL1112MCS08B Seq39	28-Sep-2011	02:27	28-Sep-2011	12:08
MGL1112MCS08T1 Seq40	28-Sep-2011	12:20	28-Sep-2011	16:21
MGL1112MCS08T1A Seq41	28-Sep-2011	16:23	28-Sep-2011	17:08
MGL1112MCS08T2 Seq42	28-Sep-2011	17:24	28-Sep-2011	21:21
MGL1112MCS09T1 Seq43	28-Sep-2011	21:32	29-Sep-2011	00:39
MGL1112MCS09 Seq44	29-Sep-2011	00:40	29-Sep-2011	05:43
MGL1112MCS09A Seq45	29-Sep-2011	05:44	29-Sep-2011	05:45
MGL1112MCS09B Seq46	29-Sep-2011	05:49	29-Sep-2011	10:25
MGL1112MCS09C Seq47	29-Sep-2011	10:27	29-Sep-2011	18:58
MGL1112MCS09D Seq48	29-Sep-2011	19:00	29-Sep-2011	19:33
MGL1112MCS09E Seq49	29-Sep-2011	19:34	29-Sep-2011	21:28
MGL1112MCS09F Seq50	29-Sep-2011	21:30	30-Sep-2011	05:22
MGL1112MCS09T Seq51	30-Sep-2011	05:36	30-Sep-2011	09:34
MGL1112MCS10 Seq52	30-Sep-2011	09:48	30-Sep-2011	18:17
MGL1112MCS10A Seq53	30-Sep-2011	18:19	01-Oct-2011	04:38
MGL1112MCS10B Seq54	01-Oct-2011	04:39	01-Oct-2011	09:50
MGL1112MCS10C Seq55	01-Oct-2011	09:53	01-Oct-2011	14:07
MGL1112MCS10T1 Seq56	01-Oct-2011	14:14	01-Oct-2011	19:07
MGL1112MCS10T2 Seq57	01-Oct-2011	19:23	02-Oct-2011	00:43
MGL1112MCS11A Seq58	02-Oct-2011	01:01	02-Oct-2011	01:14
MGL1112MCS11A1 Seq59	02-Oct-2011	01:15	02-Oct-2011	02:09
MGL1112MCS11A2 Seq60	02-Oct-2011	02:13	02-Oct-2011	04:05
MGL1112MCS11B Seq61	02-Oct-2011	04:28	02-Oct-2011	06:38
MGL1112MCS11B1 Seq62	02-Oct-2011	06:40	02-Oct-2011	07:35
MGL1112MCS11B2 Seq63	02-Oct-2011	07:37	02-Oct-2011	09:05
MGL1112MCS11B3 Seq64	02-Oct-2011	09:08	02-Oct-2011	10:09

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
MGL1112MCS11B4 Seq65	02-Oct-2011	10:12	02-Oct-2011	10:27
MGL1112MCS11B5 Seq66	02-Oct-2011	10:29	02-Oct-2011	14:58
MGL1112MCS11B6 Seq67	02-Oct-2011	15:02	03-Oct-2011	05:58
MGL1112MCS11C Seq68	03-Oct-2011	05:59	03-Oct-2011	07:52
MGL1112MCS11C1 Seq69	03-Oct-2011	07:54	03-Oct-2011	09:50
MGL1112MCS11D Seq70	03-Oct-2011	10:03	03-Oct-2011	21:52
MGL1112MCS12 Seq71	03-Oct-2011	22:29	04-Oct-2011	02:51
MGL1112MCS13 Seq72	04-Oct-2011	03:06	04-Oct-2011	07:13
MGLL1112MCS14 Seq73	04-Oct-2011	07:22	04-Oct-2011	10:36
MGL1112MCS15 Seq74	04-Oct-2011	10:58	04-Oct-2011	17:15
MGL1112MCS16 Seq75	04-Oct-2011	17:41	05-Oct-2011	01:10
MGL1112MCS17 Seq76	05-Oct-2011	01:27	05-Oct-2011	04:41

The acoustic source was active throughout the survey, with a few periods of source silence, for a total of 531 hours 50 minutes of source activity. This total includes ramping-up of the airguns, full power and partial power firing both online and during line changes, and operation of a single 40 in³ mitigation airgun (Figure 4). The mitigation source was active during mitigation power-downs initiated for protected species inside the safety radius as well as for mechanical/technical reasons for a total of 1 hour 18 minutes during the survey. Full power source operations accounted for 94% (500 hours 44 minutes) of airgun activity during the project. Line changes were often shot at full or partial power, totalling 28 hours 31 minutes of array activity. The full volume of the acoustic source (9-10 airguns firing) ranged from 1470 in³ to 1830 in³, caused by the failure of one gun or compressor problems.

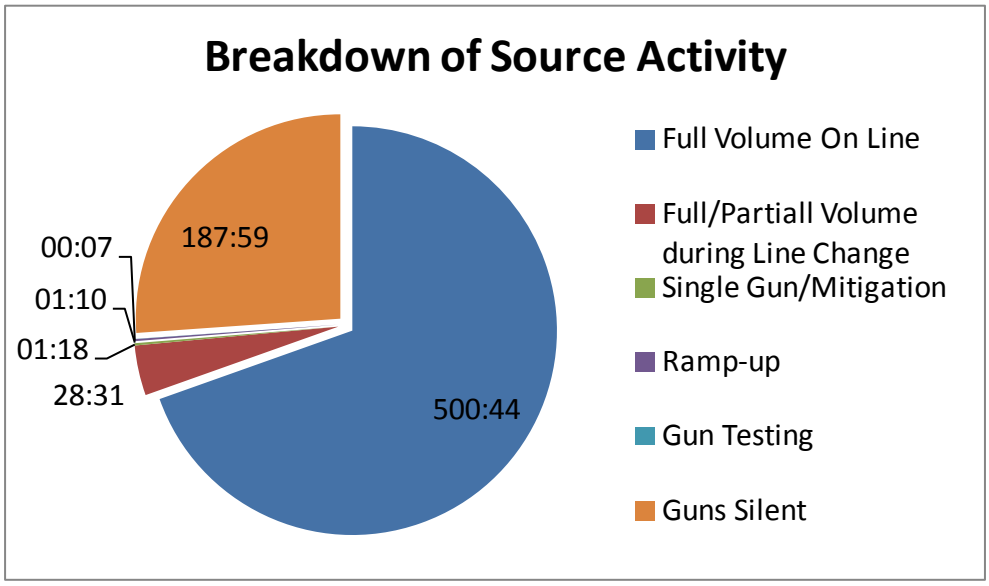

Figure 4. Breakdown of acoustic source operations.

The acoustic source was ramped up a total of three 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 20 to 30 minutes by manually increasing the number of guns firing. 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 Coakley 2D marine geophysical survey. No ramp-ups were conducted at night. One daytime ramp up was conducted from airgun silence during the survey. The remaining two daytime ramp-ups were initiated with a mitigation source already active.

Table 3. Total acoustic source operations during the Coakley marine geophysical survey.

Acoustic Source Operations	Number	Duration (hh:mm)
Gun Tests		**0:07**
Ramp-up		**1:10**
Day time ramp-ups from silence	**1**	
Day time ramp-ups from mitigation gun	**2**	
Night time ramp-ups from mitigation gun	**0**	
Full power survey acquisition		**500:44**
Full/partial power line changes		**28:31**
Single airgun (40 in³)		**1:18**
Total time acoustic source was active		**531:50**

4.2. VISUAL MONITORING SURVEY SUMMARY

Visual monitoring began at 16:30 UTC on 8 September 2011 and continued until 4:25 UTC on 9 October 2011, the evening before the vessel returned to Dutch Harbor at the completion of the survey project. 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, for a range of approximately 12 to 15 hours of visual observations per day.

Visual watches were held by two PSOs except during the scheduled meal hours for lunch and dinner when a single PSO continued visual monitoring, in addition to acoustic monitoring conducted by the PAM operator on duty while each PSO rotated for a meal break. Single PSO visual observations during these periods lasted a maximum of 40 minutes. In the event of a sighting event during a single PSO watch a second PSO would be notified and return to assist.

The acoustic source was active during the majority of visual observations (73%) and acoustic monitoring (99.8%), as shown in Figure 5. Once the survey began the acoustic source was only disabled a few times due to mechanical problems.

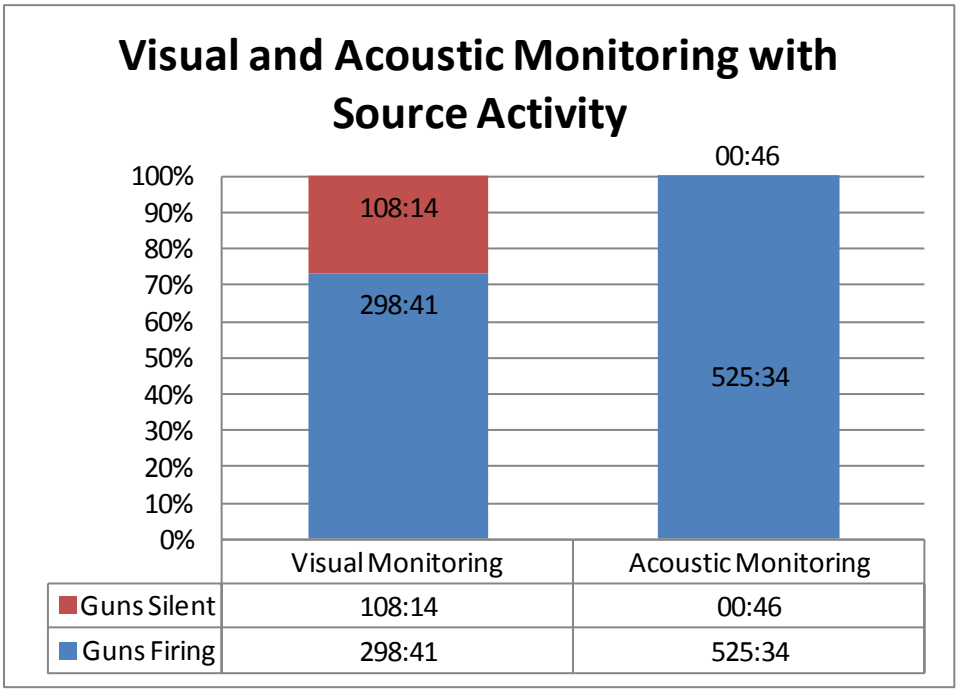

Figure 5. Duration of visual and acoustic monitoring effort while the acoustic source was active vs. silent.

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	**298:41**
Total monitoring while acoustic source silent	**108:14**
Total monitoring effort	**406:55**

The PSOs preferred to conduct visual observations from the PSO tower, providing the PSOs with a 360° view of the water around the vessel and acoustic source. However, due to the severely cold weather in the Arctic the majority of observations were held in the bridge. The PSOs also monitored from the bridge for any health or safety reasons or during periods with high winds, large swells, or heavy rain. As Figure 6 demonstrates approximately 88% of visual monitoring was conducted from the bridge during the Coakley 2D marine geophysical survey while 12% was conducted from the PSO tower.

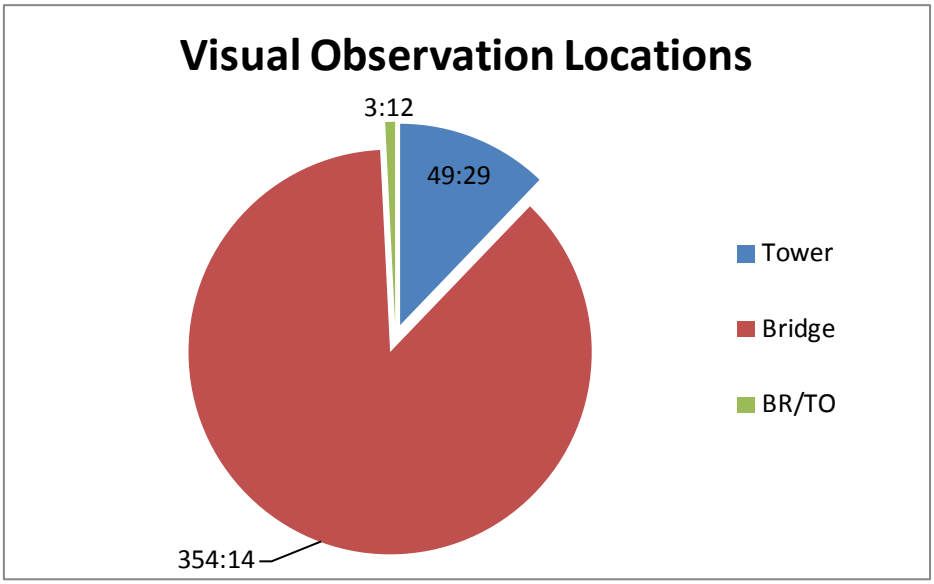

Figure 6. Total visual effort from observation locations on board the R/V Langseth.

4.3. ACOUSTIC MONITORING SURVEY SUMMARY

The hydrophone cable was deployed for the first time on 13 September 2011 after the vessel had completed deployment of the seismic equipment. Acoustic monitoring began immediately at 00:50 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 04:31 UTC on 05 October 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 526 hours and 20 minutes of acoustic monitoring, all but 46 minutes occurred while the acoustic source was active (Table 5). There was one period on of acoustic monitoring downtime (6 hours and 15 minutes) on October 2011, when the PAM system could not be utilized because the hydrophone cable was not deployed due to rough seas.

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

Passive Acoustic Monitoring Effort	Duration (hh:mm)
Total monitoring while acoustic source active	**525:34**
Total monitoring while acoustic source silent	**00:46**
Total acoustic monitoring	**526:20**

4.4. SIMULTANEOUS VISUAL AND ACOUSTIC MONITORING SUMMARY

While visual observations began on 8 September 2011 acoustic observations began on 13 September 2011, 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 44% (406 hours 55 minutes) while acoustic monitoring accounted for 56% (526 hours 20 minutes). As displayed in Figure 7 there were 294 hours 38

minutes of simultaneous visual and acoustic observations conducted during this survey. Simultaneous visual and acoustic monitoring accounted for 56% of total acoustic monitoring and 72 % of visual monitoring.

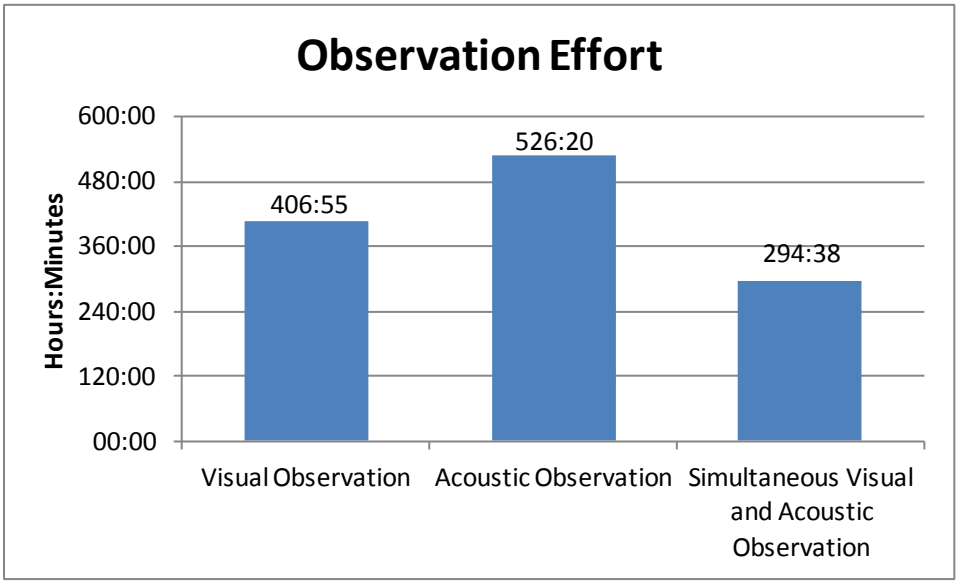

Figure 7. Total PAM and visual monitoring effort.

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 or hindered by fog or snow but the safety radii remained visible. Visibility was clear, 5 kilometers or more, for the majority of the cruise (Figure 8).

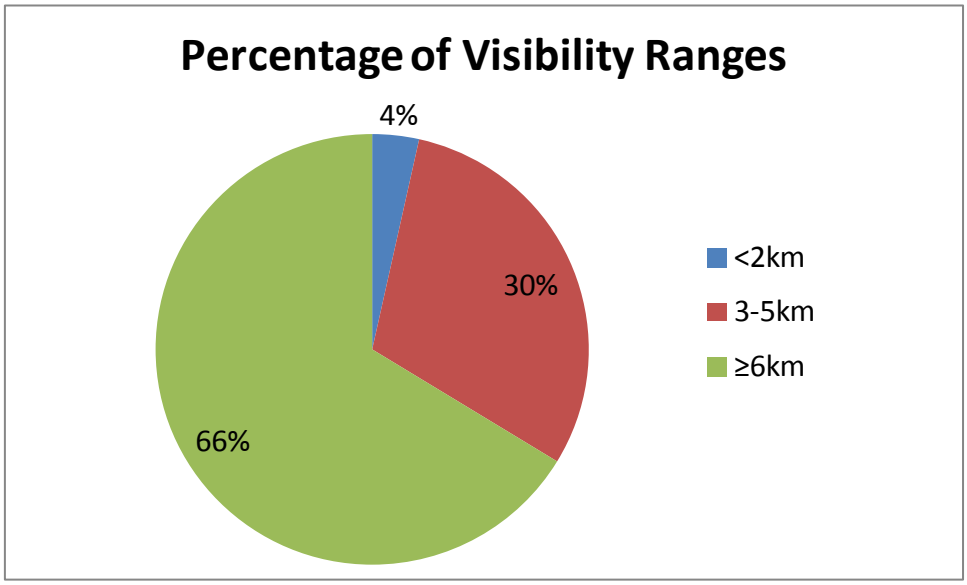

Figure 8. Visibility during visual monitoring over the Coakley marine geophysical survey.

Wind forces remained relatively calm throughout the cruise with a minimum of less than one knot to a maximum of 47 knots during transit through the Bering Sea. Higher wind speeds were also observed during periods of snow and the final transit through the Bering Sea (Figure 9). Wind forces less than 10 knots were observed for a total of 192 hours.

Periods of snow and fog were intermittent throughout the cruise but did not often obscure visibility (Figure 10). Snow was present, in a light to moderate level, for a total of 96 hours and rain or fog was observed for a total of 21 hours. The Beaufort sea state ranged from levels 1 through 8 but generally remained between a level 3 and level 6.

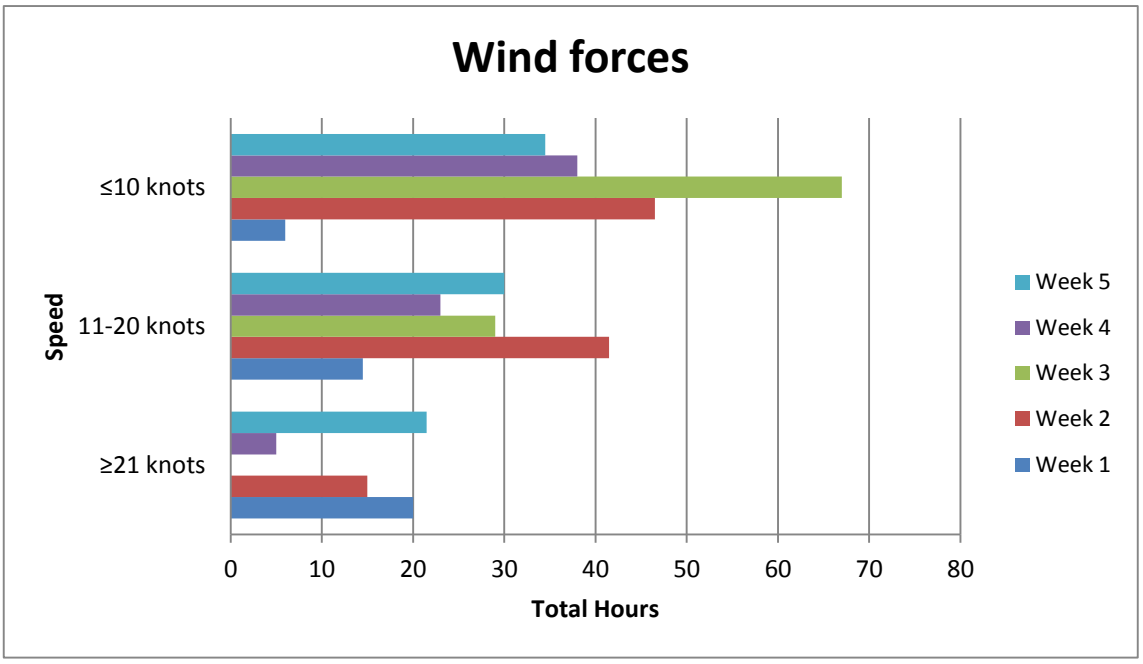

Figure 9. Wind force each week visual monitoring was conducted.

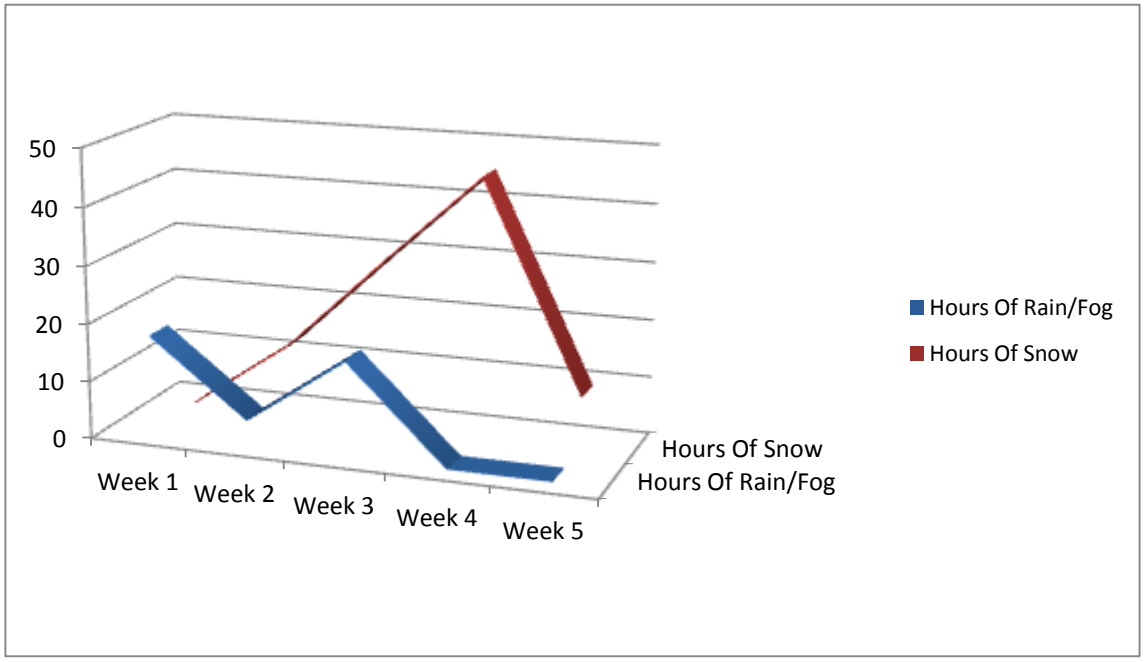

Figure 10. Duration of snow and fog while visual monitoring was conducted.

5. MONITORING AND DETECTION RESULTS

5.1. VISUAL DETECTIONS

Visual monitoring conducted during the Coakley marine geophysical survey resulted in the collection of 42 records of detection for protected species (not including the decayed marine mammal). Eight species of marine mammals, three species of cetaceans and five species of pinnipeds were identified in addition to several unidentified cetaceans and multiple unidentified pinnipeds. The total number of detection events and total number of animals recorded by species is described in Table 6.

All marine mammals detections are also described in Appendix E and detection of birds are listed in Appendix F.

Table 6. Number of detection records collected for each protected species.

	Total Number of Detection Records	Total Number of Animals Recorded
Cetaceans		
Unidentifiable cetacean	4	5
Mysticetes		
Humpback whale	1	2
Common minke whale	1	1
Odontocetes		
Killer whale	1	5
Pinnipeds		
Pacific walrus	6	14
Spotted seal	3	3
Ringed seal	5	5
Bearded seal	6	7
Northern fur seal	4	9
Unidentifiable pinniped	11	12

The number of protected species detections each day varied greatly over the course of the survey (Figure 11). Including multiple days where no protected species were observed. The greatest number of detections in one day occurred on 14 September 2011 with 10 records of detection, all pinnipeds.

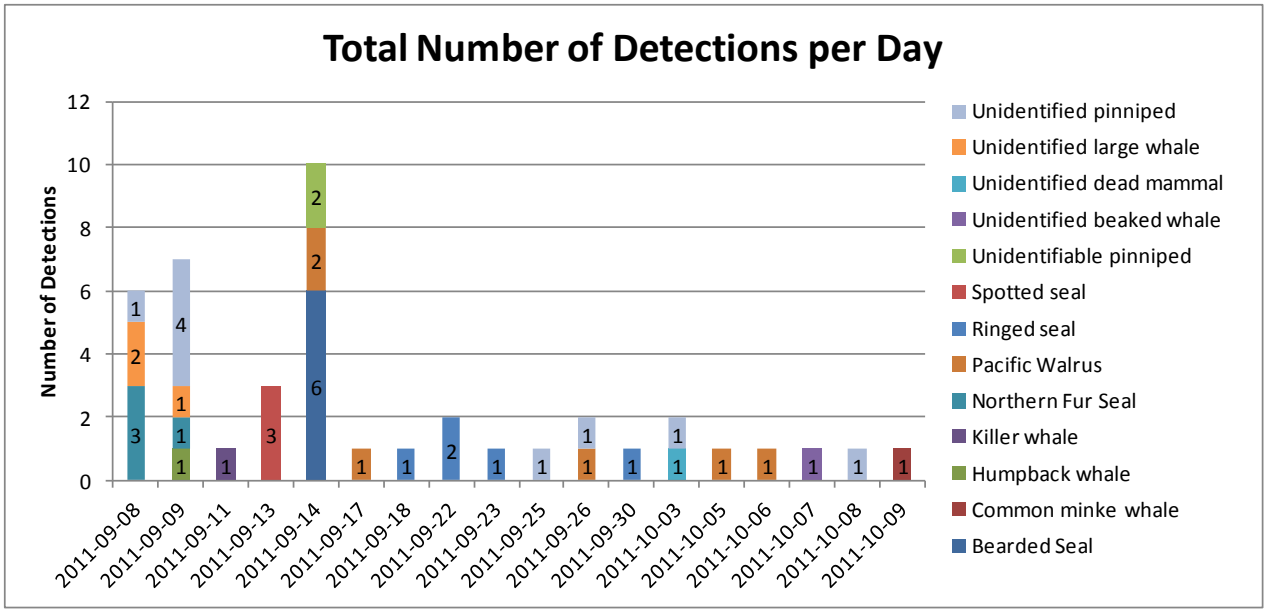

Figure 11. Number of protected species detections each day of the Coakley marine geophysical survey.

Of the 42 protected species detection events during the Coakley marine geophysical survey, 23 detections (55%) occurred while the acoustic source was active and 19 detections (45%) occurred while the acoustic source was silent. Table 7 demonstrates the average closest approach of protected species to the source at various volumes.

Table 7. Average closest approach of protected species to the acoustic source at various volumes.

Species Detected	Full Power (1830 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	-	-	-	-	-	-	1	300
Common minke whale	-	-	-	-	-	-	1	140
Killer whale	-	-	-	-	-	-	1	200
Unidentifiable cetacean	-	-	-	-	-	-	4	706
Northern fur seal	-	-	-	-	-	-	4	188
Spotted seal	3	322	-	-	-	-	-	-
Ringed seal	5	173	-	-	-	-	-	-
Bearded seal	6	572	-	-	-	-	-	-
Pacific walrus	4	846	-	-	-	-	2	175
Unidentifiable pinniped	5	594	-	-	-	-	6	230

Pinnipeds were detected most frequently, consisting of 83% (35 detection records) of the total records. Figure 12 demonstrates the total number of animals observed, per species, during the

detection events. Pacific walruses (*Odobenus rosmarus divergens*) were the most commonly detected and positively identified protected species during the survey with six detection events totaling 14 animals. The next most commonly detected protected species were bearded seals (*Erignathus barbatus*) with six detection events totalling 7 animals.

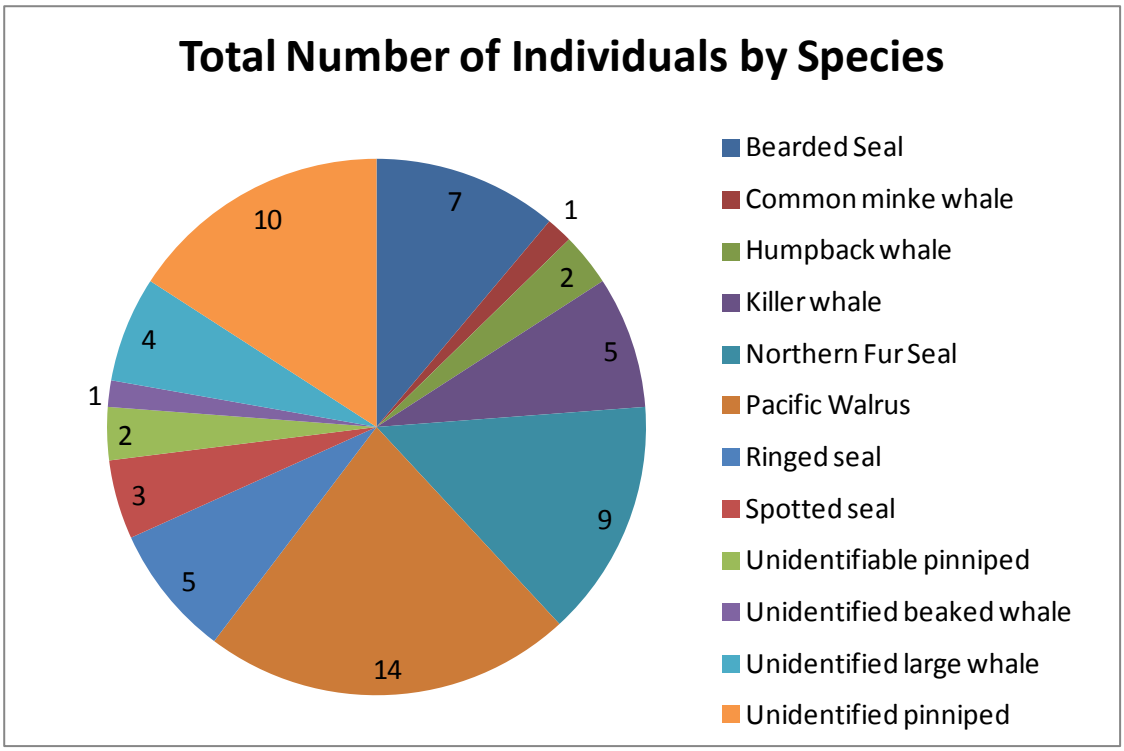

Figure 12. Number of individual animals observed.

5.1.1. Cetacean Detections

Out of the 42 protected species detections, 7 were of cetaceans. There were 4 detections of unidentified cetaceans, one humpback whale, one common minke whale and one killer whale. The spatial distribution of cetacean detections can be seen in Figure 13.

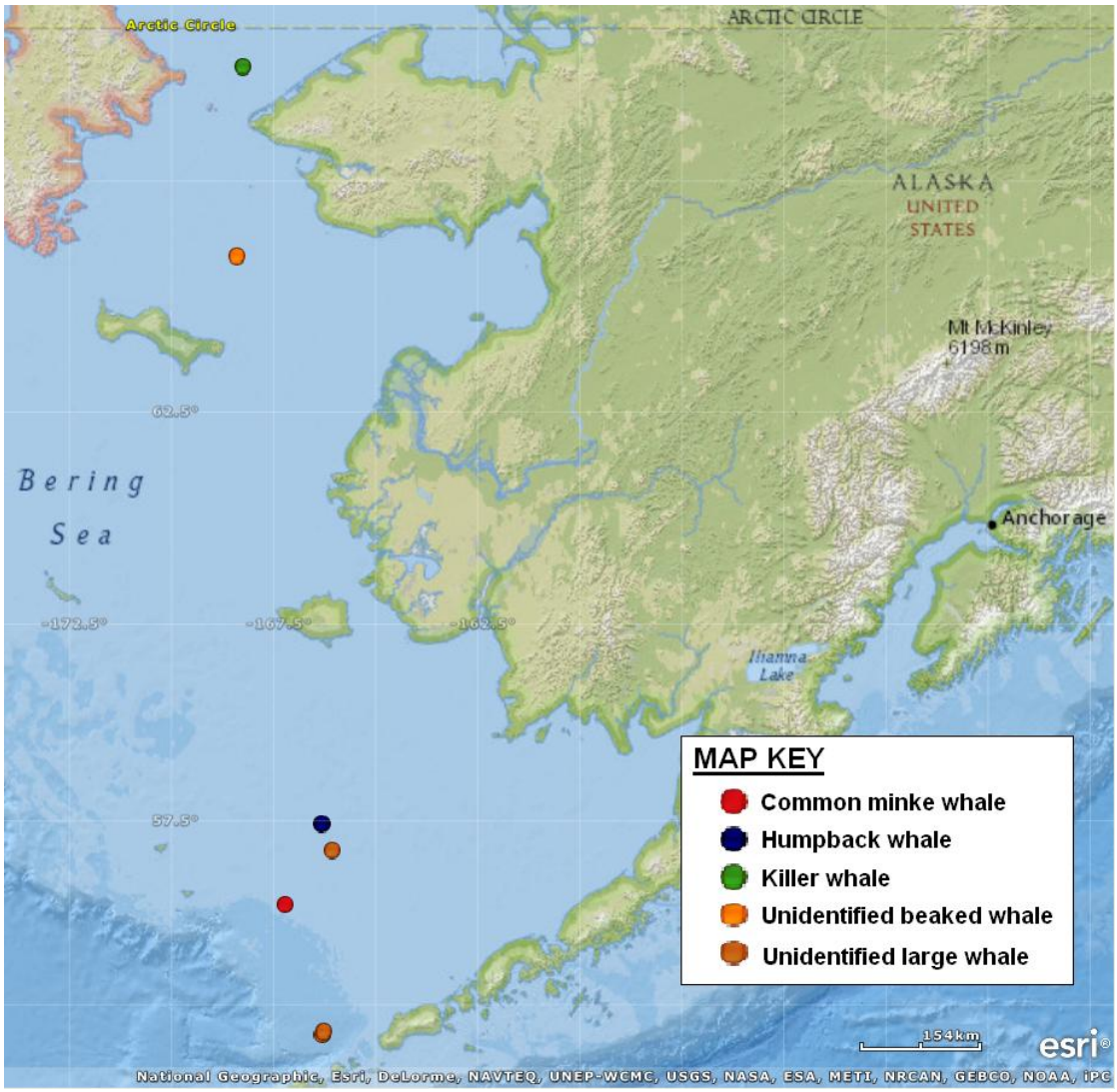

Figure 13. Cetacean spatial distribution of detections during the Coakley two-dimensional (2D) marine geophysical survey.

5.1.1.1. Humpback whale

Two humpback whales *(Megaptera novaeangliae)* were sighted on 9 September 2011 while the *Marcus G. Langseth* was underway to the survey sight. The airguns were not firing during the sighting, thus the whales were not exposed to received sound levels.

5.1.1.2. Killer whale

Killer whales (*Orcinus orca*) were sighted only once during the acquisition of the Coakley marine geophysical survey. A pod of 5 killer whales 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 on 11 September 2011.

5.1.1.3. Common Minke whale

A common minke whale (*Balaenoptera acutorostrata*) was observed on 9 October 2011 during the transit back to port. The whale was observed within the safety radii, though it was not exposed to the sound source due to the gun arrays being on board for the transit.

5.1.1.4. Unidentified cetacean

A total of five unidentified cetaceans were observed on four separate occasions. The first three sightings occurred in transit to the survey site and the fourth sighting during transit back to Dutch Harbor. The airgun arrays were on board during these sightings thus the animals were not exposed to the sound source.

5.1.2. Pinniped Detections

Out of the 42 detections, pinnipeds consisted of 35 of the detections. There was also an unidentified animal with significant decay that was suspected to be a dead pinniped. The pinniped detections consisted of 6 Pacific walrus, 3 spotted seals, 5 ringed seals, 6 bearded seals, 4 northern fur seals and 11 unidentifiable pinnipeds. The spatial distribution of cetacean detections can be seen in Figure 14.

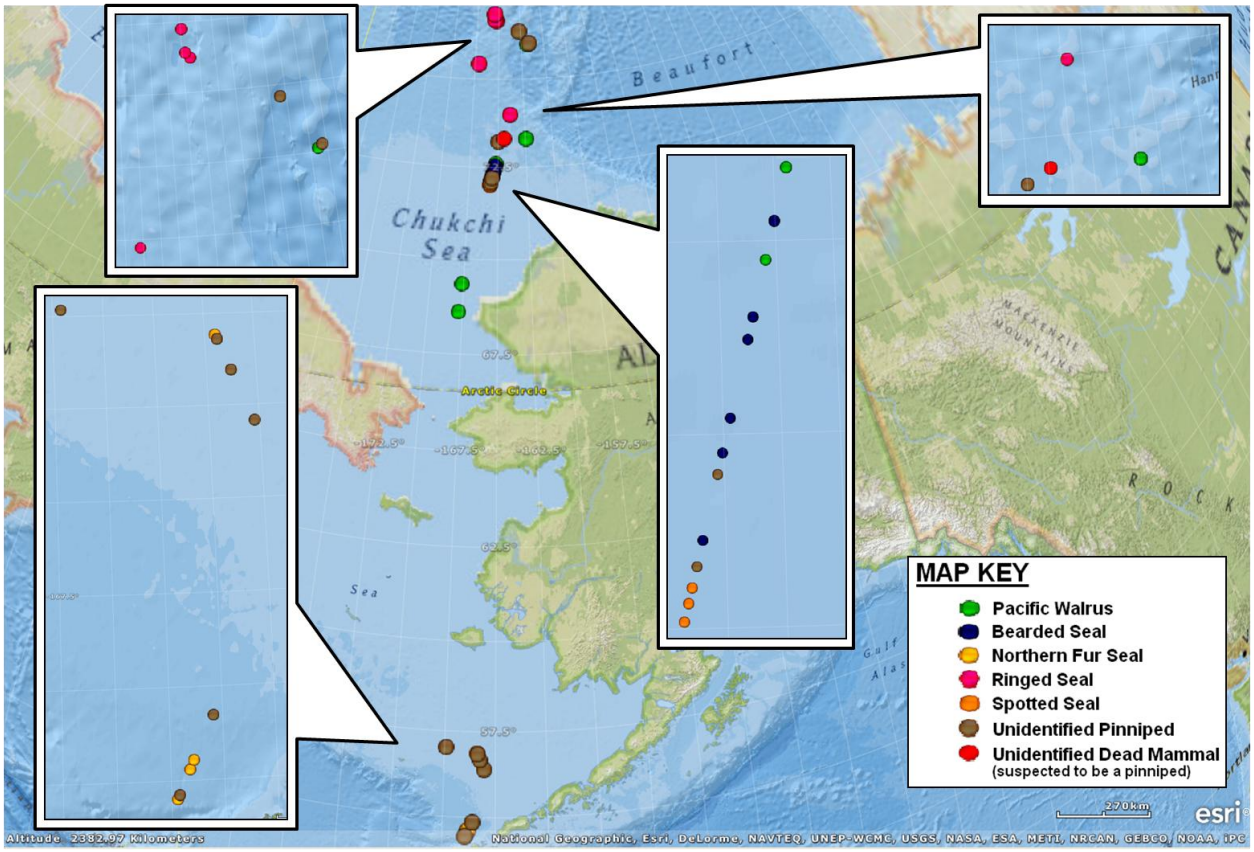

Figure 14. Pinniped spatial distribution of detections during the Coakley two-dimensional (2D) marine geophysical survey.

5.1.2.1. Northern fur seal

Northern fur seals (*Callorhinus ursinus*) were positivity identified on four occasions; with a total of 9 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 68 to 576 meters, and noted as close as 150 to as far 250 meters distance from the vessel.

5.1.2.2. Spotted seal

Three detections of spotted seals (*Phoca largha*) occurred during this project, all on 13

September. Each sighting involved one animal only. Water depths ranged from 160 – 405 meters. Guns were firing at full power at the beginning of each sighting, but only one detection (no. 15) required a mitigation power down.

5.1.2.3. Ringed seal

Ringed seals (*Phoca/Pusa hispida*) were detected five times during this cruise. All five detections of involved a single animal. Water depths for these sightings ranged from 209 – 1156 meters. Airguns were firing at full power during every sighting. Detection no. 31 required a mitigation power-down.

5.1.2.4. Bearded seal

There were six detections of bearded seals (*Erignathus barbatus*), all on 14 September. Each detection involved one animal, with the exception of detection no. 24, during which two individuals were sighted. All sightings of bearded seals occurred while airguns were firing at full power, however, only two detections (nos. 41 and 45) required mitigation power-downs. Every bearded seal sighting occurred in water depths of 45 meters or less.

5.1.2.5. Pacific walrus

Pacific Walruses (*Odobenus rosmarus divergens*) were sighted six times during the entire project. All sightings occurred in the Chukchi Sea. Two of the detections (no's. 25, 27) involved one animal, two detections (no's. 28, 39) involved mother/calf pairs, one detection (no. 40), included a mother/calf pair plus an additional adult, and one sighting (no. 35) involved five animals hauled out on small icebergs floating next to a large ice floe on 26 September. Walrus sighting reports were written and sent to the U.S. Fish and Wildlife Service as required by the federal agency.

6. MITIGATION ACTION SUMMARY

There were five mitigation actions implemented during the Coakley marine geophysical survey, all power downs of the acoustic source. The number and duration of mitigation actions is summarized in table 8. All five power downs were implemented for pinnipeds observed within the 190 dB safety radius.

Table 8. Number and duration of mitigation actions implemented during the Coakley marine geophysical survey.

Mitigation Action	Cetaceans		Pinnipeds	
	Number	Duration	Number	Duration
Delayed Ramp-up	0	-	0	-
Power Down	0	-	5	1:32
Shut Down	0	-	0	-
Total	**0**	**-**	**5**	**1:32**

The majority of mitigation actions implemented during the survey were for bearded seals, which were the cause of two power downs (Figure 15). Each mitigation action that was implemented during the survey is summarized in Table 9.

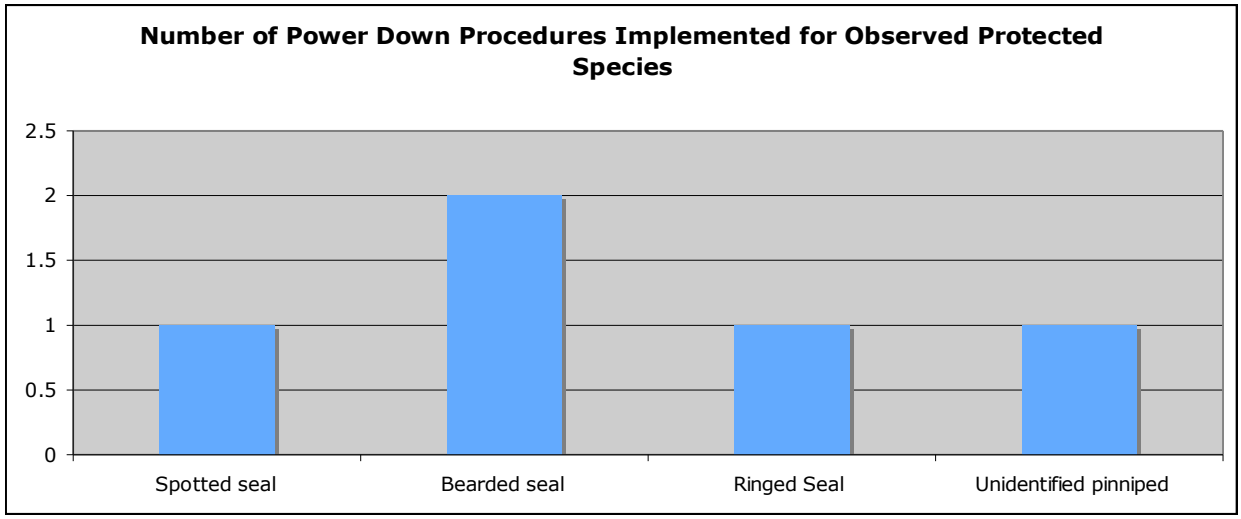

Figure 15. Number of power down procedures implemented for observed protected species.

Mitigation actions caused a total duration of downtime of 1 hour 32 minutes during the survey. With the largest amount of downtime attributed to an unidentified pinniped, with 39% of total downtime (Figure 16).

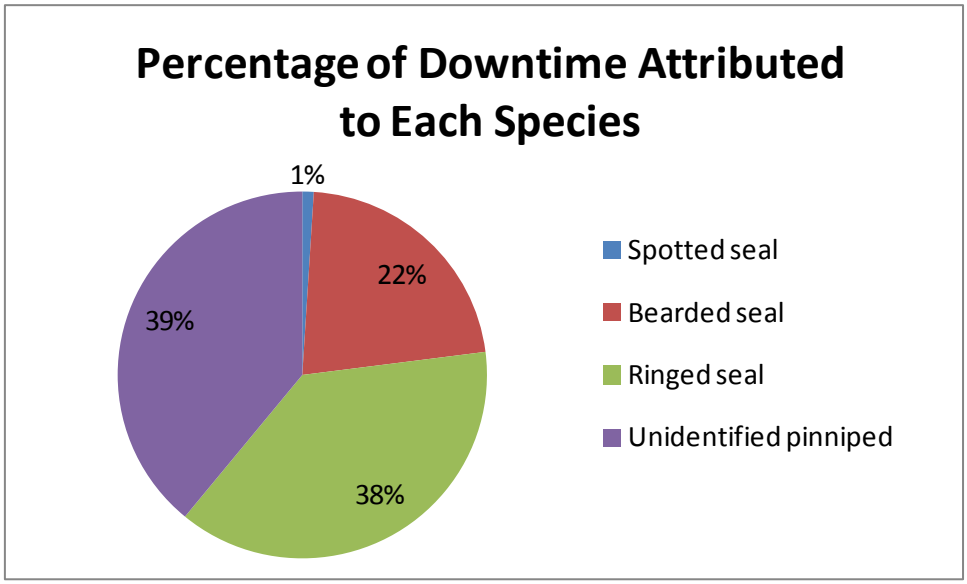

Figure 16. Percentage of overall downtime attributed to each protected species group.

Table 9. Summary of each mitigation action implemented during the Coakley marine geophysical survey.

Date	Visual Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Firing Source/Power Level	Mitigation Action	Total Duration of Mitigation Event	Comments
13-Sep	15	Spotted seal	1	Full power	160m / 1830 in^3	Power down	0:01	Seal seen leaving safety radius, airguns return to full power.
14-Sep	19	Bearded seal	1	Full power	155m / 1830 in^3	Power down	0:02	Seal seen leaving safety radius, airguns return to full power.
14-Sep	23	Bearded seal	1	Full power	155m / 1830 in^3	Power down	0:18	Seal last seen inside safety radius at 03:44 UTC. Waited 15 min. before returning to full power.
22-Sep	31	Ringed seal	1	Full power	75m / 1830 in^3	Power down	0:35	Seal last seen inside safety radius at 20:24 UTC. Waited 15 minutes before initiating ramp up.
3-Oct	38	Unidenti fied pinniped	1	Full power	180m / 1830in^3	Power down	0:36	Seal last seen inside safety radius at 4:31 UTC. Waited 15 minutes before initiating ramp up.

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

NMFS granted an IHA to the UAGI for a marine seismic survey allowing Level B harassment takes (expose to 160 dB received sound) for 11 marine mammal species: five mysticetes, two odontocete species, and four pinnipeds. Direct visual observations recorded by Protected Species Observers of three 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 Coakley marine geophysical survey seven bearded seals (*Erignathus barbatus*), three spotted seals (*Phoca largha*), and five ringed seals (*Pusa/Phoca hispida*) were observed within the 160 dB predicted distances where Level B harassment is expected to occur while the acoustic source was active (Table 10). Although Pacific walruses are protected under the jurisdiction of the Alaska Department of Fish and Wildlife Service, four individuals were exposed to received sounds levels greater than 160 dB and so have been included in the summary of known "takes".

Table 10. Level B Harassment Takes authorized by NMFS IHA for the Coakley marine geophysical survey 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			
Bowhead whale	89	-	-
Gray whale	71	-	-
Humpback whale	2	-	-
Minke whale	2	-	-
Fin whale	2	-	-
Odontocetes			
Beluga whale	794	-	-
Killer whale	2	-	-
Pinnipeds			
Bearded seal	677	2	5
Spotted seal	150	1	2
Ringed seal	7,492	1	4
Ribbon seal	42	-	-

These numbers are very likely to be an underestimate and provide the absolute minimum number of animals actually exposed. There were another five unidentified pinnipeds that were exposed to 160 dB. Because the Level-B harassment zone ranged from 13,980 meters to 14,730 meters large numbers of animals may have entered 160 dB safety radius without being detected. There were only a few sort periods where the 180/190 dB safety radius were not fully visible due to fog or snow. 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 11 describes the behavior of all animals, including unidentified species, which were exposed to 160 dB for the duration they were observed.

Table 11. 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
Bearded seal	19	1	rolling	stationary, in front of vessel	swimming	away from vessel
	21	1	resting	stationary	resting	stationary
	22	1	resting	stationary	diving	away from vessel
	23	1	swimming	away from vessel	diving	away from vessel
	24	2	resting	stationary	swimming	away from vessel
	26	1	swimming	away from vessel	swimming	away from vessel
Spotted seal	15	1	surfacing	away from vessel	swimming	away from vessel
	16	1	swimming	parallel, opposite direction	diving	away from vessel
	17	1	swimming	parallel, same direction	diving	unknown
Ringed seal	29	1	porpoising	same direction in front of vessel	porpoising	away from vessel
	30	1	swimming	same direction in front of vessel	diving	same direction in front of vessel
	31	1	surfacing	away from vessel	swimming	away from vessel
	32	1	swimming	away from vessel	diving	away from vessel
	36	1	swimming	away from vessel	swimming	away from vessel
Pacific walrus	25	1	swimming	perpendicular, ahead of vessel	swimming	parallel, opposite direction
	27	1	rolling	milling	swimming	away from vessel
	28	2	swimming	milling	shallow dive	parallel, same direction
Unidentified pinniped	29	1	swimming	parallel, opposite direction	swimming	parallel, opposite direction
	30	1	swimming	unknown	diving	away from vessel
	31	1	swimming	away from vessel	diving	away from vessel
	32	1	surfacing	unknown	swimming	away from vessel
	36	1	surfacing	parallel, opposite direction	swimming	away from vessel

6.1.1. Spotted seal

There were three detection events of spotted seals (detection numbers: 15, 16 &17) totalling a minimum of three animals that were exposed to noise levels constituting Level-B harassment during the Coakley marine geophysical survey. Two of these animals were observed within the 160 dB safety radius while the third was observed within the 190 dB safety radius, while the array was firing full power, resulting in a mitigation power-down of the acoustic source.

6.1.2. Ringed seal

There were five detection events of ringed seals (detection numbers: 29, 30, 31, 32 &36) totalling a minimum of five animals that were exposed to noise levels constituting Level-B harassment. Four of these animals were observed within the 160 dB safety radius while one was observed within the 190 dB safety radius, while the array was firing full power, resulting in a mitigation power-down of the acoustic source.

6.1.3. Bearded seal

There were six detections events of bearded seals (detection numbers: 19, 21, 22, 23, 24 &26) totalling a minimum of seven animals that were exposed to noise levels constituting Level-B harassment. Five of these animals were observed within the 160 dB safety radius while one animal was observed within the 190 dB safety radius, while the array was firing full power, resulting in a mitigation power-down of the acoustic source.

6.1.4. Pacific walrus

There were three detection events of Pacific walruses (detection numbers: 25, 27 & 28) totalling a minimum of four animals (three adults and one juvenile) that were exposed to noise levels constituting Level-B harassment. All four of these animals were observed within the 160 dB safety radius and no mitigation actions were necessary.

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 during the Coakley marine geophysical survey, mitigation measures were implemented whenever these protected species were seen near or within the safety radii designated in the IHA. Throughout this survey five power-downs were implemented, all for species of pinnipeds.

Additional mitigation measures were implemented voluntarily by UAGI after consultation with Alaska Department of Fish & Wildlife Service for Pacific walrus (*Odobenus rosmarus divirgens*) and polar bears (*Ursus maritimus*). The 190 dB safety radius was to be applied for both species and they were to be given an 800 meter buffer zone from the vessel when possible. Airgun operations were also to be suspended if subsistence hunting was actively occurring within 5 km of the *R/V Langseth.* Giving the walruses an 800m buffer zone was often not possible due to the low turning radius of the vessel when the seismic gear is deployed and the fact that sightings of Pacific walrus usually occurred when they were already closer than 800m to the vessel. The 190 dB safety radius was also to be applied to walrus and polar bears, but neither species was ever observed within the 190 dB safety radius. Four Pacific walruses, during three detection events, were exposed to received sound levels greater than 160 dB

7. ACKNOWLEDGEMENTS

The Protected Species Observers on board the *Langseth* during the Coakley marine geophysical survey from RPS Energy would like to thank the National Science Foundation, Lamont-Doherty Earth Observatory, the University of Alaska Geophysics Institute and Dr. Bernard Coakley for the opportunity to be involved with this project. 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 also like to thank Reynold Aveoganna, the native Alaskan North slope observer, who assisted with monitoring and observations.

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 Gulf of Alaska, June 2011”.

APPENDIX A:

Incidental Harassment Authorization for the Coakley marine geophysical survey.

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

AUG 26 2011

Bernard Coakley, Ph.D.
Associate Professor
Department of Geology and Geophysics
348 REIC
900 Yukon Drive
Fairbanks, Alaska 99775

Dear Dr. Coakley:

Enclosed is an Incidental Harassment Authorization (IHA) issued to the University of Alaska Geophysics Institute under the authority of Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*) to take, by Level B harassment only, small numbers of 11 species of marine mammals incidental to a marine geophysical (seismic) survey in the Arctic Ocean. The IHA is valid from September 5, 2011, through October 23, 2011.

You are required to comply with the conditions contained in the IHA. In addition, you must submit a final report to the National Marine Fisheries Service (NMFS) Office of Protected Resources within 90 days after expiration of the IHA. The IHA requires the monitoring of marine mammals by qualified individuals during activities and reporting of marine mammal observations, including species, numbers, and behavioral modifications potentially resulting from the seismic survey.

If you have any questions concerning the IHA or its requirements, please contact Candace Nachman, Office of Protected Resources, NMFS at (301) 427-8401.

Sincerely,

James H. Lecky, Director
Office of Protected Resources

Enclosure

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

Incidental Harassment Authorization

The University of Alaska Geophysics Institute (UAGI), 900 Yukon Drive, Fairbanks, Alaska 99775, 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 from the *R/V Marcus G. Langseth* (*Langseth*) in the Arctic Ocean, September-October 2011, contingent upon the following conditions:

1. This Authorization is valid from September 5, 2011, through October 23, 2011.

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

> Within the area bounded by the following coordinates, 72.5–77° North and 160–175° West, within the Exclusive Economic Zone of the United States and adjacent International Waters, as specified in UAGI's May 10, 2011, IHA request and associated Environmental Assessment.

3. Species Impacted 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 Arctic Ocean:

> (i). Mysticetes – see Table 2 (attached) for authorized species and take numbers.
>
> (ii). Odontocetes – see Table 2 (attached) for authorized species and take numbers.
>
> (iii). 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 only, are limited to the following acoustic sources, without an amendment to this Authorization:

(a). A 10 Bolt airgun array with a total capacity of 1,830 in^3 (or smaller);

(b). A multi-beam echosounder;

(c). A sub-bottom profiler; and

(d). An acoustic Doppler current profiler.

5. The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Chief, Permits, Conservation and Education Division, Office of Protected Resources, National Marine Fisheries Service (NMFS) or his designee, at 301-427-8401.

6. Mitigation and Monitoring Requirements: The Holder of this Authorization is required to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable 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.

(iii). The data listed under Condition 6(c)(ii) above 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, be present to operate or oversee PAM, and be 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, L-DEO must delay the seismic survey until the marine mammal(s) has left the area. If the PSVO sees a marine mammal that surfaces then dives below the surface, the 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 period (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), the Holder of this Authorization 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 6(h) below).

(g). Establish a 180 dB re 1 μPa (rms) and a 190 dB re 1 μPa (rms) EZ for marine mammals before the 10-airgun array (1,830 in^3) is in operation; and a 180 dB re 1 μPa (rms) and a 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 6(f) (above).

(i). Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant 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).

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

(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). To ensure no unmitigable adverse impact on subsistence uses of marine mammals, the Holder of this Authorization shall:

(i). Have at least one Native Alaskan North Slope resident aboard the *Langseth* to act as a liaison with hunters if they are encountered at sea.

(ii). Suspend airgun operations if subsistence hunting is actively occurring within 5 km (3.1 mi) of the *Langseth*'s trackline. Airgun operations will remain suspended until the *Langseth* is greater than 5 km (3.1 mi) away from the subsistence hunting vessel.

(iii). Monitor radio frequencies and signals in order to be aware of active subsistence whaling and sealing activities being conducted in the North Slope communities.

(iv). Operate in accordance with the Plan of Cooperation developed by UAGI and Lamont-Doherty Earth Observatory in cooperation with the North Slope villages and affected marine mammal commissions.

7. Reporting Requirements: The Holder of this Authorization is required to:

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

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

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

(iii). An estimate of the number (by species) of marine mammals that: (A) are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 μPa (rms) and/or 180 dB re 1 μPa (rms) 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 10-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, 1315 East West Highway, Silver Spring, Maryland, 20910, 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.

8. (a). In the unanticipated event that the survey operations 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), UAGI shall immediately cease the survey operations 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 Candace.Nachman@noaa.gov and the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barbara.Mahoney@noaa.gov). The report must include the following information: (i) time, date, and location (latitude/longitude) of the incident; (ii) the name and type of vessel involved; (iii) the vessel's speed during and leading up to the incident; (iv) description of the incident; (v) status of all sound source use in the 24 hours preceding the incident; (vi) water depth; (vii) environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility); (viii) description of marine mammal observations in the 24 hours preceding the incident; (ix) species identification or description of the animal(s) involved; (x) the fate of the animal(s); (xi) 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 UAGI to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. UAGI may not resume their activities until notified by NMFS via letter, email, or telephone.

(b). In the event that UAGI 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), UAGI 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/or by email to Michael.Payne@noaa.gov and Candace.Nachman@noaa.gov 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 Condition 8(a) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with UAGI to determine whether modifications in the activities are appropriate.

(c). In the event that UAGI 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), UAGI shall 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 Candace.Nachman@noaa.gov 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. UAGI shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

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

10. 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.

11. Penalties and Permit Sanctions

Any person who violates any provision of this Incidental Harassment Authorization is subject to civil and criminal penalties, permit sanctions, and forfeiture as authorized under the MMPA.

AUG 2 6 2011

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

Date

Attachments

Attachments

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	6	Shallow (<100)	150	296	1,050
		Intermediate (100 to 1,000)	18	60	578
		Deep (>1,000)	12	40	385
1 string 10 airguns 1,830 in^3	6	Shallow (<200)	190	1,870	14,730
		Intermediate (200 to 1,000)	130	1,400	13,980
		Deep (>1,000)	130	425	14,070

Table 2. Authorized Take Numbers for Each Marine Mammal Species in the Arctic Ocean.

Species	Authorized Take in the Arctic Ocean Study Area
Mysticetes	
Bowhead whale (*Balaena mysticetus*)	89
Gray whale (*Eschrichtius robustus*)	71
Humpback whale (*Megaptera novaeangliae*)	2
Minke whale (*Balaenoptera acutorostrata*)	2
Fin whale (*Balaenoptera borealis*)	2
Odontocetes	
Beluga whale (*Delphinapterus leucas*)	794
Killer whale (*Orcinus orca*)	2
Pinnipeds	
Bearded seal (*Erignathus barbatus*)	677
Spotted seal (*Phoca largha*)	150
Ringed seal (*Phoca hispida*)	7,492
Ribbon seal (*Histriophoca fasciata*)	42

APPENDIX B:
Basic Summary Data Form

BASIC DATA FORM				
LDEO Project Number		MGL1112		
Seismic Contractor		Lamont-Doherty Earth Observatory of Columbia University		
Client		University of Alaska Geophysics Institute		
Area Surveyed During Reporting Period		Arctic Ocean		
		Approximately between 72° to 77°N and 160° to 175°W		
Survey Type		2D marine seismic		
Vessel and/or Rig Name		*R/V Marcus G. Langseth*		
Permit Number		IHA granted by NMFS on 26 August 2011		
Location / Distance of Airgun Deployment		83.3m or 103.3m aft of MMO tower		
Water Depth	**Min**	30m		
	Max	3800m		
Dates of project		8 September 2011	THROUGH	9 October 2011
Total time airguns operating – all power levels:		531 hours 50 minute		
Time airguns operating at full power on survey lines:		500 hours 44 minutes		
Time airguns operating at full/partial power on line changes:		28 hours 31 minutes		
Amount of time mitigation gun (40 in³) operations:		1 hour 18 minutes		
Amount of time in ramp up:		1 hour 10 minutes		
Number daytime ramp ups:		3		
Number of night time ramp ups:		0		
Number of ramp ups from mitigation source:		2		
Amount of time conducted in airgun testing:		7 minutes		
Duration of visual observations:		406 hours 55 minutes		
Duration of observations while airguns firing:		298 hours 41 minutes		
Duration of observation during airgun silence:		108 hours 14 minutes		
Duration of acoustic monitoring:		526 hours 20 minutes		
Duration of acoustic monitoring while airguns firing:		525 hours 34 minutes		
Duration of acoustic monitoring during airgun silence:		46 minutes		
Duration of simultaneous acoustic and visual monitoring:		294 hours 38 minutes		
Lead Protected Species Observer:		Heidi Ingram		
Protected Species Observers:		Dara Cameron		
		Amanda Harrison		
		Meghan Piercy		
Acoustic Observer:		Emily Ellis		
Native Alaskan North Slope Observer:		Reynold Aveoganna		
Number of Marine Mammals Visually Detected:		42		
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		
List Mitigation Actions (eg. power downs, shutdowns, ramp up delays)		5 power downs		
Duration of operational downtime due to mitigation:		1 hour 32 minutes		

APPENDIX C:

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 *R/V Marcus G. Langseth*

The hydrophone deployment procedure is a draft 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.1). 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.

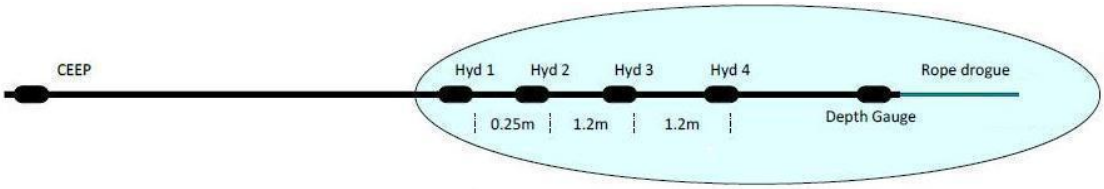

Figure D.17: Diagram of Linear Hydrophone Array

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.2). 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.3). 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.4). 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.5). 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.6). 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.18: PAM Laptops and data processing unit setup

Figure D.19: Hydrophone cable on winch

Figure D.20: Hydrophone cable secured by a yale grip to the port sponson

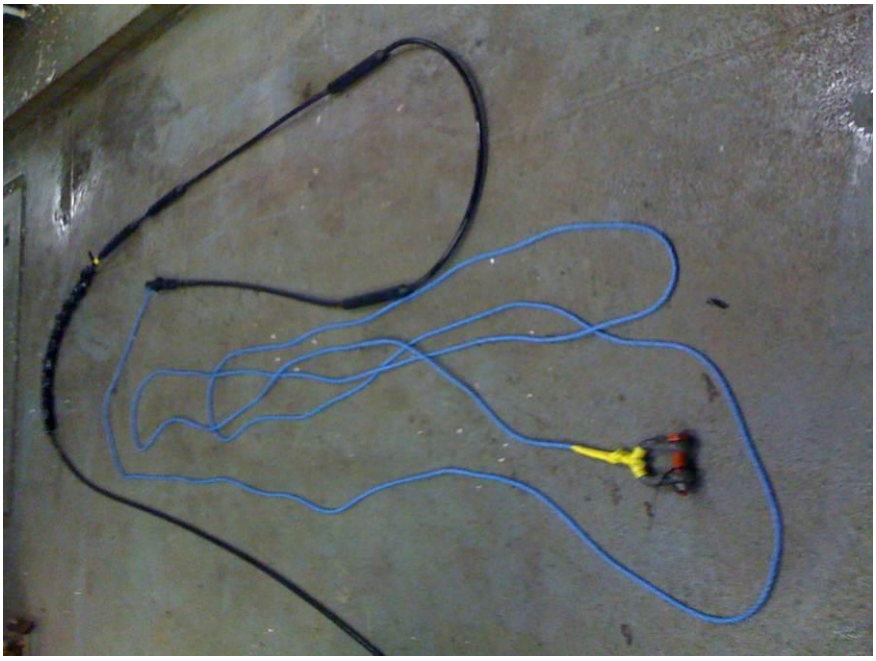

Figure D.21: Rope drogue and first chain weight secured near hydrophone elements.

Figure D.22: 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 in figure 6) 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:

Detections of protected species during Coakley marine geophysical survey

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
1	8-Sep	21:00	Northern fur seal	3	54.40175°N 166.44397°W	Not firing	MI	MI	150m Not firing	None	Observed while in transit to survey site.
2	8-Sep	21:17	Unid. pinniped	1	54.42392°N 166.42380°W	Not firing	UN	ST SA	400m Not firing	None	Observed while in transit to survey site.
3	8-Sep	22:41	Northern fur seal	2	54.55855°N 166.32147°W	Not firing	PV/OD	FT SA	200m Not firing	None	Observed while in transit to survey site.
4	8-Sep	22:45	Unid. large whale	2	54.57733°N 166.30755°W	Not firing	PE/AH	SB NS	600m Not firing	None	Observed while in transit to survey site.
5	8-Sep	23:14	Northern fur seal	2	54.60910°N 166.28358°W	Not firing	PV/OD	FT	250m Not firing	None	Observed while in transit to survey site.
6	8-Sep	23:30	Unid. large whale	1	54.62325°N 166.27407°W	Not firing	UN	SB	600m Not firing	None	Observed while in transit to survey site.
7	9-Sep	02:08	Unid. pinniped	1	54.84542°N 166.08643°W	Not firing	UN	SA ST	230m Not firing	None	Observed while in transit to survey site.
8	9-Sep	17:42	Unid. pinniped	1	56.41338°N 165.54868°W	Not firing	UN	SA	100m Not firing	None	Observed while in transit to survey site.
9	9-Sep	19:35	Unid. pinniped	2	56.68985°N 165.75340°W	Not firing	UN	SA	200m Not firing	None	Observed while in transit to survey site.
10	9-Sep	20:36	Unid. pinniped	1	56.85917°N 165.87538°W	Not firing	UN	SA	300m Not firing	None	Observed while in transit to survey site.
11	9-Sep	20:42	Northern fur seal	2	56.88277°N 165.89472°W	Not firing	ST	BA	150m Not firing	None	Observed while 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-Sep	21:58	Unid. large whale	1	57.11032°N 166.06342°W	Not firing	UN	SB	1500m Not firing	None	Observed while in transit to survey site.
13	9-Sep	23:52	Humpback whale	2	57.46143°N 166.32160°W	Not firing	MI	FF DF	300m Not firing	None	Observed while in transit to survey site. One blow observed on FLIR camera.
14	11-Sep	21:09	Killer whale	5	66.15653°N 168.24960°W	Not firing	PV/SD	NS AV	200m Not firing	None	Observed while in transit to survey site.
15	13-Sep	23:30	Spotted seal	1	72.00883°N 165.68317°W	Firing full power	AV	NS	160m Full power	Power down	Seal exposed to 190 dB received sound. Observed leading safety radius after one minute.
16	13-Sep	23:46	Spotted seal	1	72.03243°N 165.66400°W	Firing full power	PV/OD	NS DI	400m Full power	None	Seal exposed to 160 dB received sound.
17	13-Sep	23:59	Spotted seal	1	72.05248°N 165.64787°W	Firing full power	PV/SD	NS DI	405m Full power	None	Seal exposed to 160 dB received sound.
18	14-Sep	00:21	Unid. pinniped	1	72.07970°N 165.62578°W	Firing full power	PV/ OD	NS	1535m Full power	None	Unidentified Phocid exposed to 160 dB received sound.
19	14-Sep	00:45	Bearded seal	1	72.11350°N 165.59817°W	Firing full power	ST	R NS AV	155m Full power	Power down	Seal exposed to 190 dB received sound. Observed leaving safety radius after two minutes.
20	14-Sep	01:43	Unid. pinniped	1	72.19805°N 165.52885°W	Firing full power	UN	NS DI	730m Full power	None	Seal exposed to 160 dB received sound.
21	14-Sep	02:00	Bearded seal	1	72.22570°N 165.50602°W	Firing full power	ST	BA	790m Full power	None	Seal exposed to 160 dB received sound.
22	14-Sep	02:33	Bearded seal	1	72.27045°N 165.46898°W	Firing full power	ST	DI AV	943m Full power	None	Seal exposed to 160 dB received sound.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
23	14-Sep	03:41	Bearded seal	1	72.37173°N 165.38413°W	Firing full power	AV	FT DI	155m Full power	Power down	Seal exposed to 190 dB received sound. Last seen inside safety radius, waited 15 min. before resuming operations.
24	14-Sep	04:00	Bearded seal	2	72.40097°N 72.40097°N	Firing full power	PV/OD	BA FT	1089m Full power	None	Seal exposed to 160 dB received sound.
25	14-Sep	04:40	Pacific walrus	1	72.47493°N 165.29678°W	Firing full power	PE/AH	NS	500m Full power	None	Walrus exposed to 160 dB received sound.
26	14-Sep	05:21	Bearded seal	1	72.52540°N 165.25353°W	Firing full power	AV	NS	300m Full power	None	Seal exposed to 160 dB received sound.
27	14-Sep	06:15	Pacific walrus	1	72.59523°N 165.19360°W	Firing full power	MI	R NS AV	1000m Full power	None	Walrus exposed to 160 dB received sound.
28	17-Sep	17:48	Pacific walrus	2	73.28717°N 162.43527°W	Firing full power	MI	DI NS	350m Full power	None	Walruses exposed to 160 dB received sound.
29	18-Sep	23:23	Ringed seal	1	75.44312°N 167.08505°W	Firing full power	PV/SD	PO AV	180m Full power	None	Seal exposed to 160 dB of received sound.
30	22-Sep	19:49	Ringed seal	1	76.74380°N 165.26563°W	Firing full power	PV/SD	NS	190m Full power	None	Seal exposed to 160 dB of received sound.
31	22-Sep	20:22	Ringed seal	1	76.78153°N 165.40962°W	Firing full power	AV	NS DI	75m Mitigation	Power down	Seal last seen inside safety radius at 20:24 UTC. Ramp up required to resume operations.
32	23-Sep	00:10	Ringed seal	1	76.94927°N 165.46590°W	Firing full power	AV	FT DI	190m Full power	None	Seal exposed to 160 dB of received sound.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
33	25-Sep	17:59	Unid. pinniped	1	76.41627°N 162.68020°W	Firing full power	AV	NS DI	300m Full power	None	Seal exposed to 160 dB of received sound.
34	26-Sep	00:25	Unid. pinniped	1	76.05100°N 161.63617°W	Firing full power	AV	NS	224m Full power	None	Airguns firing full power during line change. Seal exposed to 160 dB of received sound.
35	26-Sep	00:47	Pacific Walrus	5	76.02570°N 161.77448°W	Firing full power	ST	ST	1535m Full power	None	Walruses hauled out on ice.
36	30-Sep	19:14	Ringed seal	1	73.97260°N 163.86635°W	Firing full power	AV	NS DI	230m Full power	None	Seal exposed to 160 dB of received sound.
37	3-Oct	03:05	Dead mammal	1	73.29735°N 164.45237°W	Firing full power	n/a	n/a	300m Full power	None	Deceased animal (likely a seal) observed passing along port side of vessel. Clear signs of decay and possible predation.
38	3-Oct	04:30	Unid. pinniped	1	73.20833°N 164.99258°W	Firing full power	AV	FT DI	180m Mitigation firing	Power down	Seal last seen inside safety radius at 04:31 UTC. Ramp up required to resume operations.
39	5-Oct	22:37	Pacific walrus	2	69.33948°N 167.62983°W	Not firing	AV	NS DI	150m Not firing	None	Observed while in transit. No gear deployed.
40	6-Oct	02:46	Pacific walrus	3	68.60357°N 167.78182°W	Not firing	MI	NS MI	200m Not firing	None	Observed while in transit. No gear deployed.
41	7-Oct	04:25	Unid. cetacean	1	64.21035°N 168.40312°W	Not firing	PV/SD	DI	125m Not firing	None	Observed while in transit, possibly a Stejneger's beaked whale.
42	8-Oct	20:24	Unid. pinniped	1	57.03450°N 167.41740°W	Not firing	UN	DI	150m Not firing	None	Observed while in transit. No gear deployed.
43	9-Oct	00:14	Common minke whale	1	56.38348°N 56.38348°N	Not firing	PV/OD	NS DI	140m Not firing	None	Observed while in transit. No gear deployed.

*Note that in the report sometimes Detection number 37, the dead mammal, was not counted.

APPENDIX F: 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*	1153	26
Sooty Shearwater	Procellariidae	*Puffinus*	*griseus*	2	1
Short-tailed Shearwater	Procellariidae	*Puffinus*	*tenuirostris*	4470	17
Tufted Puffin	Alcidae	*Fratercula*	*cirrhata*	110	6
Horned Puffin	Alcidae	*Fratercula*	*corniculata*	27	5
Common Murre	Alcidae	*Uria*	*aalge*	358	12
Thick-billed Murre	Alcidae	*Uria*	*lomvia*	12	3
Least Auklet	Alcidae	*Aethia*	*pusilla*	164	5
Cassin's Auklet	Alcidae	*Ptychoramphus*	*aleuticus*	21	2
Parakeet Auklet	Alcidae	*Aethia*	*psittacula*	36	4
Crested Auklet	Alcidae	*Aethia*	*cristatella*	224	10
Black Guillemot	Alcidae	*Cepphus*	*grylle*	35	6
Pelagic Cormorant	Phalacrocoracidae	*Phalacrocorax*	*pelagicus*	53	5
Fork-tailed Storm Petrel	Hydrobatidae	*Oceanodroma*	*furcata*	12	3
Black-legged Kittiwake	Laridae	*Larus*	*tridactyla*	527	21
Glaucous-winged Gull	Laridae	*Larus*	*glaucescens*	31	3
Glaucous Gull	Laridae	*Larus*	*hyperboreus*	133	17
Sabine's Gull	Laridae	*Xema*	*sabini*	3	2
Ross's Gull	Laridae	*Rhodostethia*	*rosea*	171	13
Long-tailed Jaeger	Stercorariidae	*Stercorarius*	*longicaudus*	2	2
Pomarine Jaeger	Stercorariidae	*Stercorarius*	*pomarinus*	12	2
Red-necked Phalarope	Scolopacidae	*Phalaropus*	*lobatus*	53	4
Harlequin Duck	Anatidae	*Histrionicus*	*histrionicus*	1	1
Long-tailed Duck	Anatidae	*Clangula*	*hyemalis*	44	3
Common Eider	Anatidae	*Somateria*	*mollissima*	26	6
Greater Scaup	Anatidae	*Aythya*	*marila*	2	2
White-winged Scoter	Anatidae	*Melanitta*	*fusca*	213	2
Spectacled Eider	Anatidae	*Somateria*	*fischeri*	5	1
Peregrine Falcon	Falconidae	*Falco*	*peregrinus*	1	1
Pacific Loon	Gaviidae	*Gavia*	*pacifica*	5	3
Snow Bunting	Thraupidae	*Plectrophenax*	*nivalis*	2	1
Unidentified Cormorant	Phalacrocoracidae	*Phalacrocorax*		1	1
Unidentified Eider	Anatidae			2	1
Unidentified Duck	Anatidae			3	1
Unidentified Alcid	Alcidae			70	3