Protected Species Mitigation and Monitoring Report

United States Extended Continental Shelf Survey

Gulf of Alaska, Kodiak Island

06 June 2011- 26 June 2011

R/V Marcus G. Langseth

Prepared for

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And

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Project No.	**UME 04075**	**RPS**	
Cruise ID No.	**MGL1109**	**411 N. Sam Houston Parkway E.**	
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ACRONYMNS AND ABBREVIATIONS

ACC	Alaska Coastal Current
ADCP	Acoustic Doppler Current Profiler
BO	Biological Opinion
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
CPA	Closest Point of Approach
dB	decibel
EA	Environmental Assessment
ECS	Extended Continental Shelf
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ESA	(U.S.) Endangered Species Act
FWS	U.S. Fish and Wildlife Service
FFT	Fourier Transform Filter
GOA	Gulf of Alaska
GPS	Global Positioning System
HF	High Frequency
hp	horsepower
Hz	Hertz
IHA	Incidental Harassment Authorization (under U.S. MMPA)
in	inch
ITS	Incidental Take Statement
kHz	kilohertz
L-DEO	Lamont-Doherty Earth Observatory of Columbia University
Langseth	R/V *Marcus G. Langseth*
MBES	Multibeam echosounder
MCS	Multi-channel seismic
MMPA	(U.S.) Marine Mammal Protection Act
ms	millisecond
M/V	Marine Vessel
NEPA	(U.S.) National Environmental Policy Act
NMFS	(U.S.) National Marine Fisheries Service
NOAA	(U.S.) National Oceanic and Atmospheric Administration
NRC	(U.S.) National Research Council
NSF	(U.S.) National Science Foundation
NVD	Night Vision Device
OBS	Ocean-bottom seismometer
PAM	Passive Acoustic Monitoring
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
RL	Received Level
R/V	Research Vessel
SBP	Sub-Bottom Profiler
SEL	Sound Exposure Level (a measure of acoustic energy)
SL	Source Level
SPL	sound pressure level
TTS	Temporary Threshold Shift
U.S.	United States of America
USGS	United States Geological Survey

1. EXECUTIVE SUMMARY

The National Science Foundation (NSF) owned research vessel (R/V), *Marcus G. Langseth* (*Langseth*), operated by Lamont-Doherty Earth Observatory (L-DEO), a part of Columbia University, was contracted to conduct the United States Geological Survey (USGS) Extended Continental Shelf (ECS) two-dimensional (2D) marine seismic program in the south-west portion of the Gulf of Alaska (GOA). The survey was conducted to delineate the United States (U.S.) ECS. The *Langseth*, acting as the source acquisition vessel, conducted the survey from 6 June through 25 June 2011 arriving back in the port of Kodiak, Alaska on 26 June 2011.

The USGS submitted an application to the National Marine Fisheries Service (NMFS) for a permit to harass marine mammals that are incidental to the marine geophysical survey. An Incidental Harassment Authorization (IHA) was granted with several mitigation measures to limit harassment of marine mammals, sea turtles and short-tailed albatross (Appendix A). Mitigation measures were implemented to minimize potential impacts to marine mammals, sea turtles and protected seabirds through the acquisition 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, the establishment of safety radii and the implementation of ramp-up, power-down and shut-down procedures.

RPS was contracted by L-DEO and USGS to provide continuous protected species observation coverage and to fulfill the environmental regulatory requirements and reporting mandated by NMFS in the IHA. Four PSOs and one dedicated PAM Operator were present on board the *Langseth* throughout the survey in this capacity.

PSOs undertook a combination of visual and acoustic watches, accumulating a total of 356 hours and 44 minutes of visual observations and 392 hours and 54 minutes of acoustic monitoring over the course of the survey project.

This visual and acoustic monitoring effort produced a project total of 50 protected species detection records all of marine mammals: 44 cetacean records and six records for pinniped species. Of the 44 cetacean records collected, 33 consisted of mysticetes and the remaining 11 records were collected for odontocete species (nine porpoise detection events and two detections of large odontocetes, both pods of sperm whales). All detections were made visually. There were no acoustic detections made from acoustically monitoring the PAM system. There were no sightings of sea turtles during the survey project.

These detections of protected species resulted in a total of 21 mitigation actions being implemented: 15 power-downs, five shut-downs and one delayed ramp-up of the acoustic source. Mitigation measures were to be applied to sightings of short-tailed albatross flocks of more than nine birds; however, there were no sightings of flocks of this size during the survey. A summary of the detections and monitoring effort can be found in Appendix B. A known 165 cetaceans and four pinnipeds were exposed to received sound levels equal to or greater than 160dB of sound from the acoustic source, constituting a Level B harassment take as defined by NMFS. Cetacean Level B harassment takes included 41 fin whale takes, 26 sperm whale takes and 98 Dall's porpoise takes.

The USGS GOA ECS 2D marine seismic survey program was conducted as mandated by the IHA, and was achieved through excellent communication and co-operation between the PSOs and *Langseth*'s science technicians.

2. INTRODUCTION

The following report details protected species monitoring and mitigation and seismic survey operations undertaken as part of the USGS GOA ECS two-dimensional marine seismic survey on board the *Langseth* from 6 June to 26 June of 2011 inside the economic exclusive zone (EEZ) of Alaska in the Gulf of Alaska (GOA).

This document serves to meet the reporting requirements dictated in the IHA issued to Dr. Jonathan Childs on behalf of the USGS by NMFS on 3 June 2011. The IHA (Appendix A) 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 160dB could potentially disturb marine mammals, temporarily disrupting behaviour, 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, behaviour 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 impacts.

An Incidental Take Statement (ITS) and Biological Opinion (BO) were also issued in conjunction with the IHA where NMFS anticipates that the USGS GOA ECS seismic survey will also take sea turtles in the form of harassment as a result of exposure to acoustic energy. To minimize incidental sea turtle takes by harassment, the NMFS mandated that mitigation measures also be applied to sea turtles observed within the 180dB isopleths.

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

2.1. SURVEY PROGRAM OVERVIEW AND LOCATION

The USGS GOA ECS survey program took place in the Gulf of Alaska inside the U.S. EEZ off the east coast of Kodiak Island (Figure 1). The closest approach (CPA) of the vessel to the coast during acquisition of the survey was approximately 650 kilometers. Water depths in the prospect area ranged between 2000 meters to over 6000 meters. The vessel departed the port of Kodiak on 6 June 2011 and returned to Kodiak on 26 June 2011.

The survey plan included 15 survey lines of the multi-channel survey (MCS) and two Ocean-bottom seismometer (OBSs) refraction lines, which were acquired with the assistance of the support marine vessel (M/V) *Norseman II*, the vessel contracted to deploy and retrieve the OBSs. Acquisition began on 7 June 2011 and continued until 25 June 2011. All of the planned transect lines were completed ahead of schedule allowing the *Langseth* to acquire an additional two contingency survey lines. The *Langseth* acquired a total of 3154.65 kilometres of survey lines over the course of the USGS GOA ECS marine seismic survey program. Approximately 140 kilometres of line changes were planned for and executed throughout the acquisition of the survey. Upon completion of the survey, the seismic equipment was retrieved while the vessel returned to the Kodiak port.

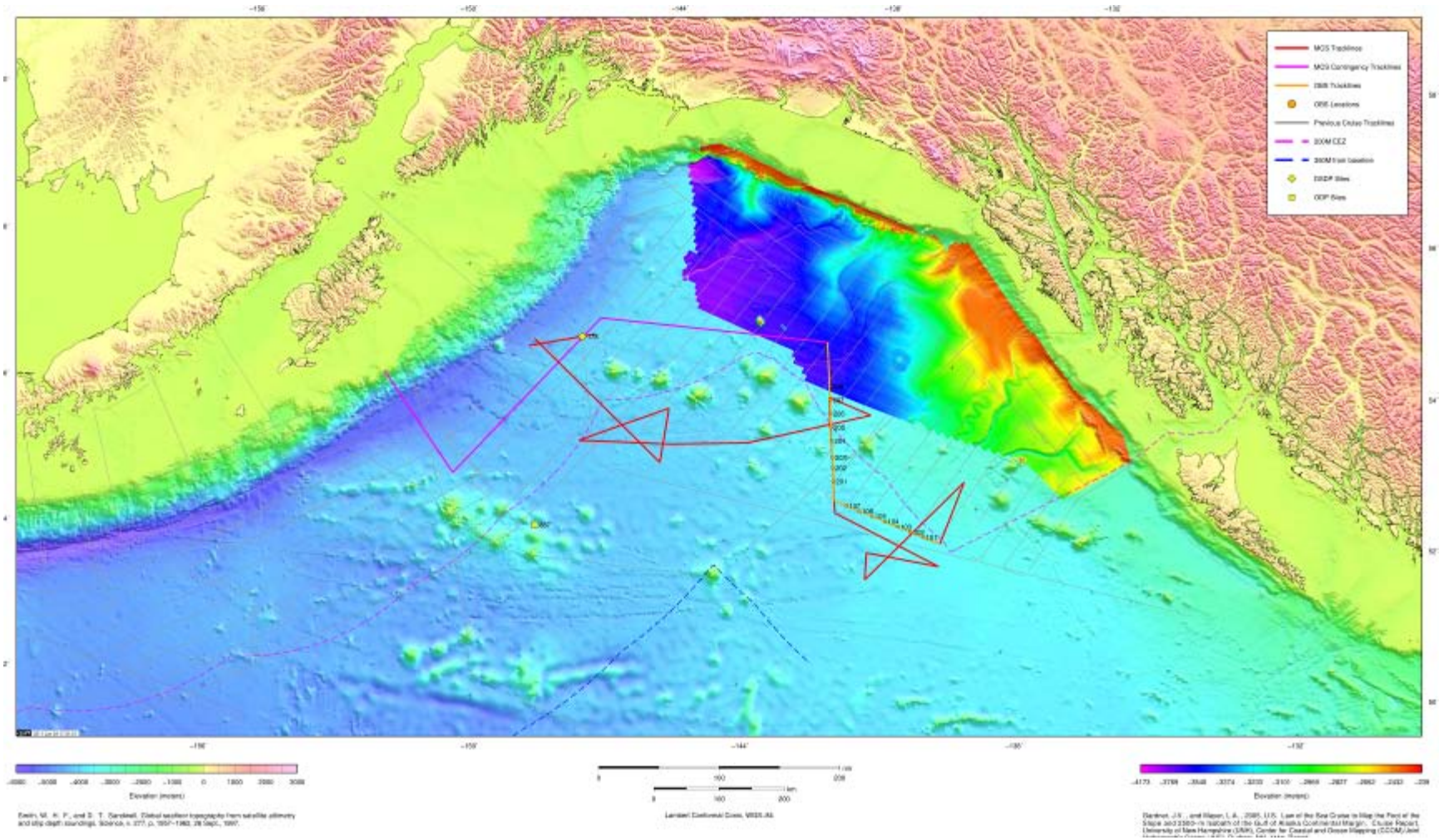

Figure 1: Location of the USGS ECS survey in the Gulf of Alaska south-east of Kodiak Island.

2.1.1. Visual Observer Personnel and Equipment

Five NMFS-approved and Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) certified Protected Species Observers (PSOs) with between one to six years of PSO field experience were deployed on board the *Langseth* for the duration of the survey. Visual observation watches were established to fulfill the requirements specified by the IHA. Visual monitoring was primarily carried out from an observation tower located 19 meters above the water surface (Figure 2) which afforded the PSOs a 360 degree viewpoint around the acoustic source.

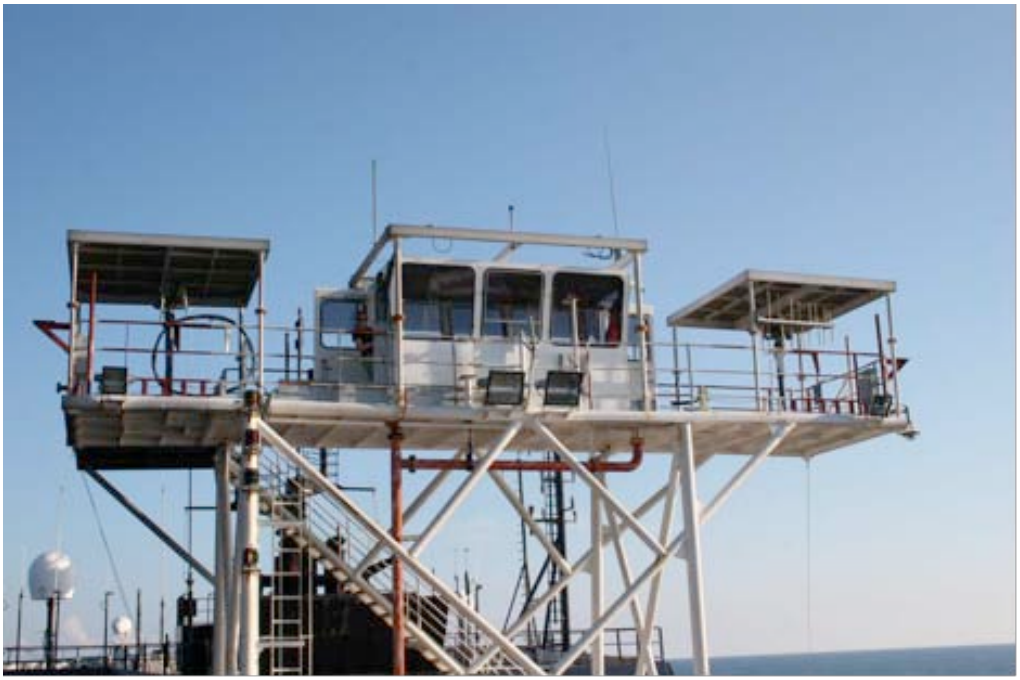

Figure 2: Protected Species Observer observation tower with mounted big-eye binoculars.

The tower was equipped with two big-eye binoculars (12 X 150), one located on the port side and the other on the starboard side. A tent in the center of the tower was set-up to facilitate data collection and communication. A monitor displayed the vessel position, water depth, vessel speed and heading, source activity, wind speed and direction and provided camera views of the stern of the vessel. A telephone was provided in addition to a UHF radio in order to allow communication between the PSOs in the tower to the PAM station or the science lab. Observations were also carried out from the bridge, catwalk or back decks for safety reasons or during periods when weather conditions were poor or severe. Fujinon 7X50 binoculars were available for daytime observations and night-vision devices, ITT Industries Night Quest NQ2200 Night Vision Viewers, were available to be utilized during night-time observations which were conducted during night-time ramp-ups of the acoustic source.

2.1.2. Passive Acoustic Monitoring Personnel and Equipment

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.

A trained and experienced PAM operator, was present throughout the cruise to oversee and conduct the PAM operations. 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. All PSOs completed a PAM training provided by the PAM Operator onboard in the initial days of the hydrophone deployment during which basic PAM system operation was covered.

The PAM system was tested and installed by the RPS Acoustic Program Manager and Langseth crew members in the San Diego Nimitz Marine Facility on 2 March 2011. Acoustic monitoring was carried out using a system developed by Seiche Measurements Ltd (PAM system specifications can be found in Appendix C). The system was comprised of 250 meters of hydrophone cable deployed from a deckhead winch at the port stern of the gun deck connected via 100 meters of deck cable to electronic processing modules located in the main science lab.

The hydrophone cable consists of a five meter linear array of four hydrophones (three broadband and one low frequency) pre-amplifiers and a depth gauge. Three hydrophones (hydrophone number one, two and three) were broadband elements, sampling mid-range frequencies of 2kHz to 200kHz. Hydrophone number four was a lower frequency hydrophone with a range of 75 Hz to 30 kHz. One spare tow array, also 250 meters with the same hydrophone configuration, and a spare 100 meters deck cable were also supplied and available onboard during the cruise.

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. 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 and visually via the screen displays. 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 kHz, then processed and displayed on a laptop computer using the program, *Pamguard version 1.9.01*. *Pamguard* is an open-source software developed with industry funding to acoustically detect, localize, and identify vocalizing species in support of mitigation (www.pamguard.org). The amplitude of clicks detected at the front hydrophone was measured at 5th order Butterworth band-pass filters ranging from 35 kHz to 120 kHz with a high pass digital pre-filter set at 35kHz (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, allowing 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 4 kHz and 24 kHz. 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 kHz per channel. The LF hydrophone signal was further processed within *Pamguard* 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 bearing to whistles and moans were configured. The bearings and distance to detected whistles and moans were calculated using the Time-of-Arrival-Distance (TOAD) method (the signal time delay between the arrival of a signal on each hydrophone was 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. Typical screenshots from the HF and LF laptop *Pamguard* program during USGS GOA ECS survey the can be found in Appendix D.

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 E.

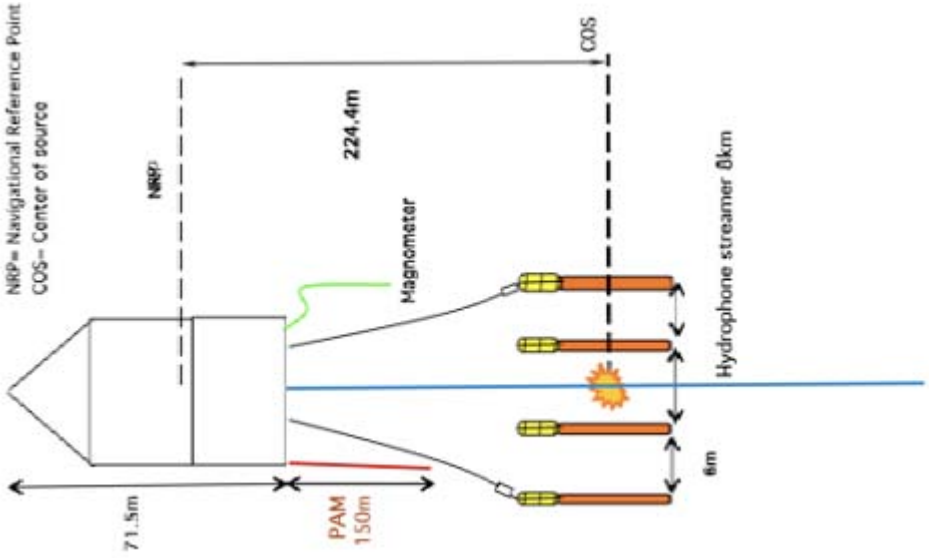

Figure 3: Location of the hydrophone deployment.

3. MITIGATION AND MONITORING METHODS

The PSO monitoring system based on the *Langseth* was established to meet the IHA requirements that were issued to the USGS by NMFS including both monitoring and mitigation objectives. Additional mitigation measures were implemented voluntarily by USGS after consultation with Alaska Department of Fish & Wildlife Service. The survey mitigation program was produced to minimize potential impacts of the *Langseth*'s seismic program on marine turtles, marine mammals, and other protected species of interest and is outlined in detail in Section 3.3 of this report and in the IHA found in Appendix A. 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 behaviour 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 behaviours those individuals exhibited; and (B) may have been exposed (based on modelling 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

Visual monitoring methods were implemented in accordance with the survey requirements outlined in the IHA. Two NMFS-approved PSOs conducted observations throughout all daytime operations of the acoustic source including while the single 40 in^3 gun was active and all ramp-ups of the acoustic source including those conducted at night. 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 entire safety radius was visible, and continued past sunset until the safety radius became obscured, from approximately 04:10 until 23:20 local time, a minimum of 19 hours every day.

A visual monitoring schedule was established by the lead PSO where each PSO completed visual observations watches varying in length from one hour to four hours, two to four times a day for a total of seven to nine hours of visual monitoring watches per day. This schedule was arranged such that two PSOs were on visual observation duty at all times except during meal breaks when up to 45 minutes only one PSO would stand watch so that the entire team could eat while maintaining both visual and acoustic monitoring.

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

Upon the visual detection of a protected species, PSOs concentrated first on initiating any necessary mitigation action, identifying the animal's range to the acoustic source, the activity of the acoustic source (full power firing, single mitigation gun of 40 in^3 firing) and the type of animal present (cetacean, pinniped, sea turtle, short-tailed albatross) in order to determine which safety radius to apply. The science lab was informed of any necessary mitigation actions by telephone to the PAM Operator who would relay the message, the seismic technician's desk being located next to the PAM station, and record the necessary data. The PAM Operator was also notified of all marine mammal sightings as soon as possible in order to enable recordings so that the recordings could later be reviewed a second time in case a detection was overlooked.

Range estimations upon the initial sighting of a protected species, the closest point of approach (CPA) of animals to the acoustic source, and the distance to the animal(s) when last sighted were determined using the naked eye, assessed by use of reticule binoculars, or applied using the known towing distances of the source and streamer head float.

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 when possible during each sighting using a Canon EOS 60D with a 300 millimeter telephoto lens. Marine mammal and sea turtle identification manuals were consulted and photos were examined during visual watch breaks to confirm identifications.

During or immediately after each sighting event PSOs or PAM Operators 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 160dB and/or 180dB of sound from the source during the sighting event.

In addition, 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 changed, environmental conditions or vessel or seismic activity changes. Each sighting event was linked to an entry on the datasheet such that environmental conditions were available for each sighting event.

3.2. ACOUSTIC MONITORING SURVEY METHODOLOGY

Acoustic monitoring operators vigilantly analyzed the LF and HF laptops visually while listening to the hydrophone output through headphones connected to the Sennheiser transmitter unit. Monitoring shifts lasted one to six hours. During daylight hours acoustic operators were in communication with visual PSOs in the tower relaying sighting information. At the time of any visual sighting of a marine mammal, the acoustic operator was notified and sound recordings were made for further analysis by the dedicated PAM Operator.

Vessel position, water depth, heading and speed, vessel and airgun activity were recorded by the PAM Operator every hour using the vessel's instrumentation that was available in the main lab along with rating the background noise level on the Gannier scale (Gannier, 2002). The LF Spectrogram was monitored for delphinid whistles, sperm whale clicks, and baleen whale vocalizations while the Click Detectors on the HF and LF system were monitored for indications of echolocation clicks. The Spectrogram's amplitude range and appearance were adjusted as needed to suit the operator's preference in order to maximize the vocalizations appearance above the pictured background noise.

3.3. MITIGATION METHODS

The following mitigation measures were implemented during USGS marine seismic survey as mandated by the IHA granted by NMFS on 3 June 2011 and found in Appendix A.

3.3.1. Safety Radii

L-DEO conducted multiple acoustic calibration studies in the Gulf of Mexico in 2003 and again in 2007/2008 to obtain measurements of seismic sounds at varying distances from seismic source in order to verify safety radii estimated in past acoustical models. Although analysis continues, it was determined that the safety radii around airgun arrays vary with water depth (USGS GOA ECS Environmental Assessment, 2011) and while the original USGS ECS survey plan was configured for survey lines acquired only in deep water, over depths of 1000 meters, additional lines in intermediate water depths were acquired in the final days of the survey after which the original project survey lines had been completed.

Safety radii for the US Geological Survey 2D survey program were established using conservative distances and are outlined in Table 1 below.

Ramp-ups, also known as soft starts, of the acoustic source were conducted prior to the commencement of any seismic activity from silence or reduced power that lasted for a period greater than eight minutes. This was done by activation of the smallest airgun in the array (40 in^3) followed by airguns added in a sequence such that the source level of the array increased in steps not exceeding 6 dB per five-minute period over a total duration of approximately 30 minutes.

Table 1: Predicted distances that 160, 180 and 190 dB re 1μPa sound levels could be received and which will be used as safety radii for a 36 gun source and a single airgun (towed at a 9m depth) during the USGS GOA ECS 2D survey program

Source and Volume	Water Depth (m)	Predicted RMS Distances (m)		
		190 dB (Pinnipeds)	**180 dB** (Cetaceans)	**160 dB** (Level-B Harassment Zone)
Single Bolt Airgun (40 in^3)	Deep (>1,000m)	12	40	385
	Intermediate (100m-1000m)	18	60	578
4 Strings 36-Airgun source (6,600 in^3)	Deep (>1,000m)	400	940	3850
	Intermediate (100m-1000m)	450	1425	6667

PSOs monitored the safety radii throughout ramp-ups, including day and night, and if marine mammals or turtles were sighted inside the safety radii. A power-down or shut-down was implemented as though the full array were operational.
Night time ramp-ups were to be conducted only when a single airgun had been active during the period prior and PSOs conducted visual observations throughout the ramp-up using night vision devices.

Daytime ramp-ups could be conducted from airgun silence if PSOs had maintained continuous visual observation during the silent period prior to the ramp-up commencement or, if observations had not been continuous, a 30 minute pre-ramp-up survey of the safety radii was conducted. If no protected species were observed inside the exclusion zones then ramp-up could proceed. Ramp-up was delayed if a protected species was detected inside the larger safety radius and could proceed only when:

1. The animal was visually observed to have left the safety zone
2. The animal had not been seen within the zone for 15 minutes, in the case of small odontocetes, or 30 minutes, in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales
3. The vessel had moved outside the zone for marine turtles, which were treated as stationary objects

3.3.2. Power-down Procedures

A power-down was implemented by decreasing the number of active airguns to a single 40 in^3 airgun such that the size of the 180dB or 190dB safety radius (depending on marine mammal/turtle present) was decreased, placing marine mammals or turtles in the vicinity safely outside the exclusion zone. A single airgun was operated throughout a power-down rather than shutting down the source entirely in order to alert marine mammals of seismic activity or presence.

Power-down procedures were conducted for protected species detected inside the 180dB (cetaceans and marine turtles) and 190dB (pinnipeds) safety radii as well as for animals detected prior to imminently entering the safety radii. Seismic operations were resumed after a power-down only when the protected species had cleared the safety zone, as determined by:

1. The animal was visually observed leaving the safety zone
2. The animal had not been sighted inside the safety zone for 15 minutes in the case of small odontocetes or 30 minutes in the case of large mysticetes or large odontocetes
3. Satisfactory time had passed to allow the vessel to move past a stationary animal, such as a turtle, that it could be considered to be outside the safety radius.

If a power-down lasted longer than eight minutes then a ramp-up procedure was required to resume seismic operations.

3.3.3. Shut-down Procedures

The seismic source was shut-down if a marine mammal or sea turtle was observed inside or approaching the safety radius for the single 40 $inch^3$ airgun, either after a power-down had already been initiated or if the animal was initially detected within the safety radius of the single airgun.

Additionally, the IHA mandated that the positive identification of the following 'zero-take' marine mammals would result in an immediate shut-down of the seismic source regardless of the animal's distance to the source: North-Pacific right whale, sei whale, blue whale, and beluga whale.

Seismic operations were resumed following a shut-down under the same criteria outlined for resumption of operations following a power-down.

3.3.4. Additional Mitigation Procedures

USGS voluntarily implemented additional mitigation procedures above and beyond the requirements of the IHA based on consultations with the Alaska State Department of Fish and Wildlife. As the ESA-listed bird species, the short-tailed albatross, was known to inhabit the survey area, procedures were established should groups of these birds be encountered during survey acquisition. In the absence of scientific protocols for seismic mitigation for avian species, USGS designated the 190dB safety radii as power-down or shut-down zones for groups of more than nine short-tailed albatross sighted on the surface during acoustic source operation.

Additionally, while it was not anticipated that the vessel would encounter any Pacific walrus or sea otter due to the prospect being located far outside of their expected ranges, it was determined that the 190dB safety radii would also be applied as a mitigation procedure for the U.S. Fish and Wildlife Service who manages those species.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

The *Langseth* departed the port of Kodiak for the survey site at 00:10 UTC on 6 June 2011, and began deployment of the seismic equipment while underway to the first survey line. Deployment of the airguns was commenced on 8 June at 02:25 UTC at which time a single 40 in^3 airgun was enabled with the first shot fired at 03:27 UTC. Maintenance and testing of the seismic equipment continued until 12:02 UTC when production began with the acquisition of survey line MGL1109MCS01 (Table 2).

Acquisition of the MCS portion of the survey continued until 15:52 UTC on 19 June 2011 when *Langseth* began acquisition of the two OBS lines. The OBSs were deployed by the support vessel M/V *Norseman II* over the previous two days. The final OBS line MGL1109OBS02 was completed at 1:07 UTC on 21 June and the vessel returned to acquisition of MCS survey lines. The USGS GOA ECS was completed with the acquisition of the last contingency MCS survey line, MGL1109MCS15, with the last shot point occurring at 21:53 UTC on 25 June. The vessel returned pier-side in the port of Kodiak at 05:58 UTC on 26 June 2011.

Table 2: USGS GOA ECS multi-channel seismic and ocean-bottom seismometer survey lines acquired

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
MGL1109MCS01	8 June	15:28	9 June	05:48
MGL1109MCS02	9 June	09:40	10 June	20:30
MGL1109MCS03	11 June	01:22	11 June	07:10
MGL1109MCS04	11 June	12:02	12 June	05:14
MGL1109MCS05	12 June	08:28	14 June	16:43
MGL1109MCS06	14 June	19:25	15 June	03:59
MGL1109MCS07	15 June	05:03	16 June	01:57
MGL1109MCS08	16 June	02:09	16 June	15:01
MGL1109MCS09	17 June	08:49	17 June	22:00
MGL1109MCS10	17 June	22:24	18 June	02:31
MGL1109MCS11	18 June	02:38	18 June	02:46
MGL1109MCS11A	18 June	02:57	19 June	02:47
MGL1109MCS12	19 June	03:50	19 June	15:28
MGL1109OBS01	19 June	15:52	20 June	11:57
MGL1109OBS02	20 June	11:58	21 June	15:07
MGL1109MCS13	21 June	15:50	23 June	06:07
MGL1109MCS14	23 June	06:13	24 June	20:51

The acoustic source was active throughout the survey, with only brief periods of source silence, resulting in a total of 416 hours and 41 minutes including ramping-up of the airguns, full power acquisition both online and during line changes, gun testing, and operation of the single 40 in^3 mitigation airgun (Figure 4).

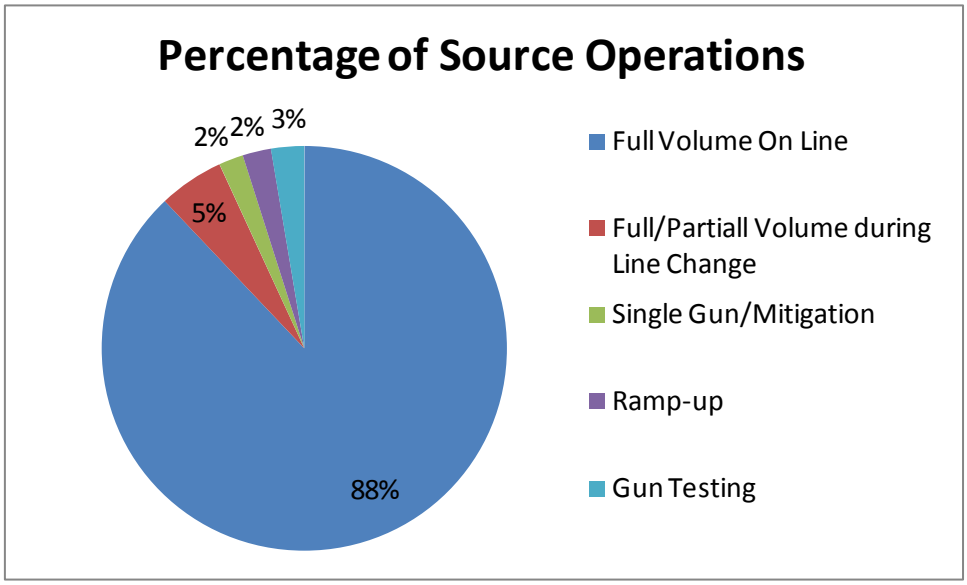

Figure 4: Source operations as a percentage of total acoustic source activity.

Full power source operations accounted for 93% of airgun activity during the project. Survey acquisition accounted for most full power seismic activity, totalling 366 hours and 26 minutes (88% of full source airgun activity). The vessel continued to fire the source at full power on most line changes resulting in an additional 21 hours and 37 minutes of full power source operations throughout the survey (less than 1% of full source airgun activity) (Table 3).

Table 3: Source operations during USGS GOA ECS marine seismic survey

Acoustic Source Operations	Number	Duration (hh:mm)
Gun Tests	**-**	**11:00**
Ramp-ups	**-**	**09:27**
Day time ramp-ups from silence	9	04:36
Day time ramp-ups from mitigation	10	04:51
Night time ramp-ups (from mitigation source)	0	00:00
Survey Acquisition	**17**	**366:26**
Full power/Partial power line changes	**-**	**21:37**
Single 40 in^3 airgun	**-**	**08:11**
Total time acoustic source was active		**416:41**

The airguns were ramped up 19 times over the course of the survey in order to commence full power survey operations in compliance with the IHA, accounting for 2% (9 hours and 27 minutes) of the project's total airgun activity (Figure 4). Each ramp-up was conducted over approximately 25 to 30 minutes, where the NMFS approved automated gun controller program DigiShot which added guns sequentially to achieve full source over the required period of time. In order to perform partial ramp-ups where multiple airguns were already active, an operator, beginning with the smaller guns and gradually increasing the volume, activated the remaining guns sequentially and manually. Ramp-ups were conducted during daylight hours only during the USGS GOA ECS survey project. No ramp-ups were conducted at night. Daytime ramp-ups could begin from airgun silence if a 30 minute pre-survey was conducted by PSOs on watch and five ramp-ups were conducted throughout the acquisition of the survey from airgun silence. The remaining 10 daytime ramp-ups were initiated with a mitigation source already active.

The single mitigation source (one gun 40 in^3) 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 08 hours and 11 minutes during the survey.

4.2. ENVIRONMENTAL CONDITIONS

The majority of visual monitoring effort was conducted during average to good observations conditions with the exception of brief and regular periods of reduced visibility and/or high Beaufort sea state (Beaufort level 5 or above) not lasting more than several hours at a time.

Visibility varied greatly over the survey project, ranging from 500 meters to nine kilometers, however most monitoring effort occurred while PSOs had visibility to five kilometers. Brief and regular periods of fog and rain obscured visibility such that on one occasion (17:14 UTC to 18:00 UTC on 17 June 2011) visibility decreased to the extent that the safety radii were not visible.

PSOs undertook visual observations during periods of rain on 17 of the 21 days during which visual monitoring was conducted, performing a total of 77 hours of monitoring effort during periods of rain, three hours of which occurred during heavy rain (Figure 5).

Fog impacted visibility during 11 days of visual observations for a total of 42 hours of monitoring fog. There were few periods of glare due to the consistent heavy cloud cover observed through-out the project. Glare was observed on 12 days for a total of 53 hours with only three of those days, totaling six hours, having moderate to severe glare.

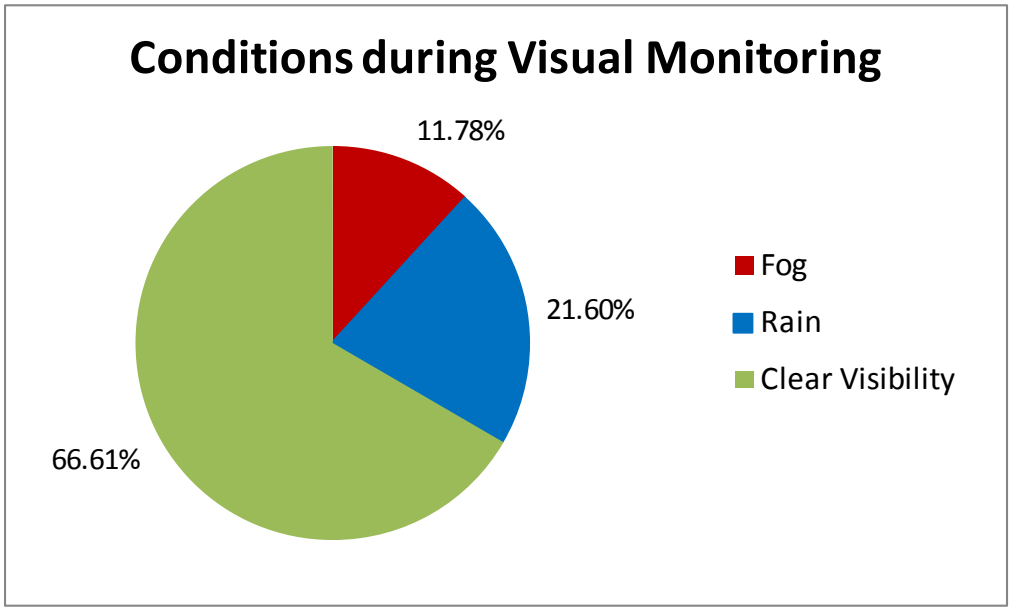

Figure 5: Visual monitoring effort conducted during observation conditions over the USGS GOA ECS survey.

The majority of visual monitoring effort was conducted at Beaufort sea state of 3, characterized as "large wavelets, crests begin to break, foam of glassy appearance. Perhaps scattered white horses" (Appendix F). Beaufort sea states recorded during visual monitoring effort varied from level 1 to a high of level 6 (Figure 6), although these extremes corresponded to short periods of visual observation effort. On only four days during which visual monitoring was conducted did the sea state increase to level 5 and above, levels at which PSOs ability to detect obscure species could have been hindered (7, 15, 16, 24 June 2011).

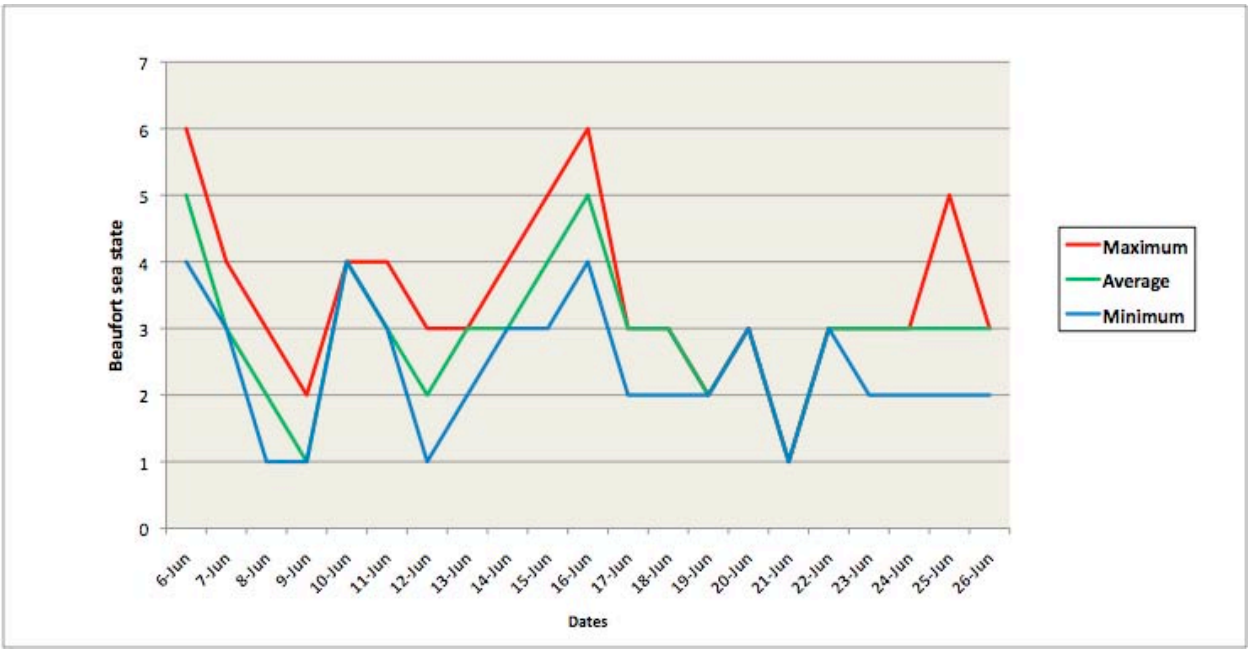

Figure 6: Beaufort sea state level each day visual monitoring observations were conducted during the USGS GOA ECS.

Wind force varied from no recorded wind speed (close to zero knots) to a high of 32 knots (16 June 2011). Wind force generally averaged between 10 and 20 knots with wind forces greater than 20 knots only recorded on three days during the project (7, 15, and 16 June 2011). These high wind forces corresponded to the highest Beaufort sea states recorded during the survey. Wind direction was highly variable throughout the survey.

As the wind force did not increase above 20 knots for more than several hours on most days, the swell also remained low, recorded as less than two meters every day with the exception of 6 and 7 June 2011, when swells reached a high level of 4 meters after sustained periods of high wind speeds.

Water clarity was low through-out the project due in part to the heavy cloud cover and rough seas.

4.3. MONITORING SUMMARY

Monitoring was conducted over a period of 20 days (7 June through 26 June UTC) within and adjacent to the USGS GOA ECS survey lines, with PSOs achieving a total of 749 hours and 38 minutes of visual and acoustic observations for protected species. Monitoring was conducted while the vessel engaged in any seismic operations, throughout the deployment and retrieval of seismic equipment, during periods of technical downtime, and while maintenance was performed on airguns or streamers. Of the total observation effort achieved by PSOs, visual monitoring accounted for 47.6% (356 hours and 44 minutes) while 52.4% (392 hours and 54 minutes) was acoustic monitoring effort. PSOs also conducted 302 hours and 45 minutes of simultaneous visual and acoustic observation completed during this survey (Figure 7).

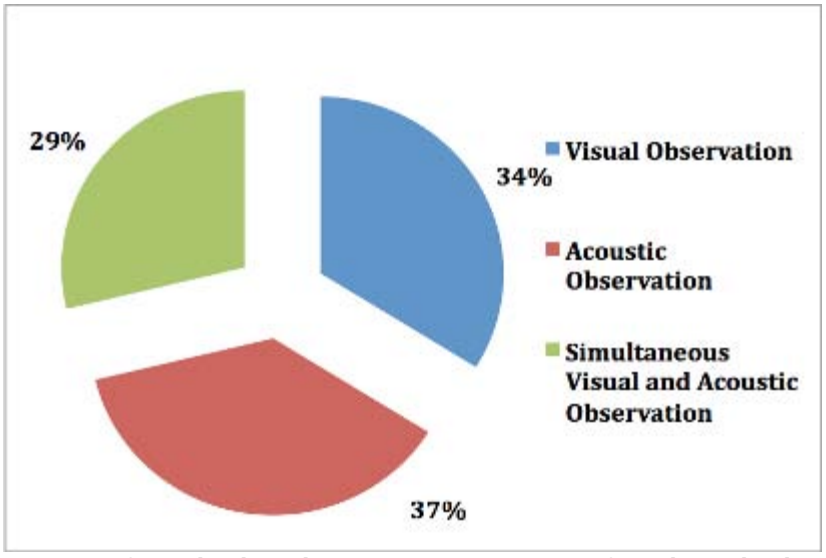

Figure 7: Type of monitoring shown as a percentage of total monitoring effort.

Airguns were active throughout the majority of visual and acoustic monitoring effort as once the survey acquisition began, the source was only disabled for protected species mitigation shut-down procedures and when mechanical complications arose requiring the survey to be suspended (Figure 8).

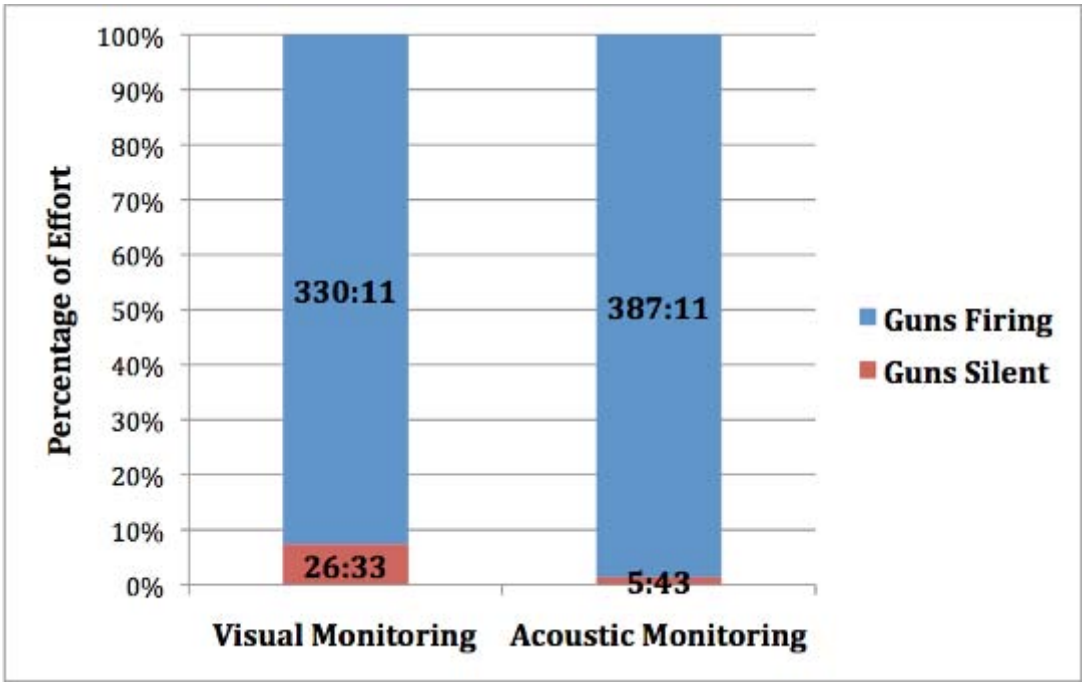

Figure 8: Duration of visual and acoustic monitoring effort while the acoustic source was active and silent shown as a percentage of total monitoring effort.

4.3.1. Visual Monitoring Survey Summary

Visual monitoring began on 7 June and continued until 26 June (UTC) when the vessel returned to port of Kodiak at the completion of the survey project. Monitoring was conducted by two PSOs every day between just before dawn until just after dusk (approximately 12:00 UTC to 22:30 to 23:00 UTC), when it became too dark for the entire safety radius to be visible, averaging approximately 19 hours of visual observations per day. As the vessel transited on survey lines from the southernmost end of the prospect to the northernmost survey sections, sunrise and sunset, and the corresponding start and end of visual observation times, varied by as much as 40 minutes.

On 7 June 2011 and 25 June 2011 prior to the start of survey acquisition and after the completion of the survey project, when the acoustic source was not active, a single PSO continued visual observations. Additionally, during lunch and dinner scheduled meal hours on the vessel, a single PSO continued visual monitoring in addition to acoustic monitoring conducted by the PAM operator on duty while each PSO rotated for a meal break. Single PSO visual observations during these periods lasted a maximum of 45 minutes and during sighting events requiring mitigation for protected species, a second PSO resumed visual observations in assistance.

Of the total 356 hours and 44 minutes of visual monitoring conducted, 92.6% (330 hours and 11 minutes) occurred while the guns were firing (Figure 8 above, Table 4).

Visual observations were preferentially conducted from the PSO tower, providing PSOs with a 360-degree view around the vessel and the acoustic source at an observation height of approximately 20 meters above the water surface. Observations could also be conducted from the stern of the vessel, the bridge and the catwalk in front of the bridge and PSOs moved to

these locations when the conditions were deemed unsafe for monitoring from the tower (when wind speed increased above 30 knots or swells and sea state increased such that the vessel was rolling) or when the exhaust from the vessel engine stacks was blowing into the tower rendering the tower unsafe for observations. Over 82% of visual monitoring effort was completed from the tower during the USGS GOA ECS survey (Figure 9).

Table 4: Visual monitoring effort during the USGS GOA ECS survey

Visual Monitoring	Duration (hh:mm)
Total monitoring while airguns active	330:11
Total monitoring during airgun silence	26:33
Total visual monitoring	356:44

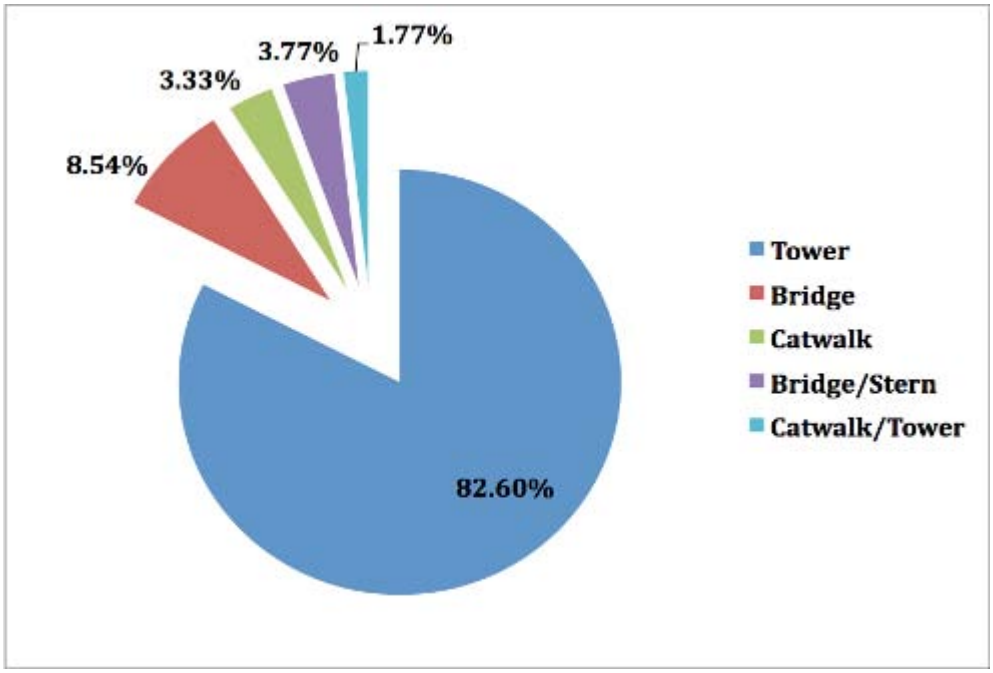

Figure 9: Visual monitoring effort performed from PSO visual observation locations on board *Langseth* during the USGS GOA ECS.

4.3.2. Acoustic Monitoring Survey Summary

The hydrophone cable was deployed for the first time on 8 June 2011 after the vessel had completed deployment of the seismic equipment. Acoustic monitoring began immediately at 14:20 UTC and continued throughout the project with PSOs monitoring the hydrophones aurally and visually monitoring the PAMguard detection software both day and night. Acoustic monitoring for the project ended at 21:53 UTC on 25 June 2011 when acquisition of the final survey lines was completed and the hydrophone cables was retrieved in preparation for the retrieval of the seismic equipment.

Over the course of the project, PSOs conducted 392 hours and 54 minutes of acoustic monitoring, the majority, 98% (387 hours and 11 minutes), of which occurred while the acoustic source was active (Figure 11 above, Table 5).

Table 5: Acoustic monitoring effort during USGS GOA ECS seismic survey

Acoustic Monitoring	Duration (hh:mm)
Total Night time monitoring	302:45
Total Day time monitoring	79:26
Total monitoring while airguns active	387:11
Total monitoring during airgun silence	05:43
Total acoustic monitoring	392:54

There was 24 hours and 28 minutes of acoustic monitoring downtime that was accumulated throughout the project. Periods of downtime consisted of occasions when PAM system could not be utilized, usually because the hydrophones were not deployed. The hydrophone would have been retrieved if the PAM Operator detected a potential problem with the system, either a potential hydrophone cable entanglement with seismic equipment or a fault with the cable itself but there were no problems of this nature with the system during the USGS GOA ECS.

Acoustic monitoring was suspended and the cable retrieved for numerous instances of seismic repairs/maintenance so as to avoid a potential entanglement when the seismic equipment was retrieved. Downtime was attributed to seismic equipment when it related to repairs, maintenance or malfunctioning of streamers, airguns or compressors (Table 6) and accounted for 7 hours and 38 minutes of the total acoustic monitoring downtime of the project. The largest portion of acoustic monitoring downtime was attributed to weather when the cable was retrieved at 15:03 UTC on 16 June 2011 and remained on board until 06:30 UTC on 17 June 2011 when the sea state had decreased to a sufficient level to make it safe to deploy the cable without risk on entanglement with seismic equipment. Other instances (01:50) of acoustic monitoring included situations where the PAM Operator was required to suspend acoustic monitoring to assist the visual PSOs on watch in the tower. A description of each instance of acoustic monitoring downtime is located in Appendix G.

Table 6: Acoustic monitoring downtime during USGS GOA ECS seismic survey

Acoustic Monitoring Downtime	Duration (hh:mm)
Seismic Equipment Repairs	07:38
PAM Cable Malfunction	00:00
PAM Cable Entanglement	00:00
Weather	15:27
Other	01:50
Total Acoustic Monitoring Downtime	24:28

4.3.3. Simultaneous Visual and Acoustic Monitoring Summary

As acoustic monitoring continued day and night whenever the hydrophone cable could remain deployed, numerous hours of acoustic observations were conducted overlapping with visual observations, a total of 302 hours and 45 minutes over the course of the survey. Simultaneous acoustic and visual monitoring accounted for 77% of the acoustic monitoring conducted this survey.

5. DETECTION RESULTS

Monitoring effort undertaken during the USGS GOA ECS marine seismic survey resulted in the collection of 50 records of detection for protected species (summarized in Appendix H). Four species of marine mammals, three cetaceans and one pinniped, were identified (Table 7 below) in addition to several unidentified baleen whales and one pinniped that was not identified to species level.

Table 7: Number of protected species records collected for each marine mammal species detected during the survey

	Total No. Detection Records	Total No. Animals Recorded
Cetacean species	**44**	**220**
Fin whale	11	48
Unidentified Mysticete sp	23	46
Sperm whale	2	28
Dall's porpoise	9	98
Pinniped species	**6**	**6**
Northern fur seal	5	5
Unidentified pinniped sp	1	1

Most detections (all except four, Detection #4 of fin whales, Detection #27 of a Northern fur seal and Detection #2 and #3 of unidentified baleen whales) occurred while the source was active (full power, ramping-up or a single mitigation gun firing), which was consistent with the majority of observation effort (92.6%) being undertaken while the source was active.

There were no detections of marine turtles made during the survey project. Protected Species Observers were also conducting visual observations for groups of short-tailed albatross to report sightings of more than two birds to the Alaska Department of Fish& Wildlife as well as to initiate mitigation procedures for flocks of birds on the surface in groups containing more than nine birds. No short-tailed albatross were sighted throughout the survey. A complete list of bird species observed and identified in addition to the approximate number of individuals observed and the number of days on which they were observed can be found in Appendix I.

Marine mammals detections were not distributed evenly over each day of visual observations. Several days during which continuous visual observations were conducted produced no protected species detections. A maximum of seven protected species detection records were accumulated on two separate observation days, 13 June 2011 and 22 June 2011(Figure 10). Large mysticetes were viewed more frequently as the vessel transited through the survey area where seamounts were located.

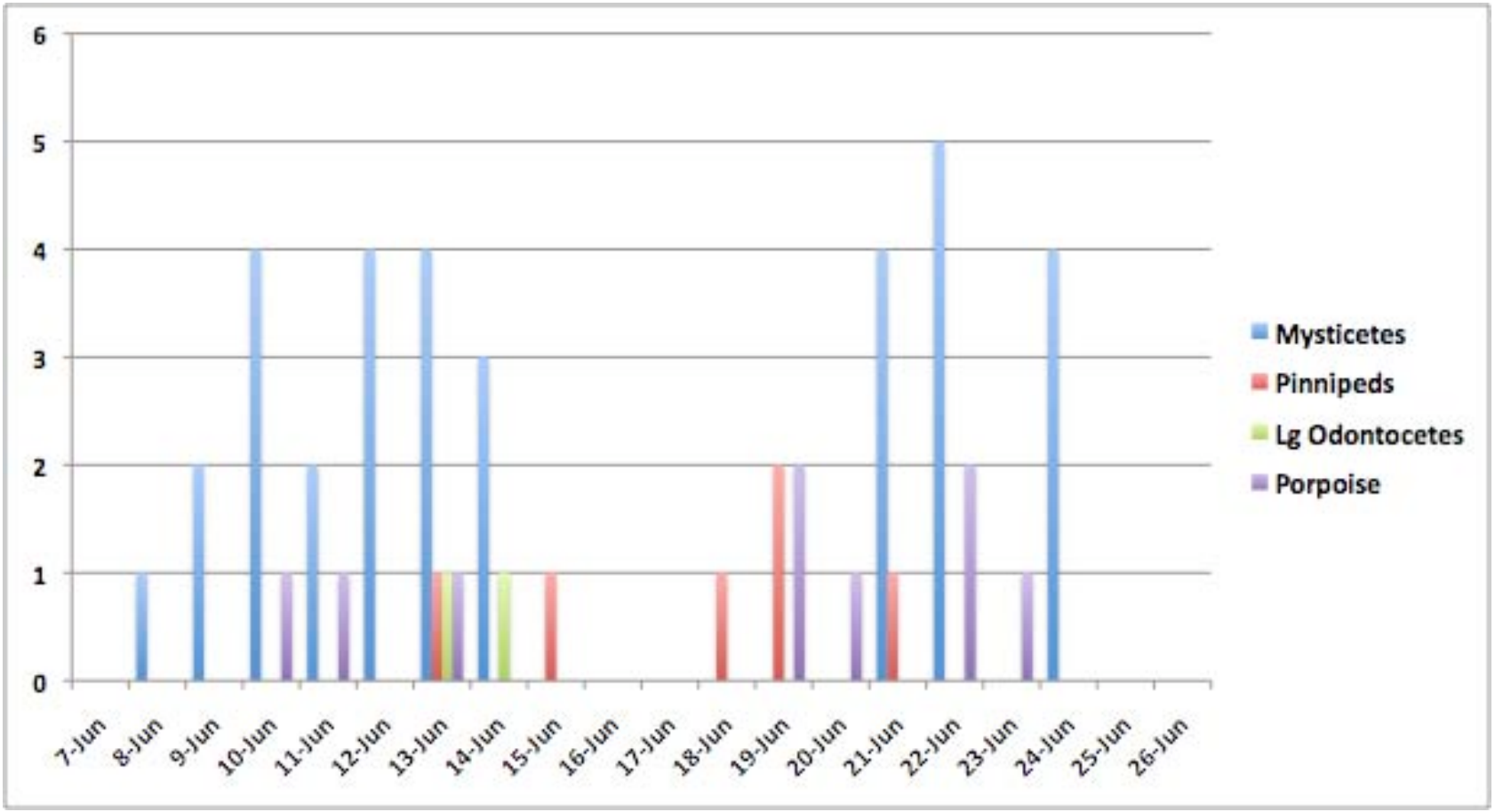

Figure 10: Number of detection records collected each day of the USGS GOA ECS survey.

The closest approach to the source and the source volume at the time of closest approach was recorded during every detection event of the USGS GOA ECS (Table 8).

Table 8: The closest approach to source of marine mammal groups detected at varying acoustic source operation levels

Type of Detection	Full Power		Mitigation Source (40 in^3)		Ramp-up / Multiple airguns (vol >40 in^3)		Not Firing	
	Number Detections	Ave Closest approach to source	Number Detections	Ave Closest approach to source	Number Detections	Ave Closest approach to source	Number Detections	Ave Closest approach to source
Pinniped	3	230	2	6.5	0	-	1	0
Porpoise	8	987	1	200	0	-	0	-
Mysticete	27	2488	2	293	1	9410	3	1525
Large Odontocete	2	1072	0	-	0	-	0	-

The average closest approach to the source for each type of marine mammal observed (pinniped, porpoise, mysticete and large odontocete) was greater when the animal or group approached while the source was at full volume (36 airguns at 6600 inch^3) than while it was not firing or was active at a lower volume (Figure 11). One exception occurred during Detection #7 of an unidentified baleen whale observed during ramp-up at a closest approach of more than nine kilometers.

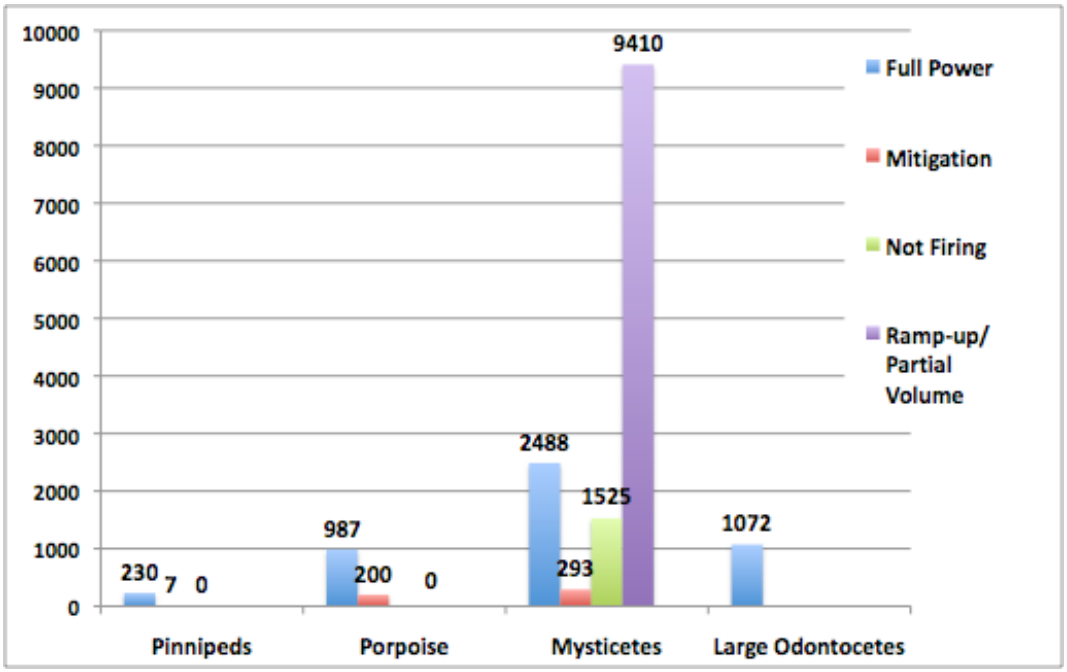

Figure 11: The closest approach to source of marine mammal groups detected at varying acoustic source operation levels.

Cetaceans were detected far more frequently than pinnipeds, making up 88% (44 records) of the total 50 detection records collected and consisting of a minimum of 220 animals observed (Figure 12).

In additions to being detected more frequently, cetaceans were detected in greater numbers, with many of the detection events consisting of several animals sighted in each group (Figure 13).

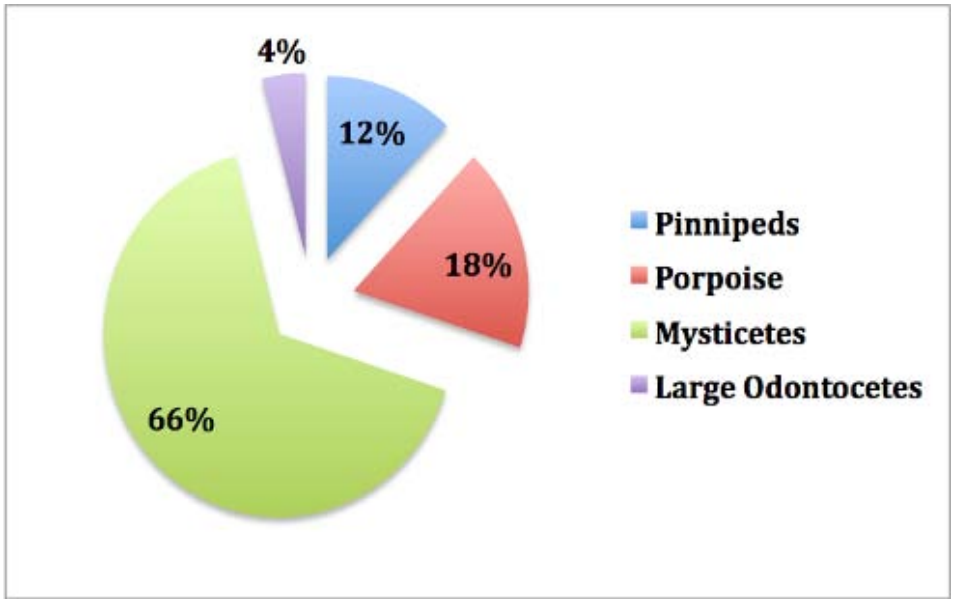

Figure 12: Type of marine mammal detection record represented as a percentage of the total number of marine mammal detection records collected during the USGS GOA ECS survey.

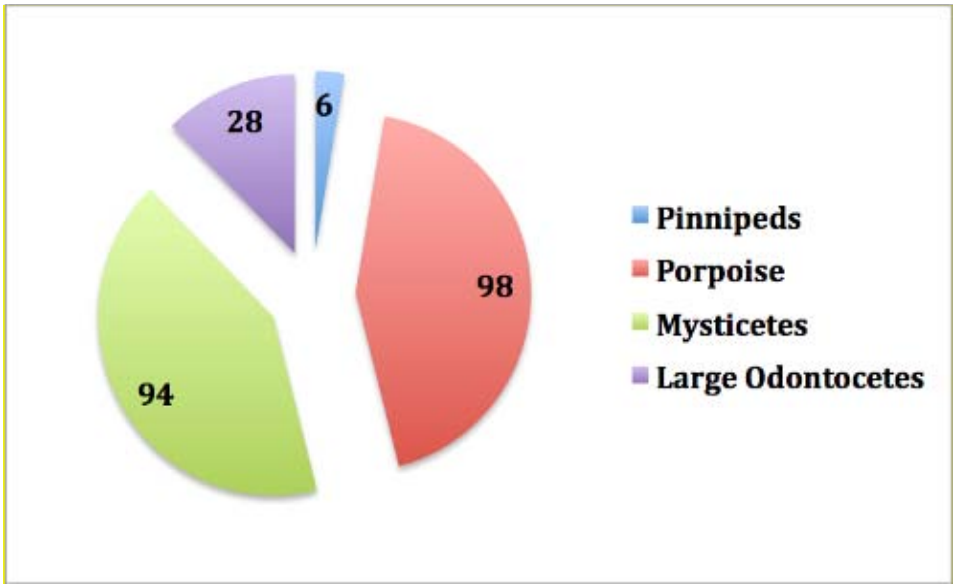

Figure 13: Number of animals observed during detection events over the course of the USGS GOA ECS.

All of the detections of marine mammals during the USGS GOA ECS were made through visual observations by the PSOs during dedicated watches. No acoustic detections were made during the USGS GOA ECS seismic survey.

5.1. PINNIPED SIGHTINGS

Pinnipeds were sighted on six occasions during the acquisition of the USGS GOA ECS survey. Each sighting event consisted of a single animal being observed, with the animal identified as a Northern fur seal during five of the sightings. The remaining detection event (Detection Record #18) was recorded as an unidentified pinniped as the sighting event was brief and species-specific characteristics were obscured as the animal quickly transited alongside the vessel. The distribution of the six pinniped detections can be seen in Figure 14.

During each pinniped sighting event, it was noted that the animal approached the acoustic source itself, not just the vessel, remaining alongside the arrays for a couple of minutes to as long as more than one hour. This behaviour was observed in pinnipeds approaching the source when it was firing on full power, when only a single mitigation gun was active and when the source was not firing at all, shut-down due to a technical error at the time of the initial sighting of the animal (Detection Record # 27 on 19 June).

On two occasions (Detection records #26 and #27 on 15 June and 19 June), a single Northern fur seal approached the acoustic source and was observed porpoising alongside the arrays, in front of the arrays, as though “bow-riding”, weaving in and around the individual strings and was sighted surfacing alongside the source, with the head visible above the surface, turned to look at the arrays. During Detection #27, the source was shut-down, and a single mitigation gun re-enabled once the smaller safety radius was clear, at which point the seal could be seen immediately swimming back to the source resulting another shut-down procedure. This occurred three times over the course of Detection event #27.

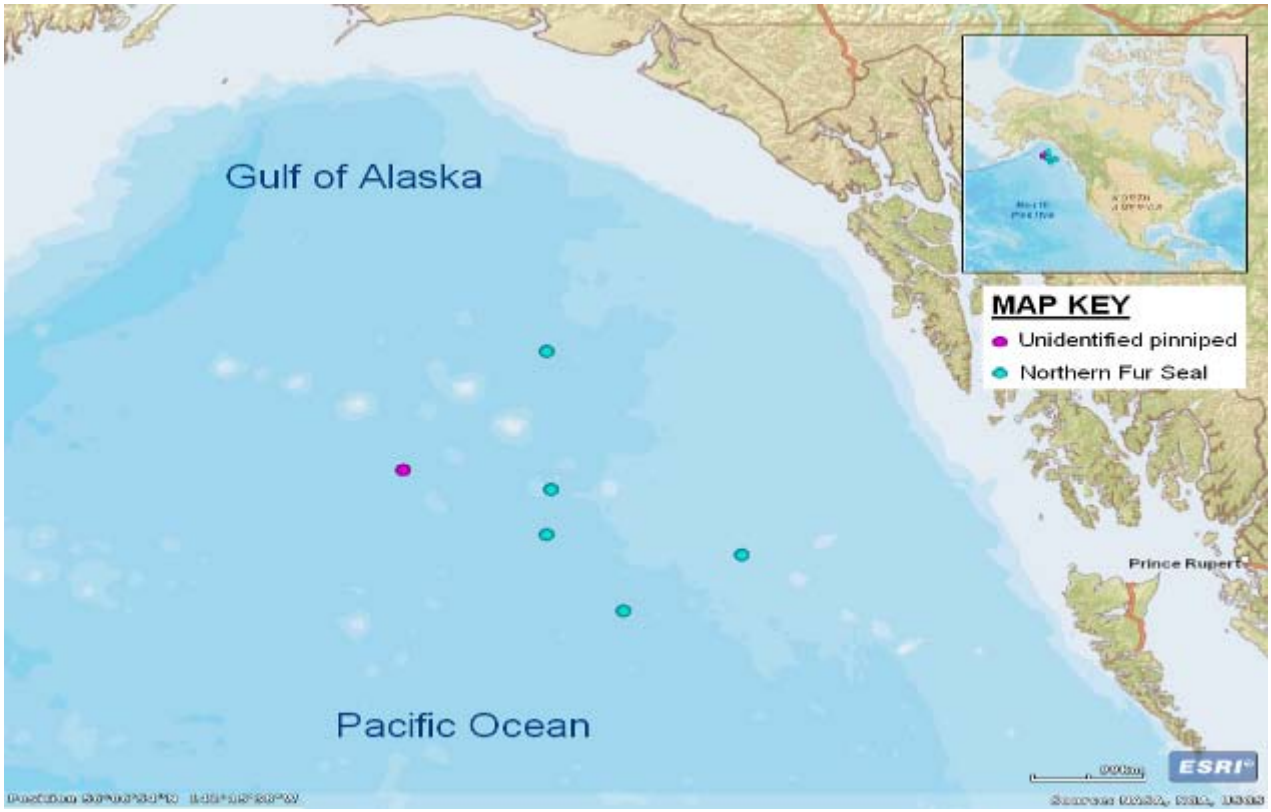

Figure 14:Spatial distribution of pinnepeds detected during the USGS GOA ECS survey.

5.2. CETACEAN SIGHTINGS

Three different species were identified among the 44 detection records collected for cetacean species during the USGS survey: fin whales (11 records), sperm whales (two records) and Dall's porpoise (nine records). An additional 22 records were collected for large baleen whales that could not be identified to species level due to the brevity of the sighting event and/or the distance from which the animal(s) was observed (Figure 15). The distribution of the cetacean sightings can be seen in Figure 16.

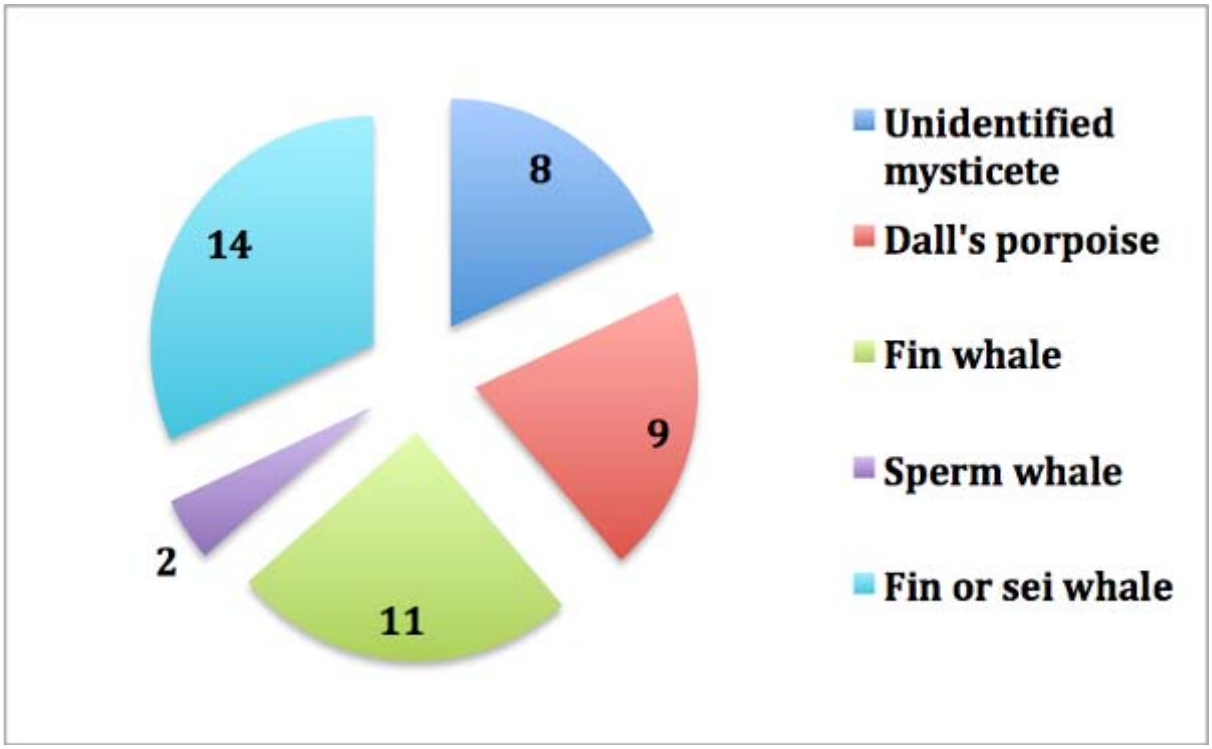

Figure 15: Number of cetacean species detection records collected during the USGS GOA ECS survey.

High sea states where surface chop was present often obscured morphological characteristics necessary to make a species identifications, particularly among species that are very similar, like the fin and sei whales, both of which are known to inhabit the Gulf of Alaska. When the definite species identification could not be made based on the characteristics observed, the animal (group) was classified to the lowest taxonomic level possible. Of the 22 records of detection collected for unidentified baleen whales, 14 animal groups were determined to be either fin or sei whales but characteristics such as the white underside of the right jaw of the fin whale were not visible such that PSOs could distinguish between the two species. For purposes of take calculations and analysis these animals were classified as unidentified mysticetes.

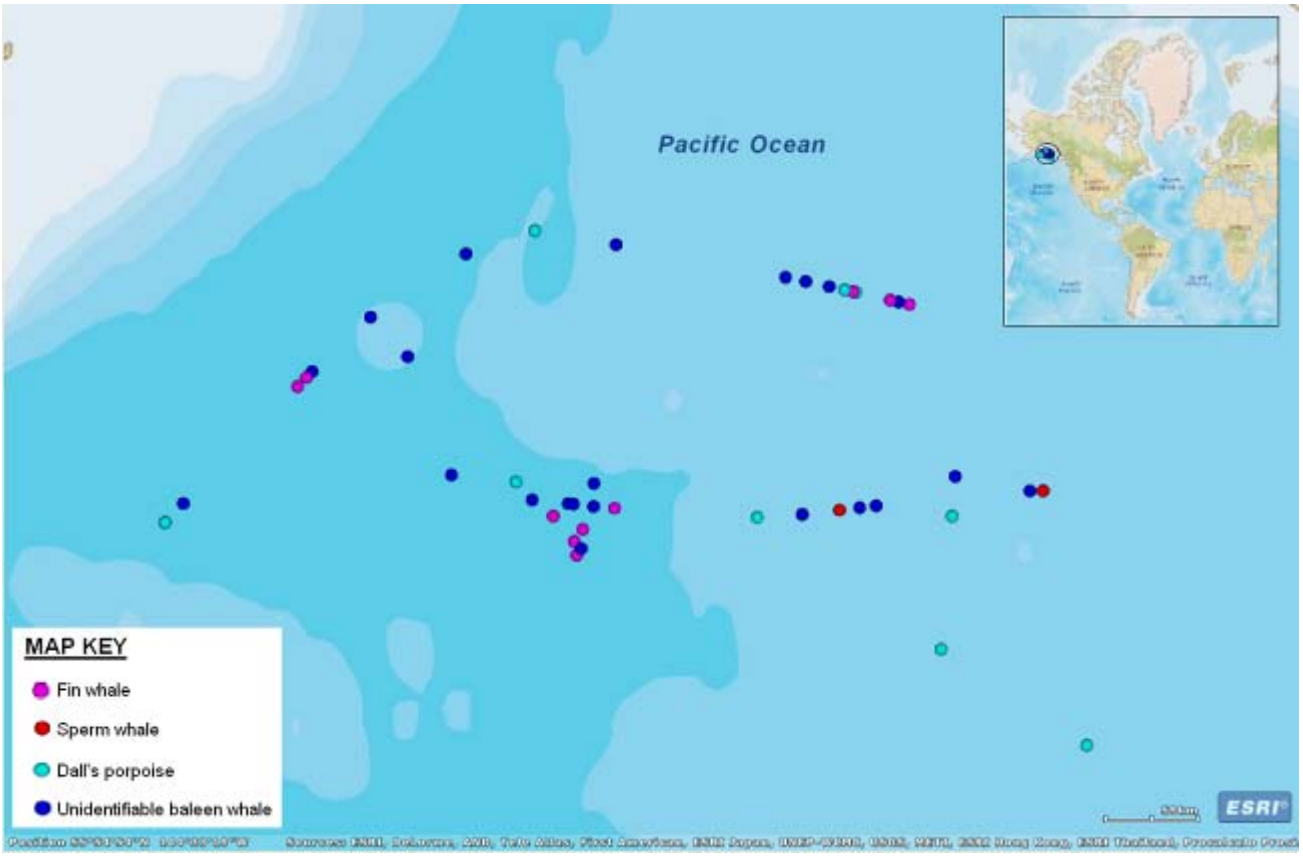

Figure 16:Spatial distribution of cetaceans detected during the USGS GOA ECS survey.

6. MITIGATION ACTION SUMMARY

There were 21 mitigation actions implemented during the USGS GOA ECS survey (a complete list can be found in Table 10): one delayed ramp-up, 15 power-down procedures, and five shut-down procedures (Table 9).

Table 9: Number and duration of mitigation actions implemented during the USGS GOA ECS

Mitigation Action	Cetaceans		Pinnipeds		Total	
	Number	Duration	Number	Duration	Number	Duration
Delayed ramp-up	0	0:00	1	1:40	1	1:40
Power-down	13	4:00	2	0:30	15	4:30
Shut-down	3	3:43	2	1:07	5	4:50
Total	16	7:43	5	2:17	21	11:00

Of the five shut-down procedures implemented, three were initiated for cetaceans, all large mysticetes (Detections #2, 3 and 4 on 9 and 10 June). Each of these shut-down procedures were performed voluntarily, above the requirement of the IHA to shut-down the acoustic source for marine mammals within or about to enter the 180 dB safety radius. Precautionary mitigation measures were implemented as the survey began whereby the acoustic source was disabled immediately upon the sighting of a large unidentified mysticete pending identification of the animal as several species including the blue whale and sei whale had been afforded no takes by the IHA. However, as several large baleen whales were being observed at too great of a distance to make positive species identifications, this pre-cautionary approach to shutting down the source above and beyond the IHA-required methods was discontinued at 18:00 UTC on 10 June. 2011

After the precautionary shut-down procedures were discontinued, there were no additional cetacean shut-down actions performed. Both subsequent shut-down procedures were implemented for pinnipeds observed within the 190 dB shut-down radius of the acoustic source.

Only one delayed ramp-up procedure was initiated during the survey, as once acquisition began, the source was never fully de-activated unless a mitigation shut-down procedure was required or in the event of a technical or mechanical failure. The single delay to ramp-up occurred on 19 June (Detection record #27) when a Northern fur seal approached the acoustic source while it was silent due to a technical error.

Power-down procedures were the most common mitigation action undertaken during the survey, initiated for both pinnipeds and cetaceans sighted inside the safety radii. While an equal number (six) of power-down procedures were implemented for porpoise as for mysticetes, the duration of downtime for mysticete power-down procedures accounted for a higher percentage of overall mitigation action downtime during the project than those power-downs initiated for porpoise sightings (Figures 17 and 18).

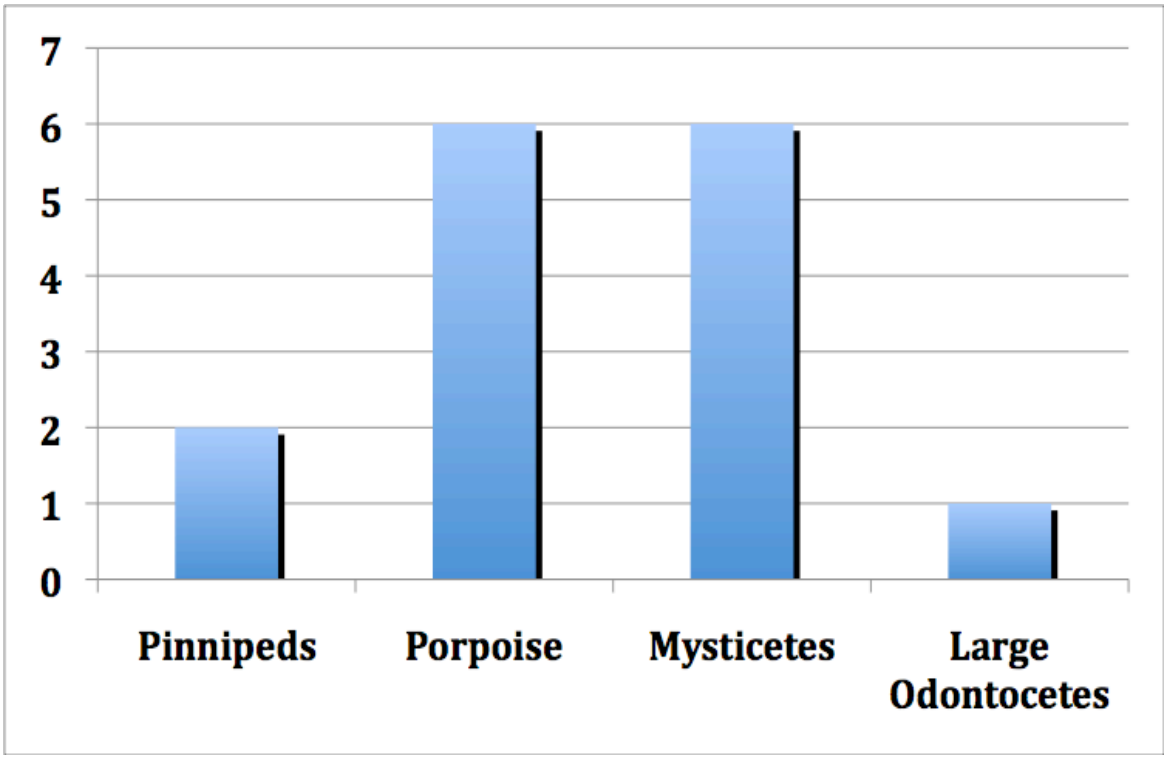

Figure 17: Number of power-down procedures implemented during USGS GOA ECS for marine mammals.

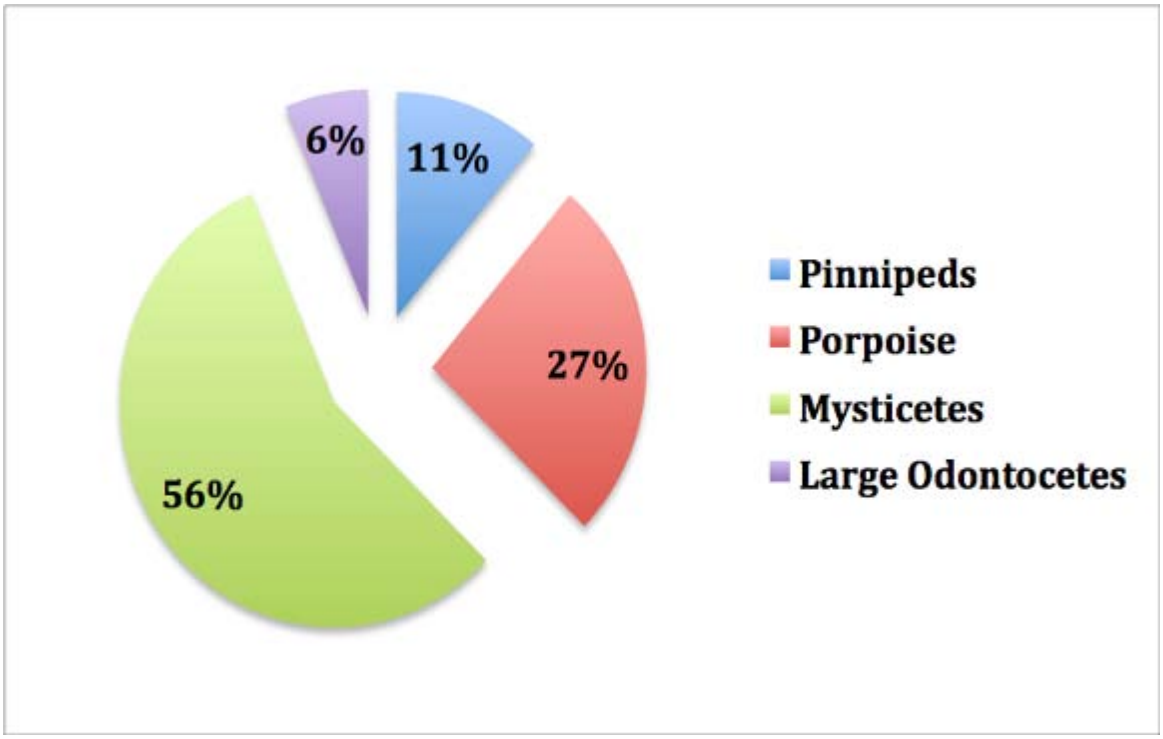

Figure 18: Percentage of overall power-down procedure down-time attributed to power-downs initiated for each marine mammal group during the USGS GOA ECS.

Table 10: Summary of every mitigation action initiated during the USGS GOA ECS

Date	Visual Detection #	Species or common name	Group Size	Source Activity (initial detection)	Closest Approach to Active Source/Power Level	Mitigation Action	Duration	Comments
6/9/11	2	Unidentified baleen whale	2	Full power	2100 / Full power	Shut-down	1:40	Pre-cautionary shut-down not required by the IHA initiated pending positive species identification of the animal
6/9/11	3	Unidentified baleen whale	1	Full power	4096 / Full power	Shut-down	0:36	Pre-cautionary shut-down not required by the IHA initiated pending positive species identification of the animal
6/10/11	4	Fin whale	6	Full power	2614 / Full power	Shut-down	1:27	Pre-cautionary shut-down not required by the IHA initiated pending positive species identification of the animal. Animals identified as fin whales mid sighting. Shut-down would have been required but airguns were already disabled
6/10/11	6	Fin whale	1	Full power	690 / Full power	Power down	0:18	
6/10/11	10	Dall's porpoise	2	Full power	190 / Full power	Power down	0:06	
6/12/11	11	Unidentified baleen whale	4	Full power	600 / Full power	Power down	0:31	
6/13/11	15	Unidentified baleen whale	2	Full power	500 / Full power	Power down	0:30	
6/13/11	16	Fin whale	2	Full power	250 / 40 in^3	Power down	0:36	
6/13/11	17	Dall's porpoise	6	Full power	200 / 40 in^3	Power down	0:19	
6/13/11	18	Unidentified pinniped	1	Full power	90 / Full power	Power down	0:25	
6/14/11	25	Sperm whale	5	Full power	870 / Full power	Power down	0:17	

Table 10 Con't: Summary of every mitigation action initiated during the USGS GOA ECS

Date	Visual Detection #	Species or common name	Group Size	Source Activity (initial detection)	Closest Approach to Active Source/Power Level	Mitigation Action	Duration	Comments
6/15/11	26	Northern fur seal	1	Full power	10 / Full power	Shut-down	1:00	After single 40 cu in gun re-enabled animal re-entered zone and guns were shut-down again. At commencement of ramp-up, animal approached again resulting in a power-down followed by a shut-down.
6/19/11	27	Northern fur seal	1	Not firing	0 / Not firing	Delayed ramp-up	1:40	Guns off at initial sighting d/t technical error. Ramp-up delayed.
6/20/11	29	Dall's porpoise	20	Full power	690 / Full power	Power down	0:05	
6/20/11	31	Northern fur seal	1	Full power	8 / 40 in^3	Shut-down	0:07	
6/21/11	34	Northern fur seal	1	Full power	400 / Full power	Power down	0:05	
6/22/11	40	Dall's porpoise	10	Full power	900 / Full power	Power down	0:06	
6/23/11	45	Dall's porpoise	15	Full power	100 / 40 in^3	Power down	0:19	
6/24/11	48	Fin whale	2	Full power	845 / Full power	Power down	0:32	
6/24/11	49	Fin whale	13	Full power	845 / Full power	Power down	0:05	
6/24/11	50	Dall's porpoise	20	Full power	763 / Full power	Power down	0:16	

6.1. MARINE MAMMALS KNOWN TO HAVE BEEN EXPOSED TO 180 DB AND 160 DB RECEIVED SOUND LEVELS

NMFS granted an IHA to the USGS for a marine seismic survey allowing Level B harassment takes (expose to 160 dB received sound) for 13 marine mammal species: two mysticetes, nine odontocete species and two pinnipeds (Appendix A). Direct visual observations recorded by Protected Species Observers of four species of marine mammals for which takes were granted in the IHA provide a minimum estimate of the actual number of animals exposed to received sound levels or 180 dB (cetaceans) / 190 dB (pinnipeds) and 160 dB.

During the USGS GOA ECS survey 41 fin whales,26 sperm whales, 98 Dall's porpoise and four Northern fur seals were observed with the 160 dB predicted distances where Level B harassment is expected to occur while the acoustic source was active (Table 11).

Table 11: Level B Harassment Takes authorized by NMFS IHA for the USGS GOA ECS and number of known exposed animals to 160 dB and 180 dB/190 dB through visual observations

Species	IHA Authorized Takes	Number of Animals Exposed to 180dB (Cetaceans) / 190dB (Pinnipeds)	Number of Animals Exposed to 160dB
Mysticetes			
North Pacific right whale	0	0	0
Gray whale	0	0	0
Humpback whale	68	0	0
Minke whale	0	0	0
Sei whale	0	0	0
Fin whale	76	9	41
Blue whale	0	0	0
Odontocetes			
Sperm whale	44	6	26
Cuvier's beaked whale	37	0	0
Baird's beaked whale	11	0	0
Stejneger's beaked whale	15	0	0
Beulga whale	0	0	0
Pacific white-sided dolphin	90	0	0
Risso's dolphin	33	0	0
Killer whale	99	0	0
Short-finned pilot whale	50	0	0
Harbor porpoise	0	0	0
Dall's porpoise	672	80	98
Pinnipeds			
Northern fur seal	2771	4	4
Northern elephant seal	0	0	0
Harbor seal	0	0	0
California sea lion	0	0	0
Steller sea lion	256	0	0

These numbers are likely an underestimate and provide a minimum number of animals actually exposed. While it is likely there was only a single pinniped present during each of the four sighting events resulting in takes of Northern fur seals, it is possible that individual pinnipeds entered within the safety radius unnoticed by PSOs due to the brevity of their presence in the vicinity or an increased sea state that made small pinnipeds difficult to observe. It is unlikely that pods of large mysticetes would have failed to have been observed at all by PSOs, although in instances of reduced visibility it is possible that a pod transiting through the area could have surfaced without being observed. It is more likely that estimated numbers of animals recorded during each sighting event were underestimates, some animals not being seen, having moved away before they were observed.

6.1.1. Fin whales

Fin whales were the only large mysticetes taken by Level B harassment during the USGS GOA ECS. Nine sighting events of fin whales constituting a minimum total of 41 animals were observed within the 160 dB safety radius while the acoustic source was active. Of those 41 animals, only nine were also exposed to received sound levels of 180 dB from the acoustic source, resulting in the implementation of a mitigation power-down or shut-down.

In each detection event of a pod of fin whales, the first observed behaviour was blowing at the surface with the movement and heading of the animal(s) highly variable. Behaviour, movement of the animal in relation to the vessel and heading was recorded throughout the sighting and compared to the initial observed behaviours and movement (Figure 19).

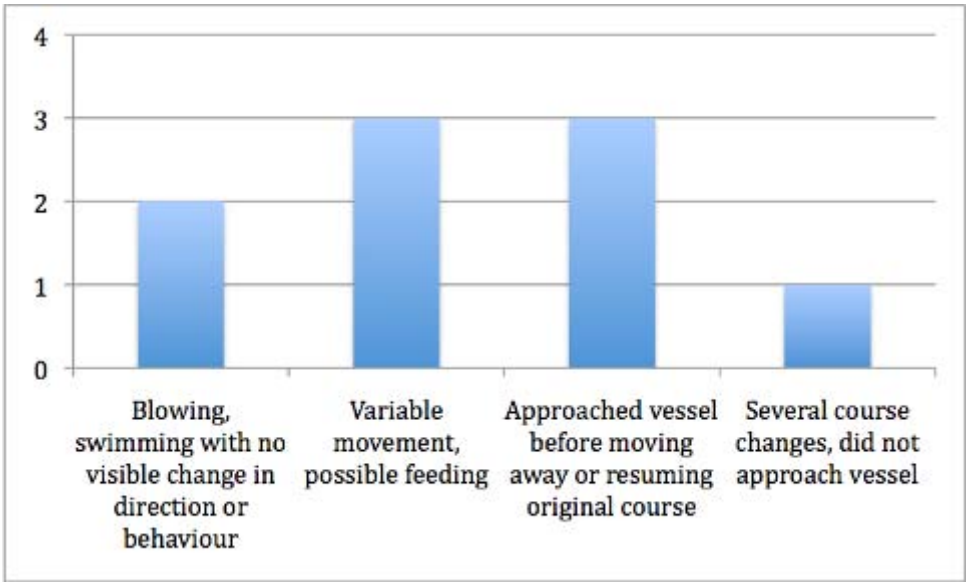

Figure 19: Behavior and movement of fin whale pods observed exposed to 160 dB received sound from acoustic source in comparison to initial observed behaviors and movement.

In two instances, the pods continued to blow at the surface, swimming at the same speed and on the same heading throughout the detection event (Detection #35 and #47 on 21 June and 24 June) with no visible change in behavior. During detection events #18, 48 and 49 (13 June and 24 June 2011) pods of whales were initially observed blowing at the surface, each pod

containing between four to 12 animals (not all of which were approached the sound source to within the 160 dB). In each case the whales were either all traveling in the same direction and were observed to change direction several times, exhibiting feeding behavior, or a single pod consisted of animals traveling in different directions when initially sighted (Detections #48 and 49), also changing direction multiple times but seemingly at random while appearing to be feeding. In each incident, no overall change in behavior pattern, movement or heading was observed from the initial sighting to the final sighting.

On three occasions, during sighting events 4, 5 and 16 (10 June 2011 and 12 June 2011), fin whale pods were initially sighted traveling quickly on a course that would take them away from the vessel but during the course of the sighting event, the animals were observed to change their heading and directly approach the vessel. In each instance the animals surfaced alongside the vessel numerous times, remaining close to the vessel before changing course.

6.1.2. Sperm whales

Two known pods of sperm whales totalling 25 animals (Detection events #21 and 25 on 13 and 14 June 2011) were observed within the 160 dB safety radius while the acoustic source was active. The first detection event consisted of 20 animals grouped loosely into several small pods. None of these animals entered the 180 dB sound radius of the acoustic source over the course of the hour-long sighting event on 13 June 2011. Initially eight animals were sighted blowing at surface while logging. This group drifted past the vessel as it travelled online, never changing behavior and were last observed still logging on the surface astern of the vessel. After the initial sighting of eight whales, several other small groups of whales were seen surfacing, blowing, and swimming at the surface parallel to the vessel and in the opposite direction. While the speed of travel varied from group to group and within some groups as some whales were seen to abruptly begin to travel more rapidly, none of the groups were observed to change heading in relation to the vessel. On 14 June a smaller pod of five whales where observed ahead of the vessel crossing perpendicular to the ship before changing heading to approach the vessel, swimming parallel to the ship in the opposite direction and entering the 180dB mitigation radius effecting a power-down of the source. Once this course change had been initiated, the pod continued to travel in the new direction with no variation in speed until they were far astern.

6.1.3. Dall's porpoise

Nine pods of Dall's porpoise consisting of a minimum of 98 individuals were taken under Level B harassment by exposure to received sound levels greater than 160 dB. Of those nine pods, all but two (Detection events #32 and 38 both on 21 June 2011) pods also entered the 180 dB safety radius where mitigation power-downs are required under the IHA.

Each pod of porpoise was initially sighted through the observation of rooster tail splashes, characteristic of this species when undergoing fast travel just below the surface. The initial movement of each pod was observed and recorded, with the direction of travel relative to the vessel highly variable in each sighting event. Direction of travel was categorised as pods observed travelling towards the vessel, parallel to the vessel in the opposite direction, parallel to the vessel in the same direction and one pod that appeared to be milling just below the surface with no discernible direction of travel (Figure 20).

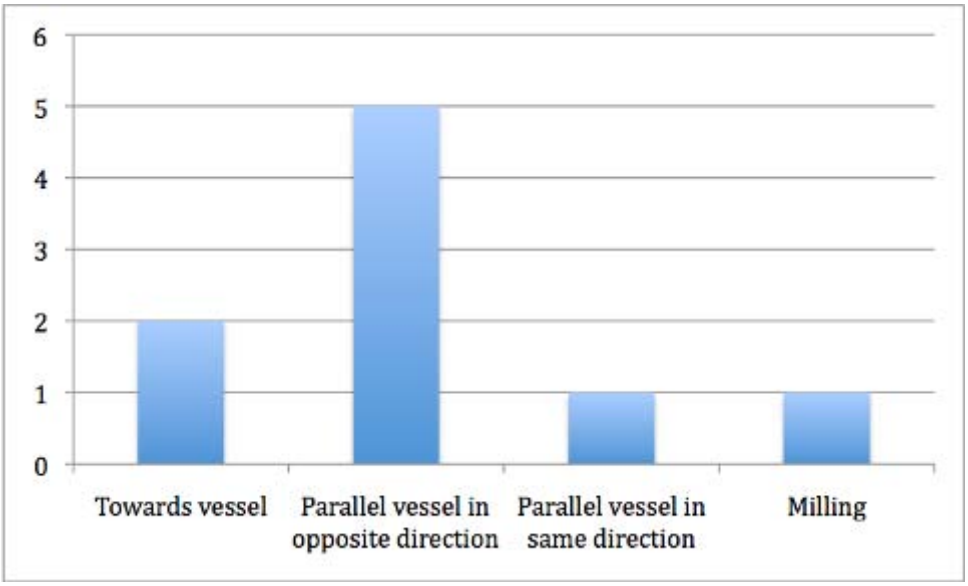

Figure 20: Initial movement relative to vessel of Dall's porpoise pods exposed to 160 dB received sound levels.

6.1.4. Northern fur seal

Four sighting events of four individual Northern fur seals occurred during the USGS GOA ECS where seals were exposed to both 160 dB and 190 dB of sound from the acoustic source. On three occasions (Detections #30, 31 and 34) seals were observed resting at surface (two on the surface, one on a log), and upon the approach of the vessel, began to swim at a slow to moderate pace away from the vessel and acoustic source. On 16 June 2011 (Detection #26) a fur seal was initially sighted porpoising alongside the active acoustic source which resulted in a mitigation power-down/shut-down.

7. CONCLUSIONS AND RECOMMENDATIONS

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

In order to minimize the Level B incidental taking of marine mammals and sea turtles during the USGS marine seismic survey, mitigation measures were implemented whenever these protected species were seen near or within the safety radii designated in the IHA.

Power-downs and shut-downs were implemented for pinnipeds, mysticetes and odontocetes and a single ramp-up delay was implemented for a pinniped.

Additional mitigation measures specific to the USGS survey required that if a North Pacific right whale, blue whale, sei whale or beluga whale were sighted, the airgun array would be shut-down regardless of the distance of the animal(s) to the sound source and that the array would not resume firing until 30 minutes after the last documented whale visual sighting. While none of these species were positively identified during the USGS survey, numerous large unidentified baleen whales were observed that could potentially have been sei whales, but due to the difficulty in differentiating sei whales from fin whales in the absence of species-specific characteristics being visible, PSOs were unable to apply mitigation measures beyond the IHA-required power-down procedures. It is unlikely that under field observation conditions, that a fin whale could be distinguished from a sei whale, except when observed at close range, especially in Alaska where a sea state of Beaufort level 2 to 3 is common most days, rendering this particular IHA stipulation redundant to the requirement that the array be powered-down for any cetacean entering the 180 dB safety radius, the event much more likely to occur prior to any species identification of a sei whale.

The IHA also mandated that concentrations of humpback whales, fin whales and killer whales be "avoided if possible" and that the "array be powered-down if necessary". A concentration of these species was defined as three or more individuals sighted that did not appear to be travelling (e.g. feeding, socializing). Groups of more than three fin whales were observed on six occasions, and on at least three occasions pods did not appear to be travelling and behaviour and movement was indicative of feeding (abrupt changes of direction that appeared unrelated to other environmental factors, repeated surfacing with head visible). However, as the vessel encountered each of these feeding fin whale pods while in acquisition of a survey line and this IHA requirement stated only that pods should be "avoided when possible", no physical avoidance manoeuvres were undertaken and the array was powered down as required as stipulated at the 180 dB range when necessary.

Reasonable and prudent mitigation procedures were outlined to minimize potential impacts of taking sea turtles known to inhabit the Gulf of Alaska but not sea turtles were observed during the USGS marine seismic survey and it is unlikely that any were exposed to received sound levels expected to cause Level B harassment.

8. ACKNOWLEDGEMENTS

The Protected Species Observers on board *Langseth* during the United States Geological Survey Extended Continental Shelf survey from RPS Energy would like to thank the National Science Foundation (NSF), Lamont-Doherty Earth Observatory (L-DEO) and United States Geological Survey (USGS) for the opportunity to work on this project. It was a pleasure to work with Dr. Jonathan Childs, Geophysicist and Associate Center Director for USGS, and Meagan Cummings, Marine Environmental Safety Coordinator for L-DEO. We would also like to thank the marine crew and science team on board the R/V *Langseth* for their assistance and hospitality.

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

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

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

9. LITERATURE CITED

Gannier, A., Drouot, V., andGoold, J.C., 2002, Distribution and relative abundance of sperm whales in the Mediterranean Sea*, Marine Ecology Progress series*, Volume 243 2002

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

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APPENDIX B: Basic Data Form

BASIC DATA FORM		
L-DEO Project Number		MGL1109
Seismic Contractor		Lamont-Doherty Earth Observatory of Columbia University
Client		United States Geological Survey
Area Surveyed During Reporting Period		Gulf of Alaska, south east of Kodiak island
Survey Type		2D marine seismic
Vessel and/or Rig Name		*R/V Marcus G. Langseth*
Permit Number		IHA granted by NMFS on 3 June 2011 (Appendix A)
Location / Distance of Airgun Deployment		Single source deployed 223.1 m astern of vessel's NRP
Water Depth	**Min**	2000
	Max	6000
Dates of project		6 June 2011 through 26 June 2011
Total time airguns operating – all power levels:		416:41
Amount of time airguns operating at full power:		388:03
Time airguns operating at full power on a survey line:		366:26
Time airguns operating at full power on line changes:		21:37
Amount of time mitigation gun operations (1 gun 40cu^3):		08:11
Amount of time in ramp up:		09:27
Number daytime ramp ups:		19
Number of night time ramp ups:		0
Number of ramp ups from mitigation source:		10
Amount of time conducted in airgun testing:		11:00
Duration of visual observations:		356:44
Duration of observations while airguns firing:		330:11
Duration of observation during airgun silence:		26:33
Duration of acoustic monitoring:		392:54
Duration of acoustic monitoring while airguns firing:		387:11
Duration of acoustic monitoring during airgun silence:		5:43
Lead Protected Species Observer:		Stephanie Milne
Additional PSOs:		Kendra Davis
		Meghan Piercy
		Christine Voigtlander
Primary Acoustic Observer:		Meghan Wood
Number of Marine Mammals Visually Detected:		50
Number of Marine Mammals Acoustically Detected:		0
Number of acoustic detections confirmed by visual sighting:		0
Number of Sea Turtles detected:		0
List Mitigation Actions		5 Shut-downs, 15 Power-downs and 1 Delayed ramp-up
Duration of operational downtime due to mitigation:		11:01

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 200kHz	(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

9.1.1.1. 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: Typical Pamguard Screenshots

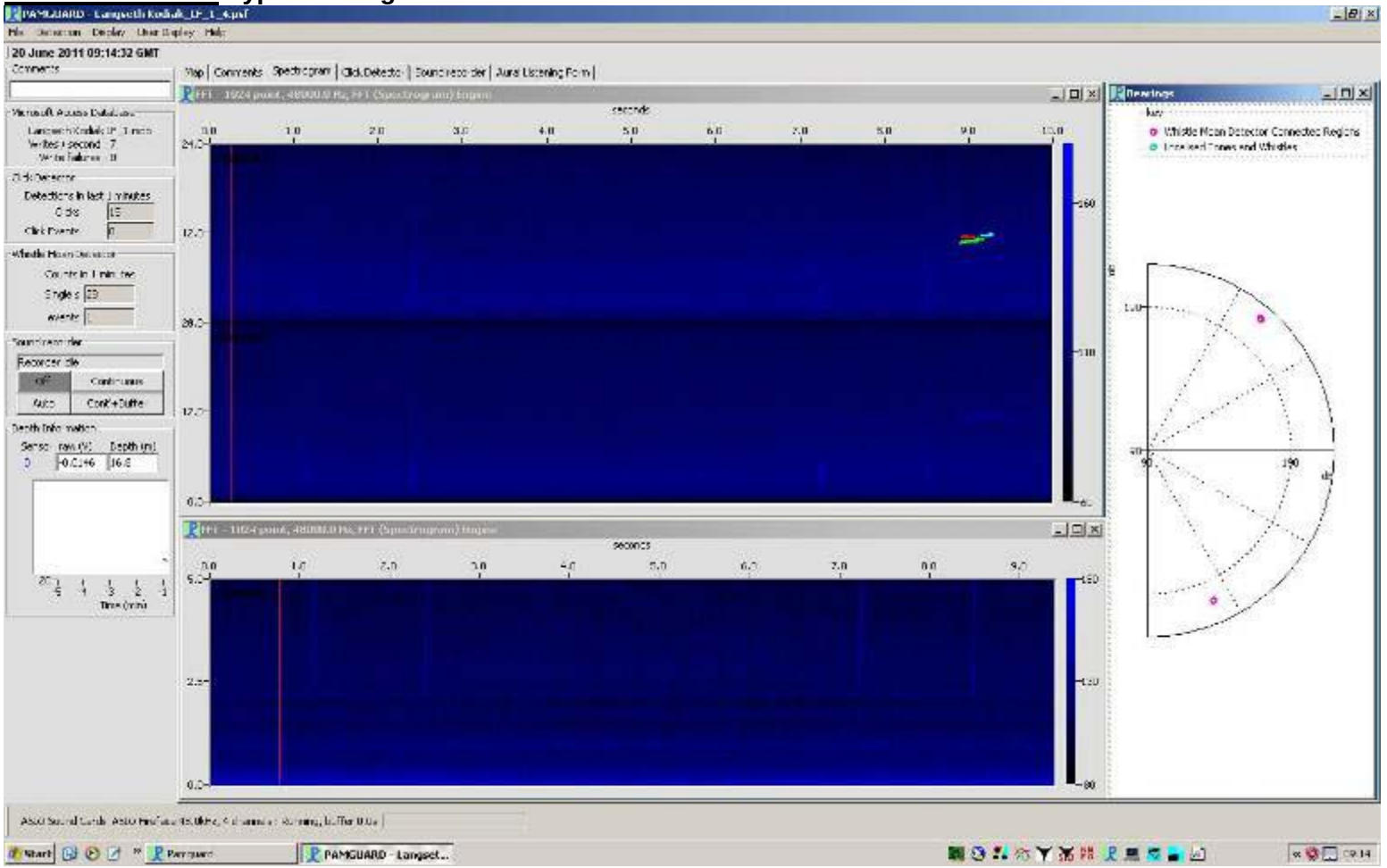

Figure 1. Main Pamguard low frequency operation screen displaying scrolling Spectrograms from three hydrophone channels and the Whistle and Moan Bearing Radar which plots the bearing of detected whistles and moans in relation to the hydrophones

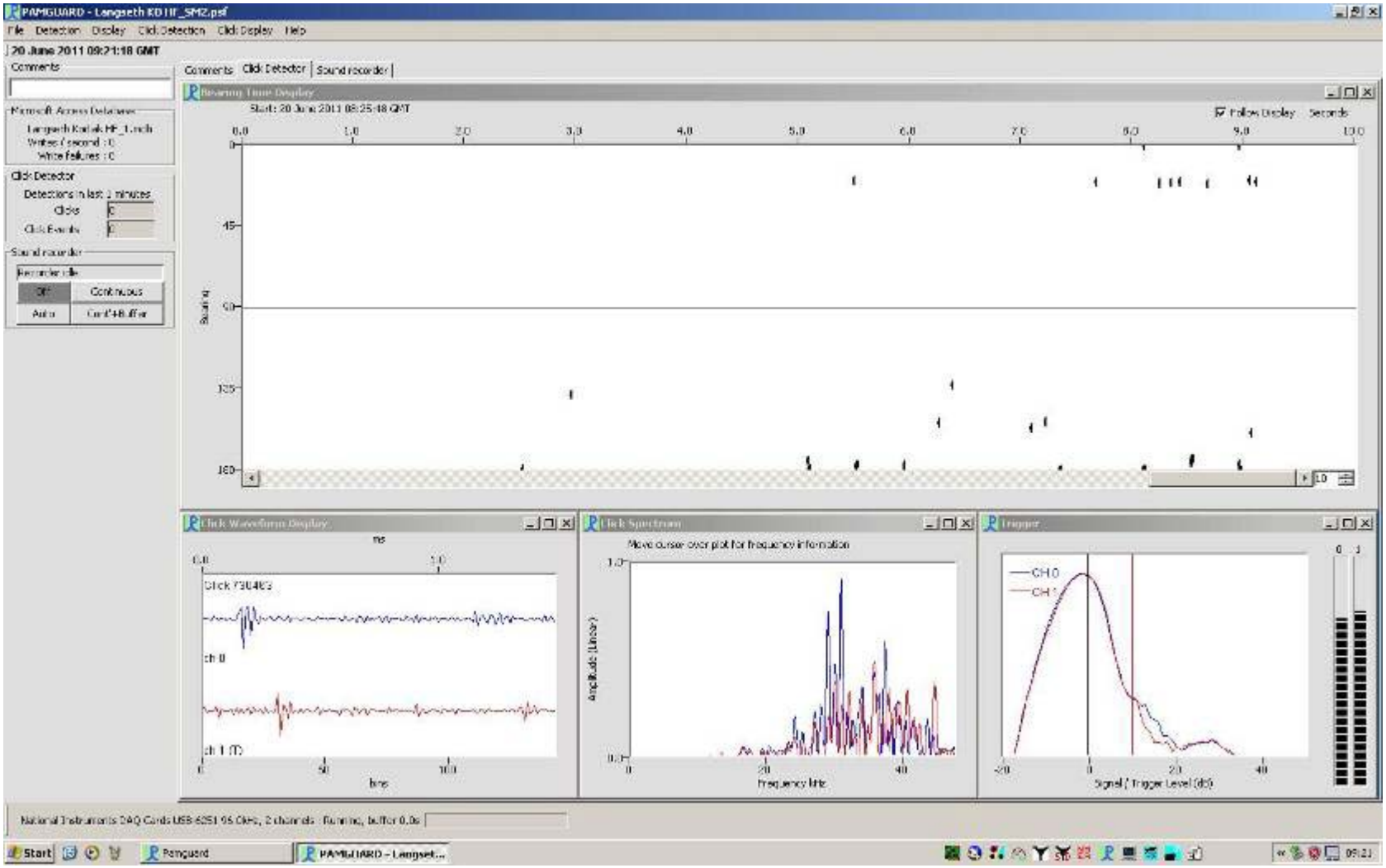

Figure 2. Click Detector module used on both high frequency and low frequency Pamguard laptops to track echolocation clicks

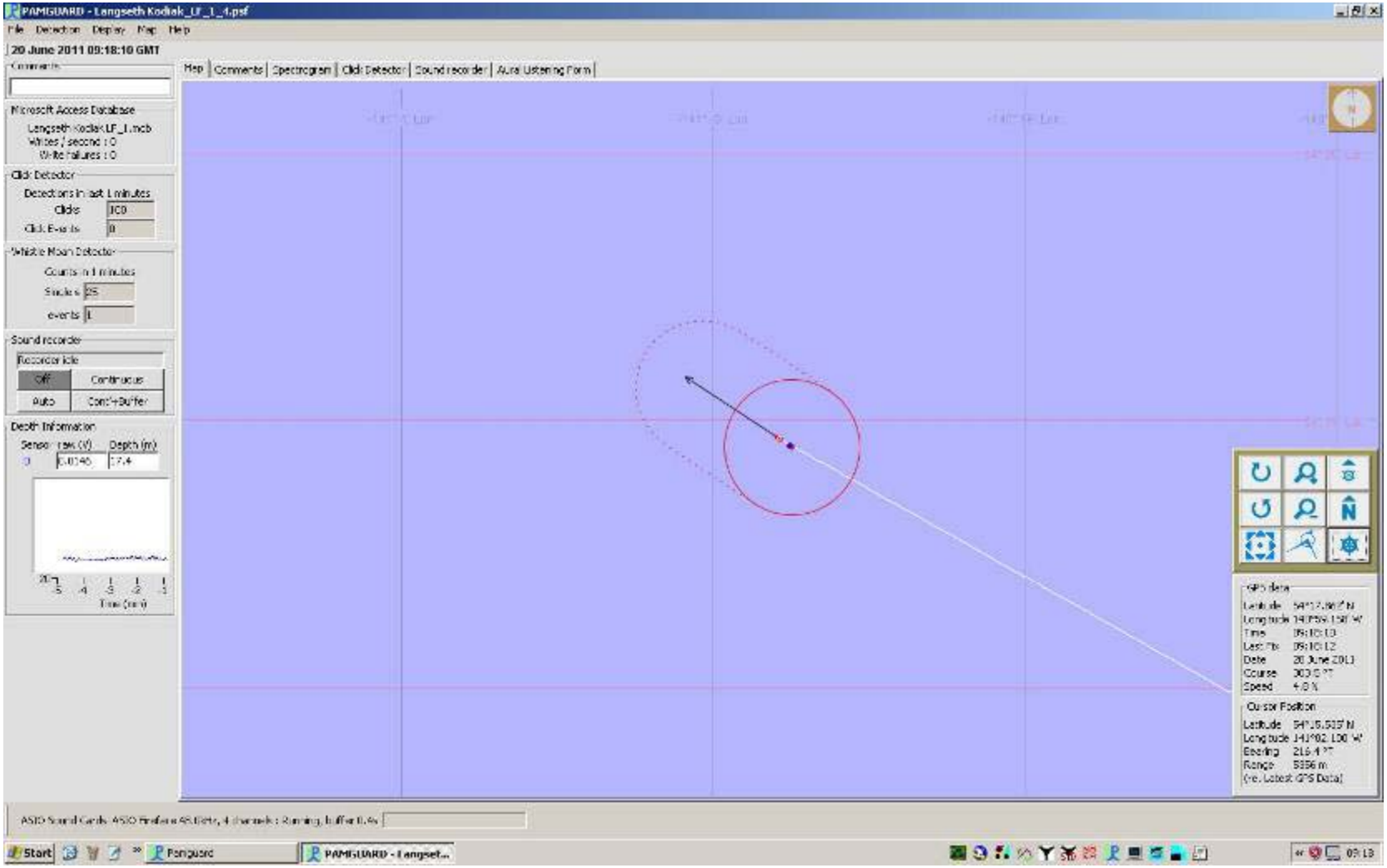

Figure 3. Map module on the low frequency Pamguard laptop where tracked marine mammal vocalisations can be plotted and range can be calculated

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

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 6). 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.

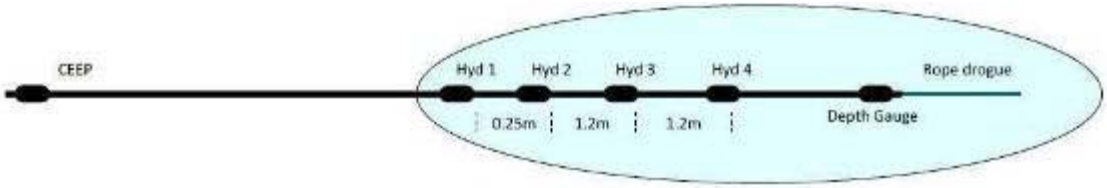

Figure 1. Diagram of Linear Hydrophone Array

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 7). 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. The 250m hydrophone cable is wound on a section of a deckhead winch on the port side of the gun deck (Figure 8). 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 9). An 8m rope drogue was secured to the end of the hydrophone cable with zip ties with a 1kg shackle secured to the end of the rope drogue with a knot and tape (Figure 10). Second three lengths of chain weighing approximately 2.5kg in each were secured on the cable with tape, 3m, 45m, and 96m up from the depth gauge (Figure 11). The hydrophone is deployed approximately 150m from the stern and 50m before the center of string (Figure 12). Being that the hydrophone cable is free and independent of the guns the cable is always retrieved before port gun strings are moved.

Figure 2. PAM Laptops and data processing unit setup

Figure 3. Hydrophone cable on winch

Figure 4. Hydrophone cable secured by a yale grip to the port sponson

Figure 5. Rope drogue and first chain weight secured near hyrdophone elements.

Figure 6. One of the three lengths of chain used to weigh down the cable.

APPENDIX F: Beaufort Sea Scale

Beaufort Number	Wind Speed (knots)	Wind Description	Specification for Use
0	Less than 1	Calm	Sea like a mirror
1	1 to 3	Light air	Ripple with the appearance of scales are formed, but without foam crests.
2	4 to 6	Light breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break.
3	7 to 10	Gentle breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.
4	11 to 16	Moderate breeze	Small waves, becoming larger; fairly frequent white horses.
5	17 to 21	Fresh breeze	Moderate waves, taking a more pronounced long form; many white horses are formed. Chance of some spray.
6	22 to 27	Strong breeze	Large waves begin to form; the white foam crests are more extensive everywhere. Probably some spray.
7	28 to 33	Near gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
8	34 to 40	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind.
9	41 to 47	Strong gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.
10	48 to 55	Storm	Very high waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes on a white appearance. The 'tumbling' of the sea becomes heavy and shock-like. Visibility affected.
11	56 to 63	Violent storm	Exceptionally high waves (small and medium-size ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected.
12	More than 64	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.

APPENDIX G: Acoustic monitoring down-time events during the USGS GOA ECS survey

Date	Time Watch Suspended	Date	Time Watch Resumed	Duration acoustic monitoring suspended	Comments
2011-06-09	17:15	2011-06-09	18:00	00:45	PAM Operator/Lead PSO needed in tower for mitigation situation with potential zero take species
2011-06-10	8:37	2011-06-10	9:42	1:05	PAM shut down to deploy the hydrophone cable further astern to reduce ship noise interference.
2011-06-10	19:00	2011-06-11	0:11	5:11	Hydrophone cable retrieved to allow for port side gun strings to be brought on board without fear of entanglement.
2011-06-14	16:13	2011-06-14	18:40	2:27	Hydrophone cable retrieved to allow for port side gun strings to be brought on board without fear of entanglement.
2011-06-16	15:03	2011-06-17	6:30	15:27	Vessel retrieving PAM cable and magnometer d/t increased sea state of B6, seas 4m.

APPENDIX H: Protected Species Detections During USGS GOA ECS survey

Movement Codes: **TV**: towards vessel; **AV**: away from vessel; **PV/SD**: parallel vessel, same direction; **PV/OD**: parallel vessel, opposite direction; **CR:** crossing ahead; **MI**: milling ; **ST**: stationary; **V:** variable, **UN**: unknown**; OM**: other movement

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

Visual Det Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	CPA to Source (m) / Source Activity	Movement at Initial Det/ Behaviour		Source Activity (Initial Detection)	Mitigation Action	Comments
1	8-Jun	14:50	Unidentified baleen whale	6	56.99233°N 146.66382°W	1535 Full power	PV/ OD	NS, BL, DF	Full power	None	Fin or sei whales.
2	9-Jun	16:41	Unidentified baleen whale	2	56.60113°N 147.74078°W	950 Not firing	CR/ AV	NS, BL, DF	Full power	Shut-down	Pre-cautionary shut-down not required under the IHA. Fin or sei whales.
3	9-Jun	21:47	Unidentified baleen whale	1	56.35470°N 147.32040°W	2100 Not firing	PV SD	NS,BL	Full power	Shut-down	Pre-cautionary shut-down not required under the IHA. Probable fin whale.
4	10-Jun	15:17	Fin whale	6	55.34533°N 145.67633°W	360 Not firing	CR	BL,SA, NS, DI	Full power	Shut-down	Pod of 6 whales including one juvenile.
5	10-Jun	18:29	Fin whale	4	55.18143°N 145.44000°W	1089 Full power	AV	NS, BL	Full power	None	
6	10-Jun	22:09	Fin whale	1	55.09260°N 145.40910°W	505 40 in3	CR	NS, BL	Full power	Power-down	
7	10-Jun	23:07	Unidentified baleen whale	4	55.13533°N 145.35933°W	9410 Soft-start (<1650in^3)	CR	NS, BL	Soft-start (<1650in3)	None	Probable fin whales. Identification could not be confirmed due to the large distance from which animals were observed.
8	11-Jun	03:18	Fin whale	3	55.25867°N 145.34000°W	4619 Full power	PV/ OD	NS, BL	Full power	None	
9	11-Jun	06:35	Unidentified baleen whale	1	55.55278°N 145.21667°W	1349 Full power	AV	NS, BL	Full power	None	Probable fin whale. Identification could not be confirmed as night approached

Visual Det Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	CPA to Source (m) / Source Activity	Movement at Initial Det/ Behaviour		Source Activity (Initial Detection)	Mitigation Action	Comments
10	11-Jun		Dall's porpoise	2	55.56450°N 146.09733°W	190 Full power	AV	FT, BR	Full power	Power-down	
11	12-Jun	00:38	Unidentified baleen whale	4	55.60723°N 146.82497°W	600 Full power	PV/ OD	BL,NS SA	Full power	Power-down	
12	12-Jun	19:38	Unidentified baleen whale	2	55.44867°N 145.91272°W	1500 Full power	PV/ SD	BL	Full power	None	
13	12-Jun	22:34	Unidentified baleen whale	1	55.42513°N 145.50733°W	1535 Full power	UN	BL	Full power	None	
14	12-Jun	22:57	Unidentified baleen whale	1	55.42148°N 145.44703°W	1715 Full power	CP	BL	Full power	None	
15	13-Jun	00:46	Unidentified baleen whale	2	55.40701°N 145.22267°W	500 Full power	AV; TV/ AV	BL	Full power	Power-down	
16	13-Jun	02:42	Fin whale	2	55.39650°N 144.98208°W	250 (40 in^3)	PV/ SD	BL,NS, SA,FF ,SBS	Full power	Power-down	
17	13-Jun	15:07	Dall's porpoise	6	55.33670°N 143.37183°W	200 (40 in^3)	PV/ OD	FT	Full power	Power-down	
18	13-Jun	16:36	Unidentified pinniped	1	55.33033°N 143.52283°W	90 Full power	CP	NS, SA	Full power	Power-down	Probable northern fur seal. Sighting was very brief.
19	13-Jun	18:44	Fin whale	4	55.35512°N 142.86407°W	3031 Full power	CP	BL	Full power	None	
20	13-Jun	19:18	Unidentified baleen whale	1	55.35512°N 142.86407°W	2819 Full power	PV/ OD	BL	Full power	None	
21	13-Jun	22:41	Sperm whale	20	55.38360°N 142.44213°W	1274 Full power	NM	BL,NS, FT, R	Full power	None	Closest group of 8 logging whales exhibited no movement. Other whales were travelling at moderate to fast pace parallel vessel and in opposite direction
22	14-Jun	00:32	Unidentified baleen whale	1	55.39847°N 142.21422°W	5700 Full power	UK	BL	Full power	None	

Visual Det Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	CPA to Source (m) / Source Activity	Movement at Initial Det/ Behaviour		Source Activity (Initial Detection)	Mitigation Action	Comments
23	14-Jun	04:06	Unidentified baleen whale	1	55.41013°N 142.02890°W	4270 Full power	AV	BL	Full power	None	
24	14-Jun	15:08	Unidentified baleen whale	1	55.50567°N 140.29233°W	3250 Full power	UK	BL	Full power	None	
25	14-Jun	19:46	Sperm whale	5	55.50650°N 140.14183°W	870 Full power	CP	NS,BL	Full power	Power-down	
26	16-Jun	14:49	Northern fur seal	1	53.72220°N 140.06825°W	10 Full power	PV, TV	PO	Full power	Shut-down	The 40in gun was enabled once after the animal moved out of the single airgun safety radius but was shut-down when the animal immediately re-entered the radius. This also occurred when the animal departed enough to allow a ramp-up to begin
27	19-Jun	03:00	Northern fur seal	1	54.37050°N 138.21183°W	0 Not firing	PV SD	SBS, SA	Not firing	Delayed ramp-up	Sighted during a technical shut-down of the source
28	19-Jun	21:28	Dall's porpoise	7	53.84610°N 139.64725°W	1151 Full power	PV OD	FT	Full power	None	
29	20-Jun	12:50	Dall's porpoise	20	54.48017°N 141.29367°W	690 Full power	PV OD	FT	Full power	Power-down	
30	20-Jun	14:30	Northern fur seal	1	54.60015°N 141.27705°W	200 Full power	CP	R,NS	Full power	None*	Identification was not made until animal was alongside gun array and mitigation action could not be executed before animal was out of safety radius
31	20-Jun	20:37	Northern fur seal	1	55.10987°N 141.20475°W	8 Not firing	NM	R, NS	Full power	Shut-down	Power-down followed by a shut-down. Seal was asleep as vessel approached, woke up and approached arrays
32	20-Jun	23:35	Dall's porpoise	8	55.34483°N 141.17083°W	1289 Full power	MI	FT	Full power	None	
33	21-Jun	02:52	Unidentified baleen whale	3	55.59842°N 141.13382°W	6000 Full power	UK	BL	Full power	None	

Visual Det Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	CPA to Source (m) / Source Activity	Movement at Initial Det/ Behaviour		Source Activity (Initial Detection)	Mitigation Action	Comments
34	21-Jun	17:47	Northern fur seal	1	56.63273°N 141.27833°W	400 Full power	NM	R	Full power	Power-down	Resting on a log on the surface
35	21-Jun	20:27	Fin whale	2	56.68033°N 141.65200°W	1355 Full power	PV OD	BL	Full power	None	
36	21-Jun	21:22	Unidentified baleen whale	3	56.69558°N 141.77318°W	1289 Full power	TV	BL	Full power	None	
37	21-Jun	22:06	Unidentified baleen whale	5	56.70747°N 141.86865°W	2132 Full power	TV	BL	Full power	None	
38	22-Jun	00:55	Dall's porpoise	10	56.75488°N 142.25707°W	2814 Full power	TV	FT	Full power	None	
39	22-Jun	01:09	Fin whale	4	56.75900°N 142.29183°W	5664 Full power	PV SD	BL	Full power	None	
40	22-Jun	01:51	Dall's porpoise	10	56.77030°N 142.38575°W	900 Full power	PV OD	PO	Full power	Power-down	
41	22-Jun	03:03	Unidentified baleen whale	1	56.79083°N 142.55950°W	1535 Full power	UK	BL	Full power	None	
42	22-Jun	04:24	Unidentified baleen whale	1	56.82167°N 142.82333°W	1735 Full power	PV SD	BL	Full power	None	
43	22-Jun	06:09	Unidentified baleen whale	2	56.84785°N 143.05142°W	2600 Full power	UK	BL	Full power	None	
44	22-Jun	19:16	Unidentified baleen whale	1	57.04923°N 144.96627°W	3600 Full power	CP	BL FF	Full power	None	
45	23-Jun	01:16	Dall's porpoise	15	57.13483°N 145.88367°W	100 40 in^3	PV OD	FT	Full power	Power-down	
46	24-Jun	00:20	Unidentified baleen whale	1	56.26033°N 148.39900°W	4271 Full power	UK	BL	Full power	None	
47	24-Jun	01:07	Fin whale	2	56.22395°N 148.46455°W	1803 Full power	PV SD	BL	Full power	None	
48	24-Jun	02:13	Fin whale	8	56.16817°N 148.56440°W	845 Full power	CP	BL,FF	Full power	Power-down	Group spread out over ~2km. Only 2 animals entered safety radius

Visual Det Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	CPA to Source (m) / Source Activity	Movement at Initial Det/ Behaviour		Source Activity (Initial Detection)	Mitigation Action	Comments
49	24-Jun	14:16	Fin whale / Unidentified baleen whale	14	55.30417°N 150.06050° W	845 Full power	CP	BL, FF	Full power	Power-down	One juvenile present. Several animals spread out and only 2 entered the safety radius briefly. One mysticete identified in group that was not a fin whale. Possible blue whale
50	24-Jun	16:45	Dall's porpoise	20	55.30417°N 150.06050° W	763 Full power	PV SD	PO	Full power	Power-down	

APPENDIX I: Bird Species Observed During USGS GOA ECS Seismic Survey

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
Laysan albatross	Diomedeidae	*Diomedea*	*immutuabilis*	22	10
Black-footed albatross	Diomedeidae	*Phoebastra*	*nigripes*	45	9
Northern fulmar	Procellariidae	*Fulmarus*	*glacialis*	290	17
Tufted puffin	Alcidae	*Fratercula*	*cirrhata*	136	17
Horned puffin	Alcidae	*Fratercula*	*corniculata*	9	2
Sooty shearwater	Procellariidae	*Puffinus*	*griseus*	13	5
Crested auklet	Alcidae	*Aethia*	*cristatella*	7	1
Parakeet auklet	Alcidae	*Aethia*	*psittacula*	1	1
Black-legged kittiwake	Laridae	*Larus*	*tridactyla*	38	5
Leach's storm petrel	Hydrobatidae	*Oceanodroma*	*leucorhoa*	189	11
Mottled petrel	Procellariidae	*Pterodroma*	*inexpectata*	4	3
Fork-tailed storm petrel	Hydrobatidae	*Oceanodroma*	*furcata*	3	1
Arctic tern	Laridae	*Sterna*	*paradisaea*	2	1
Aleutian tern	Laridae	*Onychoprion*	*aleuticus*	2	2