Protected Species Mitigation and Monitoring Report

U.S. Geological Survey 2-D Seismic Reflection Scientific Research Survey Program: Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards, in the northwest Atlantic Ocean

Phase 2

10 April 2015 – 02 May 2015

R/V *Marcus G. Langseth*

Prepared for

Lamont-Doherty Earth Observatory of Columbia University
61 Route 9W, P.O. Box 1000, Palisades, NY 10964-8000

for submission to

National Marine Fisheries Service, Office of Protected Resources
1315 East-West Hwy, Silver Spring, MD 20910-3282

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Cruise ID No.	**MGL1506**	**411 N. Sam Houston Parkway E.**	
Authors	**Amanda Dubuque, Amy Piko, Amy Schmitt, Casandra Frey, Claudia Portocarrero**	**Houston, Texas 77060, USA**	
		Tel	**: (281) 448-6188**
Reviewer(s)	**Stephanie Milne**	**Fax**	**: (281) 448-6189**
Submittal Date	**05 August 2015**	**E-mail**	**:Stephanie.Milne@rpsgroup.com**
		Web	**: www.rpsgroup.com**

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1. EXECUTIVE SUMMARY

The National Science Foundation (NSF) owned research vessel, *Marcus G. Langseth* (R/V *Langseth*), operated by Lamont-Doherty Earth Observatory (L-DEO), of Columbia University, conducted a two dimensional (2-D) seismic survey in the northwest Atlantic Ocean. The survey was conducted in support of the United States Geological Survey (USGS) Coastal and Marine Geology Program, with the purpose of mapping the United States (U.S.) Atlantic Eastern Seaboard Extended Continental Shelf (ECS) region and investigating tsunami hazards. The study was performed in two phases, with the first phase being completed from 20 August 2014 to 13 September 2014. The following report covers phase two, which began on 10 April 2015 and was completed on 02 May 2015.

USGS, L-DEO and the NSF submitted an application to the National Marine Fisheries Service (NMFS) for authorization to harass small numbers of marine mammals incidental to the seismic survey conducted for the study. On 21 August 2014, an Incidental Harassment Authorization (IHA) and an Incidental Take Statement (ITS) were granted, which stipulated the conditions and mitigation measures under which behavioral harassment to marine mammals would be allowed during the survey. The U.S Fish and Wildlife Service (USFWS) were also consulted, and a Letter of Concurrence was issued on 11 August 2014 stating that the purposed activities were not likely to adversely affect the endangered roseate tern and Bermuda petrel, both of which could possibly occur in the survey area. The mitigation measures stipulated were implemented to minimize potential impacts to marine mammals, endangered or threatened sea turtles and sea birds during the survey. These measures included, but were not limited to, the use of N~~F~~MFS approved Protected Species Observers (PSOs) for both visual and acoustic monitoring, the establishment of an exclusion zone (EZ) radii, and the implementation of ramp-up, power-down and shut-down procedures.

The following report serves to comply with the reporting requirements pursuant to the Marine Mammal Protection Act and Endangered Species Act. Continuous protected species observation coverage during the survey was provided by RPS, the environmental consulting agency contracted by L-DEO for the project. Pursuant to the contract, PSOs monitored and reported on the presence and behavior of marine species, and directed the implementation of the mitigation measures as described in the IHA and ITS issued by NMFS for the survey. Four PSOs and one Passive Acoustic Monitoring (PAM) operator were present on board the R/V *Langseth* throughout the survey. Over the course of the survey, PSOs conducted visual observations for a total of 303 hours four minutes and acoustic monitoring for 379 hours and 42 minutes. The acoustic source was active for a total of 404 hours 21 minutes during the survey, which occurred during 78% (237 hours 42 minutes) of visual monitoring and all but 1 hour 29 minutes of acoustic monitoring.

There were a total of ten protected species detections during the survey, including eight resulting from visual monitoring efforts and two resulting from acoustic monitoring efforts. Detections included loggerhead sea turtles, unidentified delphinids, short-beaked common dolphins and bottlenose dolphins totalling approximately 39 individuals. Of the three detections that occurred while the acoustic source was active, only one resulted in the implementation of a power-down, which totaled 15 minutes of mitigation downtime. Only one cetacean (an unidentified delphinid) was observed to have been exposed to sound levels equal to or greater than 160 dB from the acoustic source, constituting a potential level B harassment take as defined by NMFS. Although the approximately nine unidentified delphinids detected acoustically occurred during active acoustic source, they were not visually

confirmed to have been exposed to sound levels equal to or greater than 160 dB. No sea turtles were observed to be exposed to sound levels equal to or greater than 166 dB.

A total of 24,126 animals, 19,428 marine mammals (including 224 whales listed as endangered species) and 4,698 endangered sea turtles, were authorized for takes in the IHA and ITS issued by NMFS. Of these animals, 12,230 were authorized for phase two of the project in 2015. During the survey, one unidentified delphinid was observed to be potentially exposed to sound levels greater than 160 dB. The monitoring and mitigation measures required by the IHA and ITS appear to have been an effective means to protect the few marine species encountered during this survey.

A project summary sheet of observation, detection, and operational totals for the R/V *Langseth* can be found in Appendix B.

2. INTRODUCTION

The following report details the protected species monitoring and mitigation measures as well as seismic survey operations conducted as part of phase two of the USGS Extended Continental Shelf (ECS) 2-D marine geophysical survey on board the R/V *Langseth* from 10 April to 02 May 2015.

This document serves to meet the reporting requirements described in the IHA and the ITS issued to USGS, L-DEO, and NSF by NMFS on 21 August 2014. The IHA and ITS authorized non-lethal "takes" of Level B harassment of specific marine mammals and sea turtles, incidental to a marine seismic survey. NMFS has stated that seismic source received sound levels greater than 160 dB re 1 µPa (root mean square (rms)) and 166 dB re 1 µPa (rms) could potentially disturb marine mammals and sea turtles, respectively, temporarily disrupting behavior, such that they could be considered non-lethal 'takes'.. Potential consequences of Level B harassment taking could include effects such as temporary hearing threshold shifts, behavior modification and other reactions. NMFS has stated that seismic source received sound levels greater than 166 dB re 1 µPa (root mean square (rms)) could potentially disturb sea turtles. A safety exclusion zone was established for sound levels greater than 180 dB re 1 µPa (rms) for which the sound source must be powered down or shut down to avoid exposing cetaceans and sea turtles to these higher sound levels, where permanent hearing threshold shifts might occur. It is unknown to what extent cetaceans exposed to seismic noise of either 160 or 180 dB re 1 µPa (rms) level would express these effects, and in order to take a precautionary approach, NMFS required that provisions such as EZ radii, power-downs and shut-downs be implemented to mitigate for these potentially adverse effects.

United States Fish and Wildlife Service (USFWS) issued a Letter of Concurrence on 11 August 2014 that the proposed actions may affect but were not likely to adversely affect, the endangered roseate tern and Bermuda petrel. Mitigation for endangered seabirds would include shut-downs in the event that the seabirds were observed diving within the established exclusion zone for the survey. No specific reporting requirements were identified for encounters with endangered seabirds; however, they would have been included in this report along with mitigation actions if any had occurred over the course of the survey.

2.1. PROJECT OVERVIEW AND LOCATION

The purposes of the study were (1) to define the seafloor and sub-seafloor that is part of the United States of America's (U.S.'s) Extended Continental Shelf (ECS) and (2) to study landslides on the Atlantic margin as part of understanding tsunamigenic hazards. Regarding the first purpose, the ECS project is part of an interagency task force to identify all the parts of the U.S. margins beyond 200 nautical miles where the U.S. can potentially exert its sovereign rights. Only after the ECS is delineated can it be designated for conservation, management, resource exploitation, or other purpose. Regarding the second purpose, the data acquired will be used to study the geologic conditions that may trigger submarine landslides and to provide better constraints on modeling their origin and extent.

This report discusses phase two of a two-part cruise survey with the first portion completed August – September 2014. During phase one of the project, the R/V *Langseth* departed Brooklyn, New York on 20 August 2014 and began the survey on 23 August 2014. Phase one of the survey was completed on 11 September 2014 and the R/V *Langseth* arrived in Norfolk, Virginia on 13 September 2014. A total of 2,742.875 kilometers of transect lines were surveyed in phase one.

During phase two of the project, the R/V *Langseth* departed Charleston, South Carolina on 10 April 2015 and began seismic acquisition at 12:09 UTC on 12 April 2015. Phase two was completed at 4:00 UTC on 30 April 2015 and the R/V *Langseth* arrived in Brooklyn, New York at 02:55 UTC on 02 May 2015. A total of 3,168 kilometers of transect lines were surveyed in phase two.

The survey was conducted in the northwest Atlantic Ocean within the U.S. Exclusive Economic Zone (EEZ) and international waters, operating approximately 130 nautical miles to as far as 350 nautical miles from the coast (Figure 1). The water depth in the survey area ranged from 1,450 meters to 5,400 meters. The following geographic coordinates bound the survey area:

40.5694°N, 066.5324°W
38.5808°N, 061.7105°W
29.2456°N, 072.6766°W
33.1752°N, 075.8697°W
39.1583°N, 072.8697°W

The R/V *Langseth* deployed four acoustic source arrays approximately 175.5 meters astern of the vessel at a depth of 9 meters. Each array consisted of nine sub-arrays, with a total of 36 airguns as an energy source. The receiving system consisted of one eight-kilometer hydrophone streamer. As the acoustic source array was towed along the survey lines, the hydrophone streamer received the returning acoustic signals and transferred the data to the onboard processing system where the data was processed while the survey was underway.

The survey was designed with almost continuous track line segments and seismic data was continuously acquired during the short line changes. Phase one survey lines consisted primarily of the track lines that ran along the periphery of the survey area, including several internal track lines. During phase two, the survey included dip and strike lines (dip lines are lines that are perpendicular to the north-south trend of the continental margin and strike lines are parallel to the margin).

A total of 24 transect lines were surveyed in phase two. The R/V *Langseth's* cruising speed was about nine knots during transits and varied between one and eight knots during the seismic survey, with most variation due to currents.

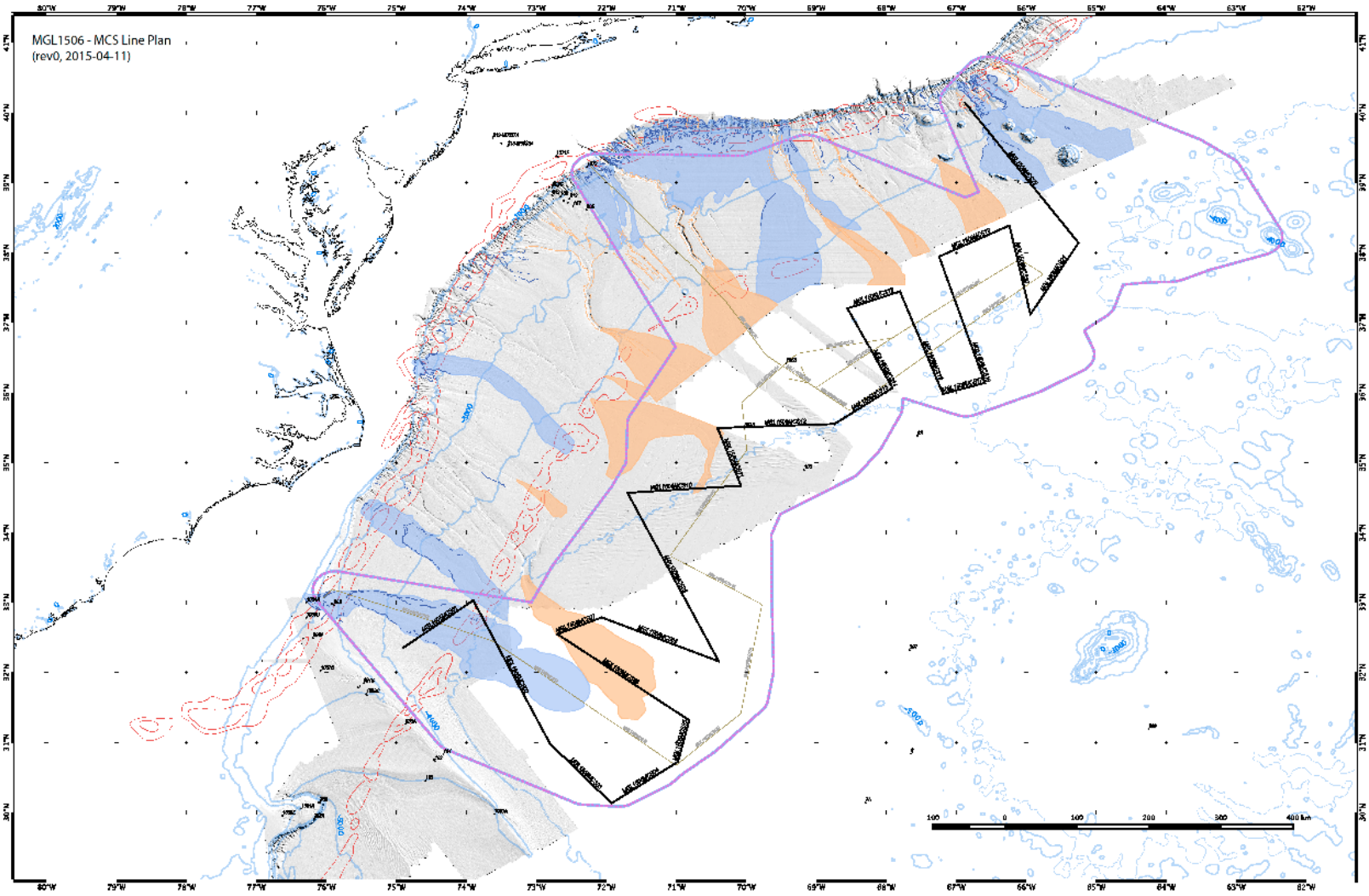

Figure 1. Location and survey lines of the USGS ECS 2-D marine geophysical survey in the Northwest Atlantic Ocean.

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L-DEO/NMFS
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2.1.1. Energy Source

The acoustic source consisted of 36 airguns on four towed airgun sub-arrays and one eight-kilometer hydrophone streamer cable. The sub-arrays were deployed in two pairs located approximately eight meters apart; within each pair, the arrays were separated by approximately six meters. The airguns were towed at a depth of nine meters and were situated 205 meters from the Navigational Reference Point (NRP), which was located on the PSO observation tower.

Each source array utilized a mixture of Bolt 1500LL and Bolt 1900LLX elements ranging in volume from the smallest airgun of 40 in^3 to the largest of 360 in^3. Each sub-array contained ten elements, with the first and last spaced 16 meters apart. Only nine airguns on each sub-array were active during survey acquisition, with the tenth gun utilized as a spare. The total volume of each sub-array was 1,650 in^3. The full power source of all four sub-arrays (36 airguns) had a total discharge volume of 6,600 in^3 and a pressure of approximately 2,000 psi. Each discharge of the source consisted of a single brief pulse of sound (duration of approximately 0.1 second) with the greatest energy output occurring in the zero to 188 hertz frequency range.

The shot interval for the majority of the multichannel seismic (MCS) survey was 50 meters, equating to approximately 20 to 24 seconds at typical survey speed.

The sound signal receiving system during the acquisition of the MCS transect lines consisted of one eight kilometer long hydrophone streamer which received the returning acoustic signals and transferred the data to the processing system located on board the vessel. Due to the length and placement of the cables, the maneuverability of the vessel was limited while the gear was deployed.

Two additional acoustical acquisition systems were operated throughout the survey. A Kongsberg EM 122 multibeam echosounder (MBES) was in use throughout most of the operations to map characteristics of the ocean floor. The hull-mounted echosounder emitted brief pulses of sound (also called a ping) (10.5 to 13.0 kilohertz (kHz)) in a fan-shaped beam that extended downward and to the sides of the ship. The nominal source level for the MBES was 242 dB re: 1 µPa. The R/V *Langseth* also operated a Knudsen Chirp 3260 sub-bottom profiler (SBP) concurrently during airgun and echosounder operations to provide information about the sedimentary features and bottom topography. It was capable of reaching water depths of 10,000 meters and penetrating tens of meters into the sediments. The hull-mounted SBP emitted a ping with a dominant frequency component at 3.5 kHz. The nominal source level for the profiler was 222 dB re: 1 µPa.

3. MITIGATION AND MONITORING METHODS

The PSO monitoring program on the R/V *Langseth* was established to meet the standards set forth in the PEIS, NSF Final EA and FONSI, USGS Final EA and FONSI, USFWS LOC, and the IHA and ITS requirements that were issued to USGS, L-DEO and NSF by NMFS, which included both monitoring and mitigation objectives. The survey mitigation program was designed to minimize potential impacts of the R/V *Langseth*'s seismic program on marine turtles, marine mammals, and other protected species of interest. The following monitoring protocols were followed to meet these objectives. A complete list of mitigation procedures can be found in Appendix C.

- Visual observations were conducted to provide real-time sighting data, allowing for the implementation of mitigation procedures as necessary.
- Operation of a Passive Acoustic Monitoring system to augment 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.
- Power downs or source shut downs for protected species that come within the 180 dB re 1 µPa (rms) safety zone (cetaceans and sea turtles) and the 190 dB re 1 µPa (rms) for pinnipeds.

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

3.1. VISUAL MONITORING SURVEY METHODOLOGY

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

Figure 2. Protected Species Observer observation tower with mounted big-eye binoculars, as seen from the stern of the vessel.

The PSO tower was equipped with Fujinon 7x50 binoculars as well as two mounted 25x150 Big-eye binoculars. A D-300 Night Vision Monocular was also available, but was not used during this survey as no ramp-ups were conducted during the night during this survey program. Inside the tarpaulin tent located in the middle of the platform was a laptop for data collection as well as a telephone for communication with the PAM station, bridge, or main lab. Also inside the tent was a monitor that displayed current information about the vessel's position, speed, and heading, along with water depth, wind speed and direction, and source activity. Environmental conditions along with vessel and acoustic source activity were recorded at least once an hour, and every time there was a change to one or more of the variables. Most observations were held from the tower; however, when there was severe weather or the ships exhaust was blowing on the tower, observations would be performed from the bridge (approximately 12.8 meters above sea level) or the catwalk (approximately 12.3 meters above sea level) in front of the bridge.

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

When the acoustic source was activated from silence, PSOs maintained a two-person watch for 30 minutes prior to the activation of the source. Visual watches commenced each day before sunrise, beginning as soon as the safety radii were visible, and continued past sunset until the safety radii became obscured. Start of observation times ranged from 09:30 to 10:00 UTC (05:30 to 06:00 local time), while end of observation times ranged from 23:30 to 24:00 UTC (19:30 to 20:00 local time).

A visual monitoring schedule was established by the PSOs where each person completed visual watches of varying lengths between one to four hours, two to four times a day, for a total of four to seven hours of visual monitoring per day. This schedule was arranged to ensure that two PSOs were on visual observation duty at all times except during meal breaks when PSOs would maintain a solo watch so that

the entire team could eat while maintaining both visual and acoustic monitoring. Solo watches lasted less than 50 minutes and occurred each day at meal times. As noted previously, two PSOs were always on watch during ramp-ups of the source.

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 would first identify the animals range to the acoustic source while identifying the observed animal (cetacean, pinniped, or sea turtle) to determine which safety radius applied to the animal. The visual PSOs would then notify the PAM operator of a presence of an animal and provide the location, relative to the mitigation radius. If the animal was observed inside the safety radius and a mitigation action was necessary, the PAM operator would relay the message to the seismic technician who was stationed next to the PAM Operator. This method was determined to be the most efficient as the phone at the PAM station is only called by PSOs in the tower whereas the phone at the technician desk is used by all the vessel departments and would occasionally be busy during a detection event.

Table 1 describes the various safety radii applied to cetaceans/sea turtles and pinnipeds, as well as the predicted Level-B harassment zone. The PAM operator was also notified of all marine mammal sightings as soon as possible in order for recordings to be made for analysis later by one of the more experienced acoustic operators to determine whether vocalizations had been detected on the PAM system during the sighting.

Table 1. Predicted mitigation radii/zones implemented

Source and Volume	Array Tow Depth (m)	Water Depth (m)	Power/Shut-down SR for Pinnipeds 190 dB (m)	Power/Shut-down SR for Cetaceans / Sea turtles 180 dB (m)	Level-B Harassment Zone 160 dB (cetaceans) / 166 dB (sea turtles) (m)
Single Bolt Airgun (40 in^3)	9	Deep (>1,000)	100	100	388
36 Airguns (6,600 in^3)	9	Deep (>1,000)	286	927	5,780

3.2. PASSIVE ACOUSTIC MONITORING SURVEY METHODOLOGY

Passive Acoustic Monitoring (PAM) was used to augment visual monitoring efforts by helping to detect, identify, and locate marine mammals within the area. PAM was not used as a stand-alone method to detect and mitigate for marine mammals; any detections originating from PAM monitoring were to be confirmed by visual monitoring to prompt a mitigation action. PAM was particularly beneficial during periods of darkness or low visibility when visual monitoring was not as effective. The PAM system was monitored 24-hours per day during seismic operations and when the acoustic source was not in operation, to the maximum extent possible.

Five Protected Species Observers (PSOs) were on-board to provide monitoring for protected species. One PSO was designated as the Primary PAM Operator who oversaw PAM operations. Three of the five PSOs, the Primary PAM Operator and two others, were trained and experienced with the use of PAM prior to the survey. The Primary PAM Operator trained the inexperienced PSOs in basic PAM system operation at the beginning of the survey.

All five PSOs rotated through acoustic monitoring shifts, which were one to six hours in duration. The Primary PAM Operator monitored many of the night time hours when visual monitoring was not being conducted and PAM was the only system in use for detecting cetaceans. For an acoustic detection during the night-time, the PAM operator was to notify an "on-call" PSO to visually monitor for the animals and request mitigation, if necessary. During daylight hours, PAM operators were in communication with visual PSOs to relay sighting and seismic activity information.

The PAM system was located in the main science lab to provide adequate space for the system, allow for quick communication with the visual PSOs and seismic technicians, and provide access to the vessel's instrumentation. The vessel's position, water depth, heading and speed, vessel and acoustic source activity were recorded at least once an hour.

In the event of an acoustic detection of a protected species, the PAM operator recorded the following information: acoustic encounter identification number; whether it was linked with a visual sighting; date; time when first detected, last detected, and when additional information was recorded; position and water depth when first detected; bearing, if determinable; species or species group; types and nature of sounds heard (e. g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.); and any other notable information.

Acoustic monitoring for marine mammals was conducted aurally using Sennheiser headphones, listening to lower audible frequencies from the Asio Fireface soundcard, and visually with Pamguard Beta 1.12.05. Dolphin whistles, clicks, and burst pulses as well as sperm whale and baleen whale vocalizations may be viewed on a spectrogram display within Pamguard. Sperm whale, beaked whale, Kogia species, and dolphin echolocation clicks may be viewed on low and high frequency click detector displays. The Spectrogram's amplitude range and appearance were adjusted as needed to suit the operator's preference to maximize the vocalizations appearance above the pictured background noise.

The map module within Pamguard could be monitored when vocalizations were detected to localize the position and distance to vocalizing marine mammals, when possible. When Pamguard could not determine the distance to a vocalizing animal, the experienced PAM operator made a distance estimation using the noise or detection score system developed by Gannier et al. (2002). Sound recordings were made using the sound recording module when potential marine mammal vocalizations were detected or when the operator noted unknown or unusual sound sources.

3.2.1. Passive Acoustic Monitoring Parameters

A Passive Acoustic Monitoring (PAM) system designed to detect most species of marine mammals was installed on board the R/V *Langseth*. The system was developed by Seiche Measurements Limited and consisted of seven main components: 250 meter conventionally towed linear array hydrophone cable, 100 meter deck cable, data processing unit, two laptop computers, acoustic analysis software package, and headphones for aural monitoring. A spare hydrophone array cable, deck cable and DPU were also present on board in the event the main array became damaged or inoperable. PAM system specifications can be found in Appendix D.

The hydrophone cable contained four hydrophone elements and a depth gauge moulded directly into the cable. The four-element linear hydrophone array allowed the system to sample a large range of marine mammal vocalization frequencies. The first two hydrophones were low frequency channels, with a frequency response of 200 hertz to 200 kilohertz. The third and fourth hydrophones were standard elements, with a frequency response of 2 kilohertz to 200 kilohertz.

The deck cable interfaced the hydrophone array and the data processing unit, which was set up in the main lab, along with two laptop computers. The electronic data processing unit contained a buffer processing unit with USB output and an RME Fireface 800 ADC processing unit with firewire output. One of the laptops displayed the high frequency range (HF system), using the signal from two hydrophones and the second laptop displayed the low frequency range (LF system), receiving signal from all four hydrophones. A GPS feed of GNGGA strings was supplied from the ship's Seapath navigation system and routed to the LF system, reading data every 20 seconds.

The HF system was used to detect and localize ultrasonic pulses produced by some dolphins, beaked whales, and Kogia species. The signal from two hydrophones was digitized using an analogue-digital National Instruments data acquisition (DAQ) soundcard at a sampling rate of 500 kilohertz, then processed and displayed on a monitor using the program Pamguard Beta 1.12.05 via USB connection. The amplitude of clicks detected at the front hydrophone was measured at 5th order Butterworth band-pass filters ranging from 120 kilohertz to 150 kilohertz with a high pass digital pre-filter set at 40 kilohertz (Butterworth 6th order). Pamguard used 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 displayed the detected clicks within the HF envelope band pass filter in real time, allowing for the identification and directional mapping of detected animal click trains.

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

3.2.2. Hydrophone Deployment

The PAM hydrophone cable was deployed from a winch on the port stern deckhead of the vessel's gun deck. Two deck cables, main cable and spare, were installed along the gun deck deckhead running from the winch to the science lab. The hydrophone array was towed 130 meters from the stern and 45.5 meters forward of the source array (Figure 3).

Details of the PAM system specifications can be found in Appendix D. A more detailed description of the hydrophone deployment methods and photos of the equipment can be found in Appendix E.

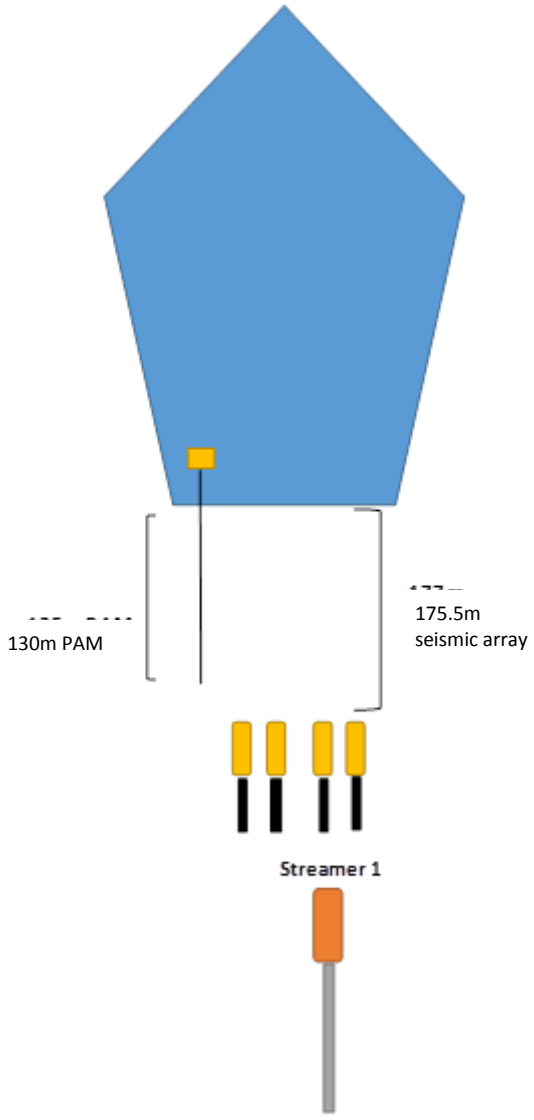

Figure 3. Location of the PAM cable in relation to the seismic gear.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

The R/V *Langseth* departed Charleston, South Carolina at 12:56 UTC on 10 April 2015 to transit to the survey site. At 01:06 UTC on 11 April 2015, the vessel stopped transit approximately 125 kilometres from the start of the first survey line to perform several tests with the multi-beam and vessel roll, which were completed at 11:41 UTC. The seismic gear deployment began at 11:48 UTC and was completed at 06:04 UTC on 12 April 2014. The source was initiated for the first time at 11:08 UTC on 12 April 2015 and acquisition began at 12:09 UTC with the first survey line.

The acoustic source was active continuously throughout the survey, with a few short breaks (see below), for a total of 404 hours 21 minutes. This includes ramp-ups, full and reduced volume firing both online and during line changes, and operation of a single 40 in³ mitigation airgun (Figure 4). Full volume (6600 in^3) sourcing while on a survey line accounted for 51% (205 hours 30 minutes) of all operations, while full volume sourcing during a line change accounted for 1% (3 hours 55 minutes) of operations. The volume of the acoustic source was reduced and changed frequently throughout the survey, mainly due to problems with individual source elements and during retrieval source arrays for maintenance and rough seas. Source volume varied from 1830 in^3 and 6570 in^3 using a range of ten to 36 source elements. While on a survey line, reduced volume sourcing accounted for 47% (189 hours 52 minutes) of all operations, and while on a line change it accounted for 1% (2 hours 55 minutes) of operations. Ramp-ups accounted for 1 hour 48 minutes and single/mitigation source activity accounted for 21 minutes of all source operations. There was no testing of the acoustic source performed during this survey.

A summary of the short breaks in acquisition is listed below:

- On 25 April 2015 three of the source arrays were brought on board due to rough weather conditions and source activity continued with the remaining arrays active. The arrays were re-deployed on 26 April 2015 when conditions improved.
- At 12:18 UTC on 26 April 2015 the source was silenced following compressor failure and acquisition resumed following a ramp-up.
- On 28 April the source was silenced at 18:52 UTC due to compressor failure. The mitigation source was enabled from 18:52 to 18:59 UTC while the issue was resolved and then the source resumed full volume.
- At 19:42 UTC that same day two arrays were brought on board due to rough sea conditions. At 22:03 UTC, worsening conditions prompted the survey line to be aborted and the remaining seismic arrays to be silenced and retrieved. The seismic gear was re-deployed on 29 April 2015 at 16:18 UTC and a ramp-up conducted to resume survey operations at 18:16 UTC.

Acquisition of the last survey line was completed at 04:00 UTC on 30 April 2015. The seismic equipment was retrieved and the R/V *Langseth* began the transit to Brooklyn, New York, arriving at 02:55 on 02 May 2015. The dates and times of acquisition for each survey line can be found in Appendix F.

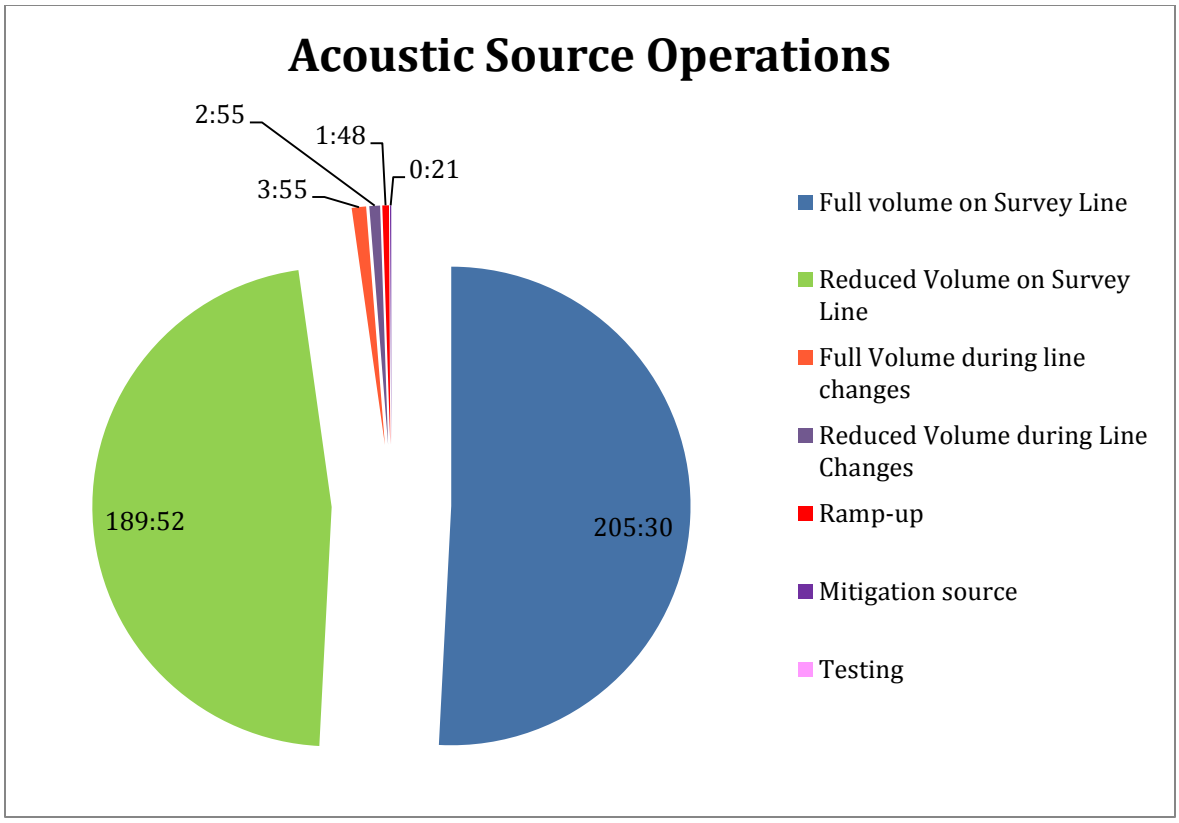

Figure 4. Total acoustic source operations over the course of the USGS ECS 2-D seismic survey

The acoustic source was ramped up three times, all during the day, during the survey in order to commence full volume operations from silence (Table 2). The first ramp-up was conducted to begin the start of the survey on 12 April 2015, the second on 26 April 2015 to resume operations from a mechanical shut-down, and the third on 29 April 2015 to resume operations that had been suspended briefly due to rough sea conditions. Each ramp up lasted approximately 36 minutes. The ramp-ups were conducted using the NMFS approved automated gun controller program, DigiShot which adds guns sequentially to achieve the full source volume over the required period of time. Specifically for this survey, Beaufort C was utilized, which allowed for an extra shot per gun before the next was added and for the time between shots to be increased from 17 seconds to 20 seconds. The ramp-ups were conducted starting with the smallest airgun and adding airguns in a sequence such that the source level would increase in steps not exceeding 6 dB in a five minute period. Since a doubling of the number of airguns is typically equal to a 6 dB increase in sound level, the array was not ramped up if more than half of the airguns in the array were already firing.

Table 2. Total acoustic source operations during the USGS ECS 2-D seismic survey

Acoustic Source Operations	Number	Duration (hh:mm)
Gun Tests		**00:00**
Ramp-up	**3**	**01:48**
Day time ramp-ups from silence	**3**	
Day time ramp-ups from mitigation	**0**	
Night time ramp-ups from mitigation	**0**	
Full volume survey acquisition		**205:30**
Full volume line changes		**03:55**
Reduced volume survey acquisition		**189:52**
Reduced volume line changes		**02:55**
Single airgun (40 in³)		**00:21**
Total time acoustic source was active		**404:21**

4.2. VISUAL MONITORING SURVEY SUMMARY

The PSOs began conducting visual monitoring as the vessel departed the port of Charleston at 13:00 UTC on 10 April 2015 and continued observation while the vessel was in transit to the survey site. This was undertaken to collect baseline data about protected species in the area. Visual monitoring was conducted during all daylight hours during all survey operations throughout the program. Visual monitoring was terminated at 00:20 UTC on 02 May 2015 when the vessel arrived in New York after the completion of the project.

Visual monitoring was conducted over a period of 23 days for a total of 303 hours 04 minutes. Monitoring was conducted from just before dawn to just after dusk, when the entire safety radius was first and lastly observable. Observations averaged 13 hours 40 minutes each day.

Two PSOs held visual watch at all times except during the scheduled meal hours. During this time a single PSO continued visual monitoring along with the PAM operator acoustically monitoring while each PSO rotated for a meal break. If a protected species sighting occurred during a single PSO watch, a second PSO would be notified to return to assist in monitoring. Two PSOs were always on watch for at least 30 minutes prior to the initiation of the acoustic source and throughout all ramp-ups, except for the first ramp-up on 12 April 2014 when the final 14 minutes were conducted with a single PSO on visual watch. This occurred because the first ramp-up was conducted during the breakfast meal hour, and one of the PSOs on watch stopped monitoring to attend breakfast, overlooking that ramp-up was in progress. Following the incident, procedures were reviewed, and it was agreed that, PSOs would confirm the seismic operating status with the PAM Operator on shift (such as ramp-up), prior to leaving for meal breaks.

The majority of visual monitoring was performed while the acoustic source was active (78%; 237 hours 42 minutes) (Figure 5). Visual monitoring during acoustic source silence was mainly conducted during the transit to and from the survey site (65 hours 22 minutes, or 22%). The total monitoring effort during both active and silent acoustic source is also provided in Table 3.

Table 3. Total visual monitoring effort during the survey program

Visual Monitoring Effort	Duration (hh:mm)	% of Overall Visual Monitoring Effort	% of Acoustic Source Activity Conducted with Visual Monitoring
Total monitoring while acoustic source active	237:42	78%	58%
Total monitoring while acoustic source silent	65:22	22%	-
Total monitoring effort	**303:04**	**-**	**-**

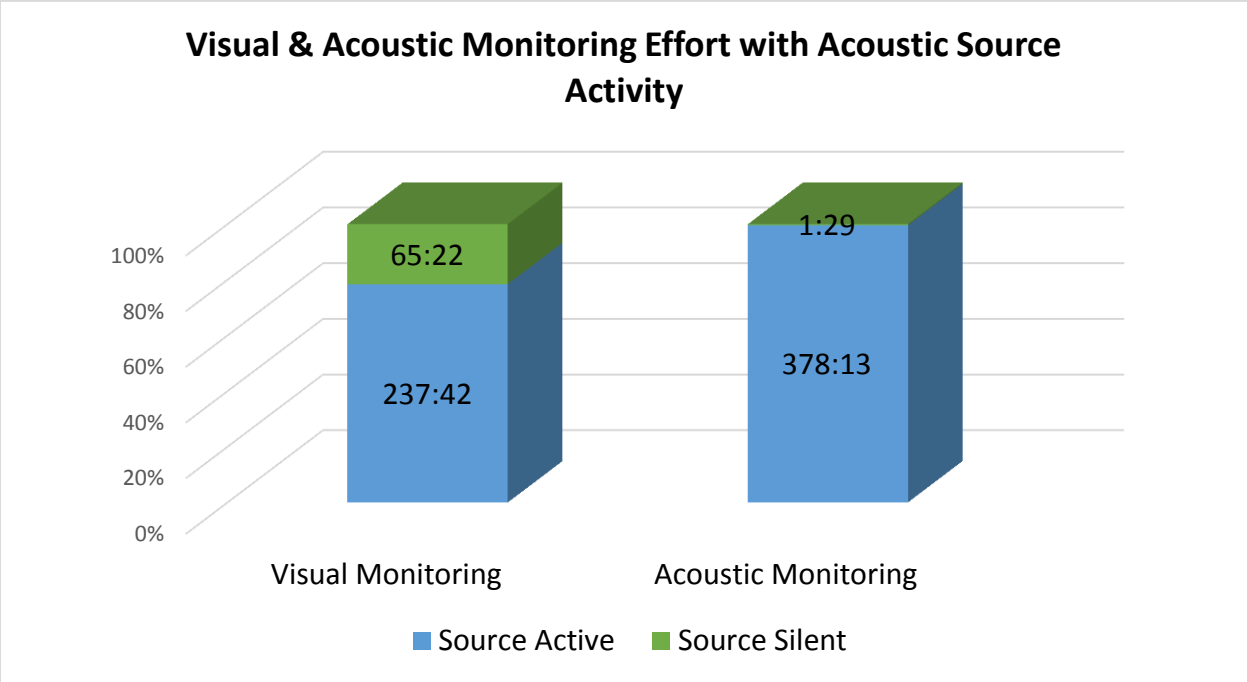

Figure 5. Visual and acoustic monitoring effort while the acoustic source was active and silent

Visual observations were preferentially conducted from the PSO tower, which provided a 360-degree view of the water around the vessel and the acoustic source. Visual watches could also be conducted from other locations including the catwalk or bridge if monitoring conditions could not be undertaken from the tower. During this survey, this mainly occurred during the several days where rough weather and sea conditions made the tower unsafe, and when the vessel was heading directly into the wind blowing the engine exhaust right onto the tower. PSOs monitored mainly from the tower (49%, 148 hours 04 minutes) and from the bridge (49%, 148 hours 48 minutes) (Figure 6).

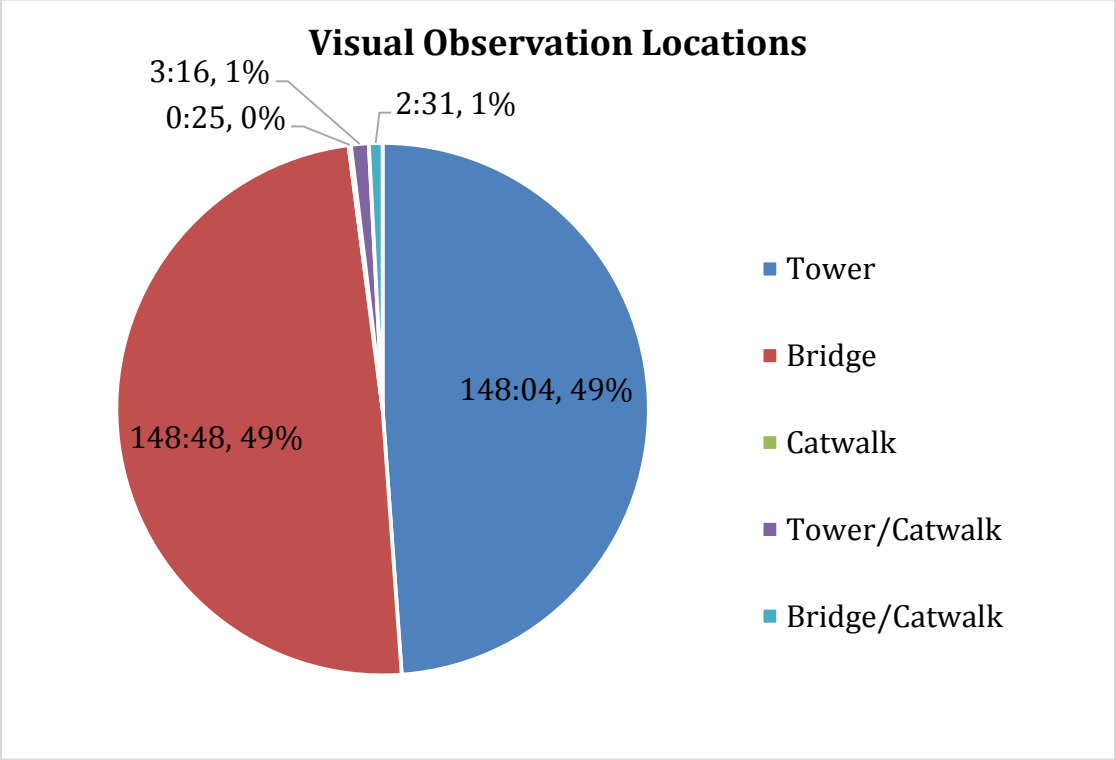

Figure 6. Total visual effort from observation locations during the USGS ECS program

4.3. ACOUSTIC MONITORING SURVEY SUMMARY

The PAM hydrophone cable was deployed for the first time on 12 April 2015 at 10:00 UTC after the seismic gear had been completely deployed. Acoustic monitoring began at 10:35 UTC and continued, day and night, whenever operationally possible for the duration of the project. Acoustic monitoring ended at 03:55 UTC on 30 April 2015 upon completion of the survey. During the survey, acoustic monitoring was conducted for a total of 379 hours and 42 minutes; all but 1 hour 29 minutes of acoustic monitoring occurred while the seismic source was active (Figure 5, Table 4).

Table 4. Total passive acoustic monitoring (PAM) effort during the USGS ECS survey program

Passive Acoustic Monitoring Effort	Duration (hh:mm)
Total night time monitoring	**156:01**
Total day time monitoring	**223:41**
Total monitoring while acoustic source active	**01:29**
Total monitoring while acoustic source silent	**378:13**
Total acoustic monitoring	**379:42**

The PAM cable was retrieved twice and acoustic monitoring was suspended four times during the survey. Acoustic monitoring was suspended for a total of 45 hours and 41 minutes (Table 5).

On 20 April 2015, there was concern that the PAM cable had become entangled with the seismic array. Acoustic monitoring was suspended to evaluate the situation. It was determined that the PAM cable was not entangled with the seismic gear and instead was under tension due to strong currents and the vessel's heaving motion in rough seas. No action was taken and monitoring resumed. Acoustic monitoring was suspended for a total of 17 minutes on this occasion during which time the acoustic source was active.

On 25 April 2015 acoustic monitoring was suspended at 04:04 UTC and the PAM cable was secured on deck following the evaluation that rough seas had increased the risk of entanglement of the hydrophone cable with seismic equipment. The PAM cable was redeployed on 26 April at 04:07 UTC and monitoring resumed at 04:15 UTC. Acoustic monitoring was suspended for a total of 19 hours and 56 minutes on this occasion during which time the acoustic source remained active.

On 28 April 2015, PAM was suspended from 18:46 to 18:59 UTC to untangle the hydrophone cable from the seismic gear. Acoustic monitoring was suspended for 13 minutes on this occasion during which time the acoustic source remained active.

On 28 April 2015, PAM was suspended at 20:50 UTC and the cable brought onboard at 22:38 UTC when the decision was made to bring all gear onboard due to increasingly rough sea conditions. On 29 April 2015, the hydrophone cable was redeployed at 17:47 UTC and acoustic monitoring resumed at 17:50 UTC when conditions improved enough to resume operations. PAM was suspended for a total of 21 hours during which time the acoustic source was active for 1 hour and 26 minutes.

Table 5. Passive Acoustic Monitoring (PAM) downtime during the USGS ECS survey program

Cause of Downtime	Duration (hh:mm)
Debris Removal and Maintenance Hydrophone Cable	**00:00**
Replacement of Damaged PAM Equipment	**00:00**
Rough Seas/Risk of Entanglement	**45:11**
Assessment and Adjustment to PAM Equipment	**00:30**
Seismic Gear Maintenance	**00:00**
Total Passive Acoustic Monitoring Downtime	**45:41**

4.4. SIMULTANEOUS VISUAL AND ACOUSTIC MONITORING SUMMARY

Acoustic monitoring was undertaken during all day and night hours during the USGS ECS survey when possible. During the day, a total of 223 hours 41 minutes of simultaneous visual and acoustic monitoring were undertaken (Figure 7), mainly during those periods when the acoustic source was active. Additional visual monitoring undertaken during transit periods could not be accompanied by acoustic monitoring for operational reasons.

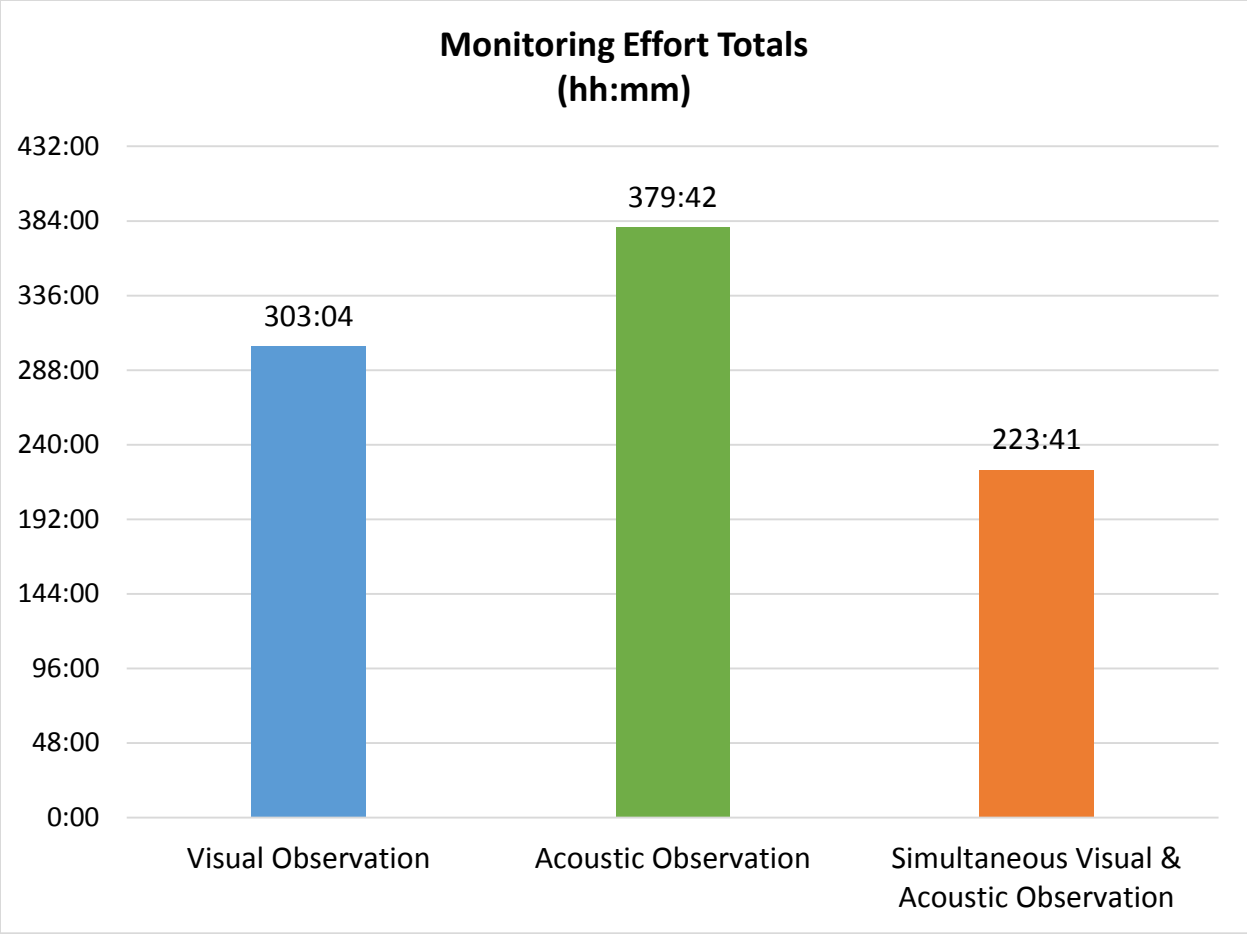

Figure 7. Total acoustic and visual monitoring effort

4.5. ENVIRONMENTAL CONDITIONS

Environmental conditions can have an impact on the probability of detecting protected species in a survey area. The environmental conditions present during visual observations undertaken during this survey program were highly variable.

Visibility was classified as 'excellent' if it extended to 10 kilometres or greater. A total of 152 hours and 10 minutes (50% of total effort) of visual monitoring effort was undertaken while visibility extended to 10 kilometres or greater (Figure 8). Periods of fog, light to heavy rain, and squalls were intermittently present throughout the survey and occasionally resulted in reduced visibility. A total of 48 hours 42 minutes of precipitation were recorded during periods of visual monitoring (15% of all monitoring effort) in addition to 1 hour and 11 minutes of fog and 1 hour and 47 minutes of squalls. Only 21 hours 51 minutes of monitoring was undertaken while visibility extended to less than 2 kilometres. The entirety of the 180 dB radius was occasionally obscured during visual monitoring while the acoustic source was active, occurring on several brief occasions during the survey for a total duration of 7 hours 43 minutes. The entire 160 dB radius was not visible during visual monitoring while the acoustic source was active on several occasions throughout the survey for a total of 64 hours.

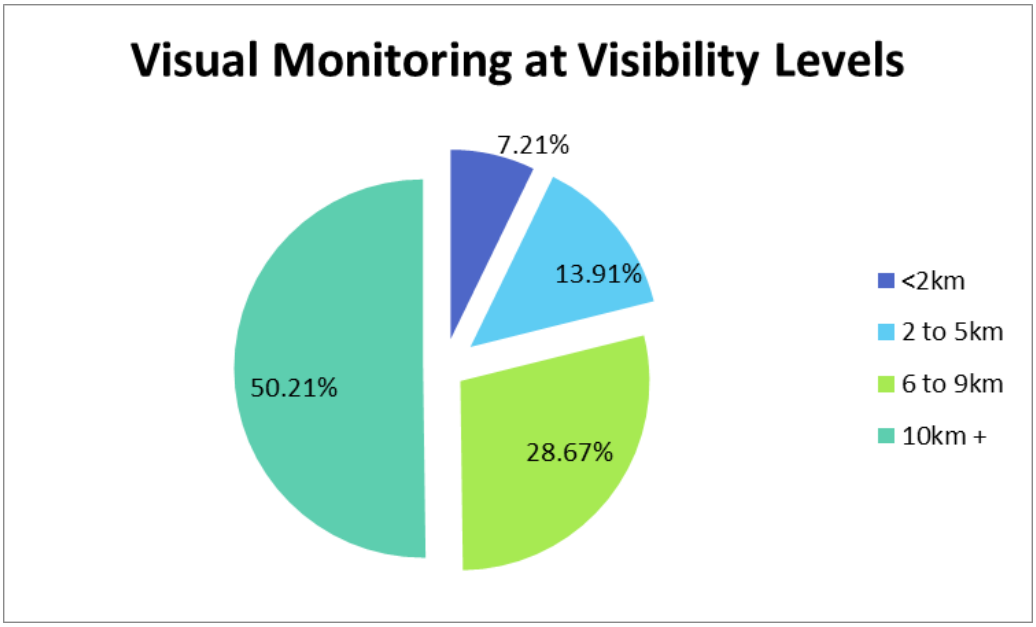

Figure 8. Visibility during visual monitoring.

The Beaufort Sea state recorded during visual monitoring ranged from level one to level eight over the course of the survey. Figure 9 shows a general breakdown of the Beaufort scale during each observation week of the survey. A total of 174 hours 26 minutes (57%) of visual observations were undertaken in conditions where the Beaufort state was rated level three or less, good conditions for the detection of most protected species.

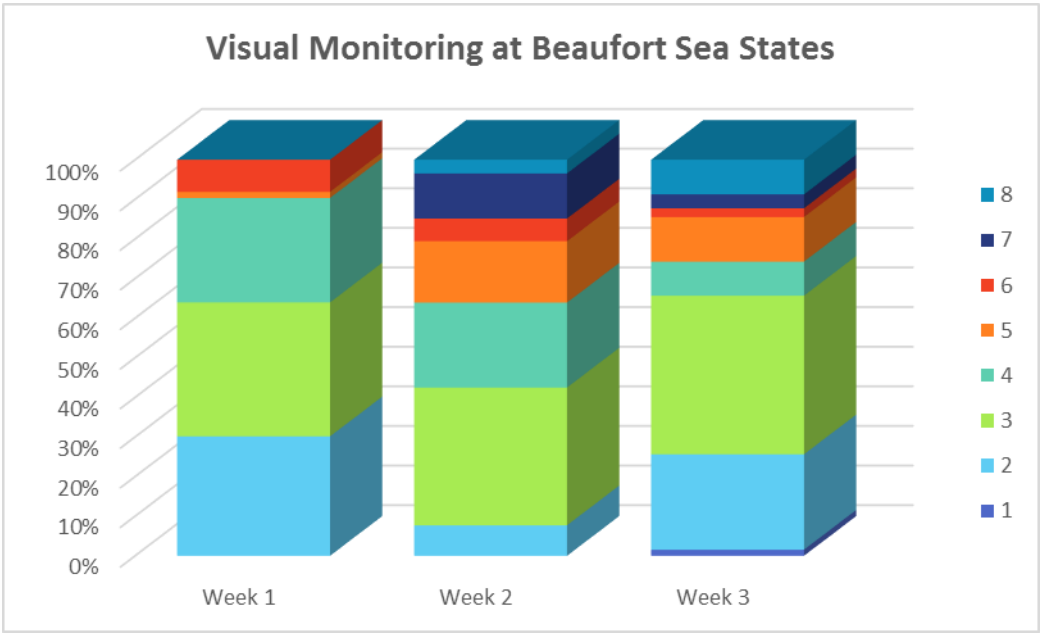

Figure 9. Total hours of observation at each Beaufort scale over the duration of the USGS ECS 2-D survey.

The largest percentage of visual monitoring was undertaken while wind speeds measured between 11 and 16 knots (87 hours 7 minutes, 29% of effort) (**Error! Reference source not found.**).

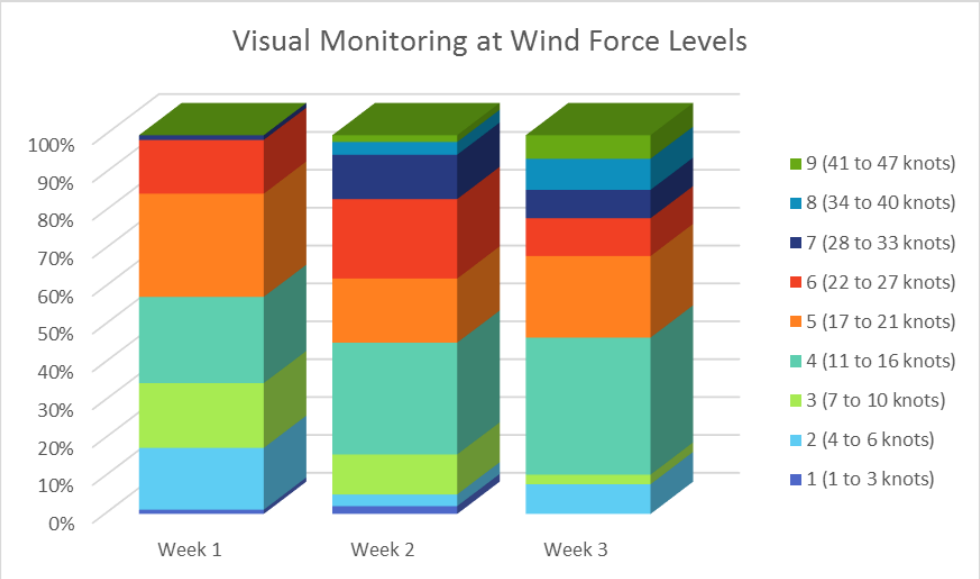

Figure 10. Average wind speed each week during visual monitoring.

Swell heights during visual observations were generally low, with swells of less than two meters recorded for over 79% of total visual effort. Only 10 hours 57 minutes (less than 4%) of visual observations were undertaken while swells were recorded at heights of greater than four meters, all of which occurred during the second and third of the survey program (Figure 11).

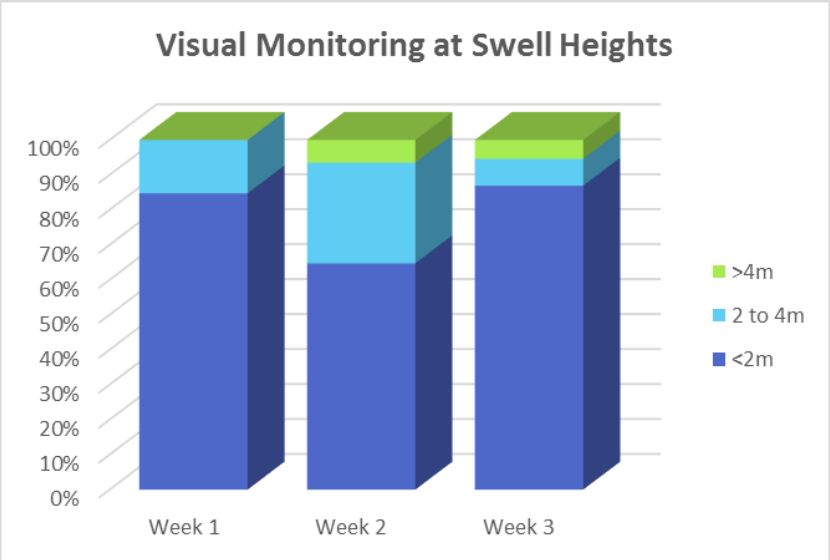

Figure 11. Swell heights while visual monitoring was conducted.

Moderate glare was present during 60 hours 47 minutes (20%) and severe glare was present for 48 hours 15 minutes (16%) of visual monitoring during the survey, possibly hindering the detection of protected species in areas of glare (**Error! Reference source not found.**).

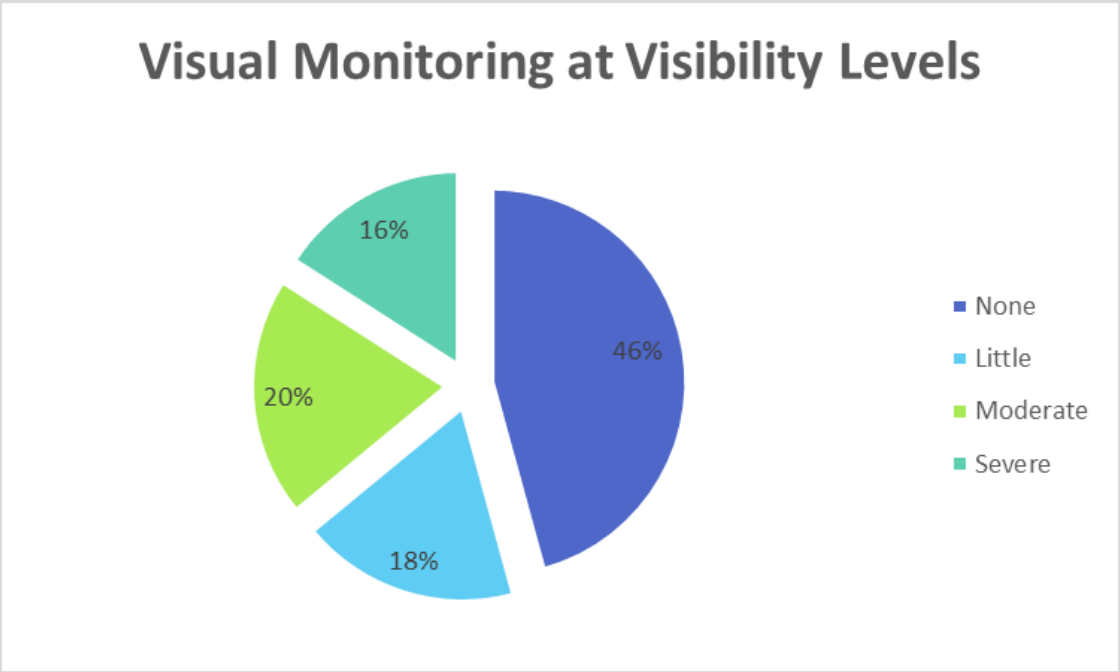

Figure 12. Total hours of glare present throughout visual monitoring.

5. MONITORING AND DETECTION RESULTS

Visual monitoring by observers on the *R/V Langseth* during the USGS ECS 2-D seismic survey resulted in eight detections of protected species and acoustic monitoring yielded an additional two detections for total of ten detections throughout the program, nine of which were of marine mammals and one of which consisted of a sea turtle (summarized in Appendix G). Two species of marine mammals were positively identified, along with unidentified delphinids and a loggerhead sea turtle. The total number of detection events and total number of animals recorded by species is described in Table 6.

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

	Total Number of Detection Records	Total Number of Animals Recorded
Sea Turtles		
Loggerhead sea turtle	1	1
Marine Mammals		
Unidentifiable dolphin	6	9*
Bottlenose dolphin	1	10
Short-beaked common dolphin	2	10
TOTAL	**8**	**30**

*Does not include an estimate of animals present from the two acoustic detections of unidentified dolphins

Only one visual protected species detection and both acoustic detections occurred within the survey area during the USGS ECS 2-D seismic survey. The remaining seven detections occurred while the vessel was in transit to and from port: four detections in transit to the survey site and three detections in transit to the dock at the end of the project (Figure 13).

Of the eight visual protected species detections that occurred during the survey, only one detection of an unidentified delphinid occurred while the acoustic source was active. During this detection, the single delphinid was observed at a closest distance of 270 meters to the full volume source (Table 7). During detection events occurring while the sources were on board the vessel or not fully deployed, the average closest distance to source was recorded for the position where the source would have been located if in position for survey acquisition. Both acoustic detections of unidentified delphinids occurred while the source was active but the detections were not correlated with a visual sighting of the animals and these detections are not included in Table 7 with the closest approach to the seismic source.

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

Species Detected	Full Volume (6,560 in³)		Single Airgun (40 in³)		Ramp-up		Not Firing	
	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)
Loggerhead sea turtle	-	-	-	-	-	-	1	350
Bottlenose dolphin	-	-	-	-	-	-	1	200
Short-beaked common dolphin	-	-	-	-	-	-	2	250
Unidentified dolphin	1	270	-	-	-	-	3	683

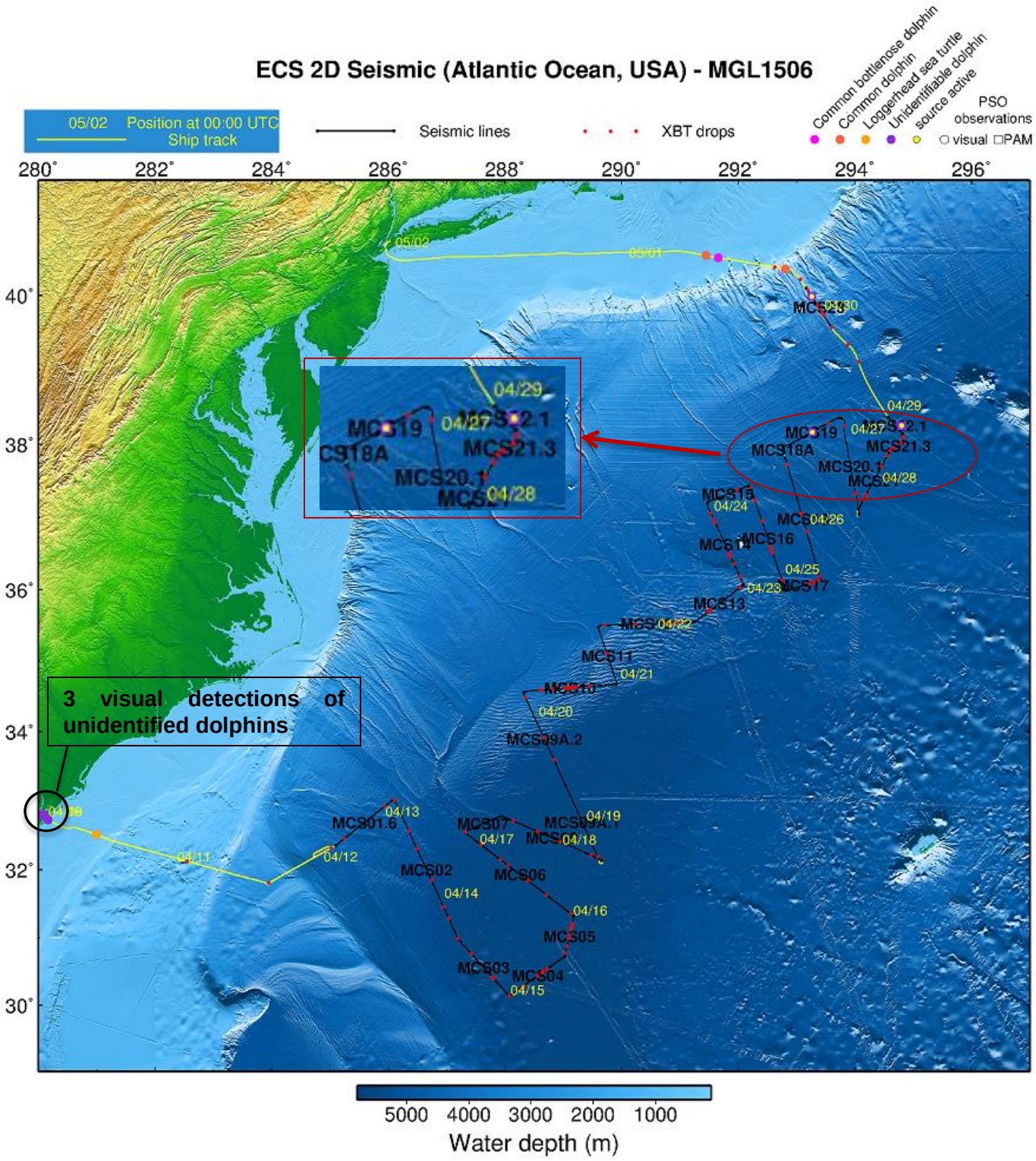

Figure 13: Protected species detections during phase two of the USGS ECS 2-D seismic survey program.

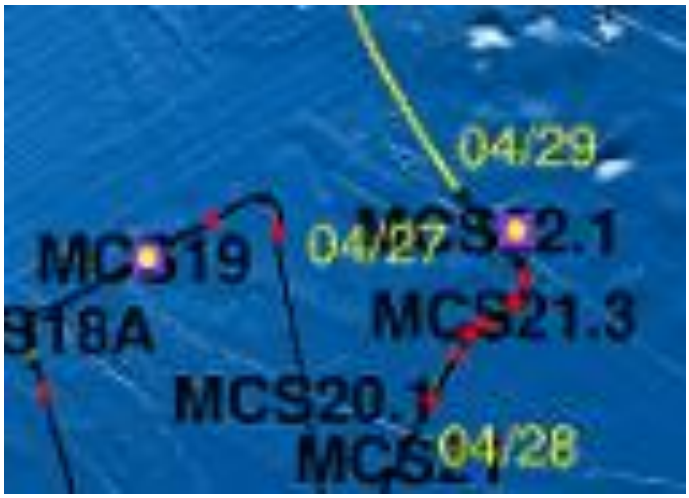

Figure 14:Close-up of unidentified dolphin detections made while the source was active as shown in Figure 13 at the north end of the survey area.

5.1. VISUAL DETECTIONS

The largest group of animals observed was a pod of ten bottlenose dolphins Short-beaked common dolphins also totaled ten animals, which were observed over two detection events. Unidentified dolphins had the most occurrences, with four detections; however, there were only nine animals sighted. Only a single loggerhead sea turtle was sighted during the survey (Figure 14).

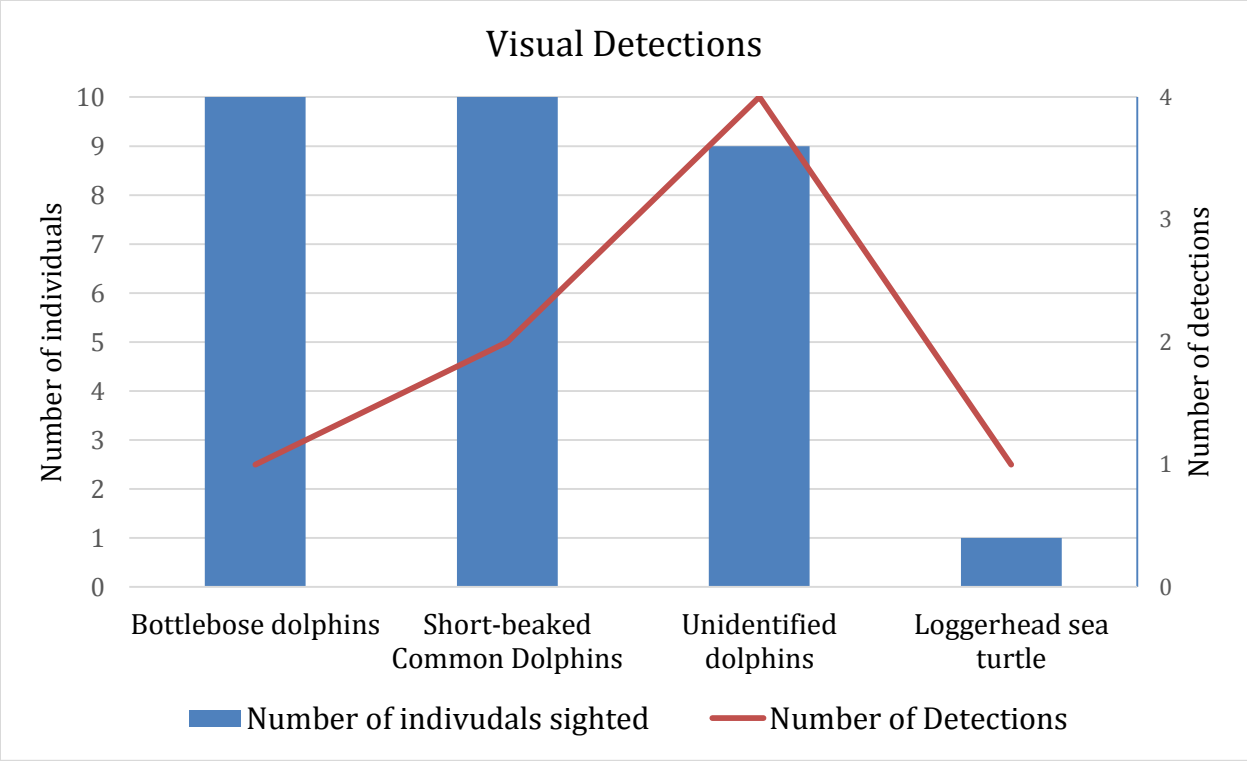

Figure 15. Number of individuals per species detected

5.1.1. Cetacean Detections

5.1.1.1. Bottlenose dolphins

There was one sighting of bottlenose dolphins (*Tursiops truncatus*) during the survey (Figure 15). On 30 April 2015 while the vessel was in transit to the dock after completion of the survey, a small pod of approximately ten individuals was sighted for nine minutes. Behaviors observed included porpoising, fast travel and a brief time of bow riding. The closest approach of the dolphins to the vessel was approximately ten meters. The acoustic source was on board the vessel at the time of the detection.

Figure 16: Bottlenose dolphin, visual detection #7, 30 April 2015.

5.1.1.2. Short-beaked common dolphin

Short-beaked common dolphins (*Delphinus delphis*) were observed on two occasions during the survey, both on 30 April 2015, while the vessel was in transit to the dock after completion of the survey. The first sighting consisted of two individuals and the second consisted of eight individuals (Figure 16). Behaviors observed included porpoising, fast travel, swimming under the surface and bow riding. The closest approach to the vessel during both detections was estimated at ten meters. The acoustic source was on board the vessel at the time of both detections.

Figure 17: Short-beaked common dolphins, visual detection #8, 30 April 2015.

5.1.1.3. Unidentified dolphin

There were four visual detections of unidentified dolphins during the survey. Three of the detections occurred on 10 April 2015 while the vessel was transiting out of the harbor in Charleston, South Carolina at the start of the project. Behaviors observed during these detections included moderate swimming, surfacing, jumping and possible feeding behavior. The closest distance of the dolphins to the vessel varied between 50 and 1300 meters during these three detections occurring during transit, and the acoustic source was on board during these detections. The fourth detection occurred on 26 April 2015, and was the only visual detection occurring while the acoustic source was deployed and active. A single dolphin was observed breaching and then swimming around an inflated balloon-like object floating on the surface approximately 15 meters off the port bow of the vessel and 270 meters from the active acoustic source. A power-down was implemented right away. The detection lasted only one minute and the dolphin was not observed exiting the exclusion zone. After 15 minutes had passed and no further sightings of the animal had occurred, the source was returned to full volume.

5.1.2. Sea Turtle Detections

5.1.2.1. Loggerhead sea turtle

There was one detection of a loggerhead sea turtle (*Caretta caretta*) during the survey on 10 April 2015 while the vessel was in transit to the survey site at the beginning of the project. The turtle was observed approximately 350 meters off the port side of the vessel, briefly swimming at a moderate pace at the surface before diving and disappearing from sight. The acoustic source was on board the vessel at the time of the detection

5.1.3. Other Wildlife

Observations were carried out for other wildlife species, including bird and fish species, throughout the survey program. A complete list of birds and other marine animals 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 H. No impacts to any other observed wildlife species as a result of survey activities were detected during this program.

5.2. ACOUSTIC DETECTIONS

5.2.1. Unidentified delphinids

On 28 April 2015 at 20:15 UTC, unidentifiable dolphin whistles were observed on the Pamguard spectrogram and click trains were observed on the Low-frequency Click detector. Over the course of the detection, the pod's direction of travel was variable with click trains noted at multiple bearings relative to the hydrophones on the click detector display. Post detection analysis through Spectrogram 16 showed simultaneous whistles of at least seven individuals. The whistles had an average frequency of approximately 4.5 kHz to 9 kHz, with occasional whistles reaching a maximum of 21 kHz. Repetitive measured clicks between 8 kHz and in excess of 24 kHz were shown on Spectrogram 16 with tightly packed burst pulses lasting up to 0.50 seconds and ranging between 6 kHz to 24 kHz (Figure 17). No vocalizations were aurally detectable by the PAM Operator. The last whistles detected on the spectrogram at 20:27 UTC. A reliable range estimate to the vocalizing animals could not be produced using Pamguard but the Operator estimated that the animals were located within the predicted 180 dB safety radius as high frequency clicks were observed at large amplitudes relative to the background noise present. PSOs conducting visual monitoring were notified of the detection but the animals were not visually observed. The acoustic source was at a reduced volume of 3300 dB while acquiring survey data at the time of this detection. No mitigation actions were conducted.

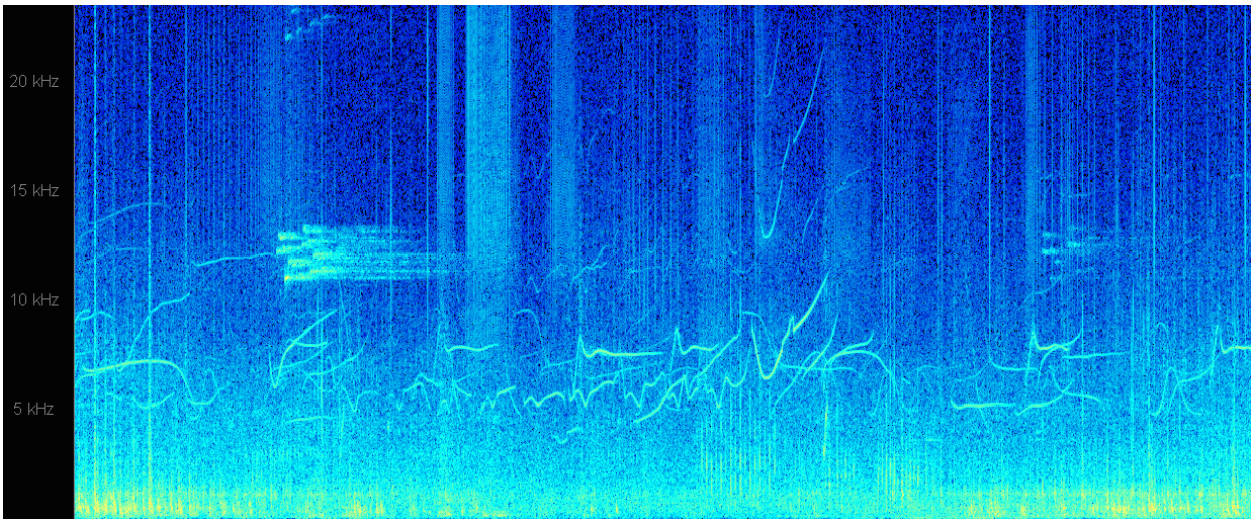

Figure 18: Unidentified delphinid whistles, clicks and burst pulses displayed on Spectrogram 16. Acoustic Detection #1, 28 April 2015

On 30 April 2015 at 2:02 UTC, unidentifiable dolphin whistles were visually observed on Pamguard's spectrogram and detected aurally by the PAM Operator. Post detection analysis through Spectrogram 16 showed whistles and clicks of two individuals. One down sweeping whistle and one convex whistle took place between 2:02:28 UTC to 2:02:45 UTC. The whistles had an average frequency of approximately 8 kHz to 22 kHz. Clicks were observed shortly after at 21 kHz to 160 kHz. At 2:09 UTC six sinusoidal whistles were observed between 8 kHz and 116 kHz, ending at 2:10 UTC (Figure 18) and no further vocalizations were detected after that. A reliable range estimate to the vocalizing animals could not be produced using Pamguard but the Operator estimated that the animals were located within the

predicted 180 dB safety radius as whistles were detected at high amplitudes relative to the background noise present and high-frequency clicks were detected during the event. PSOs were notified of the probable presence of delphinids inside the exclusion zone and conducted a visual search of the area using night-vision devices but the animals were not sighted. The acoustic source was at full volume of 6600 dB and in production at the time of this detection. No mitigation actions were conducted.

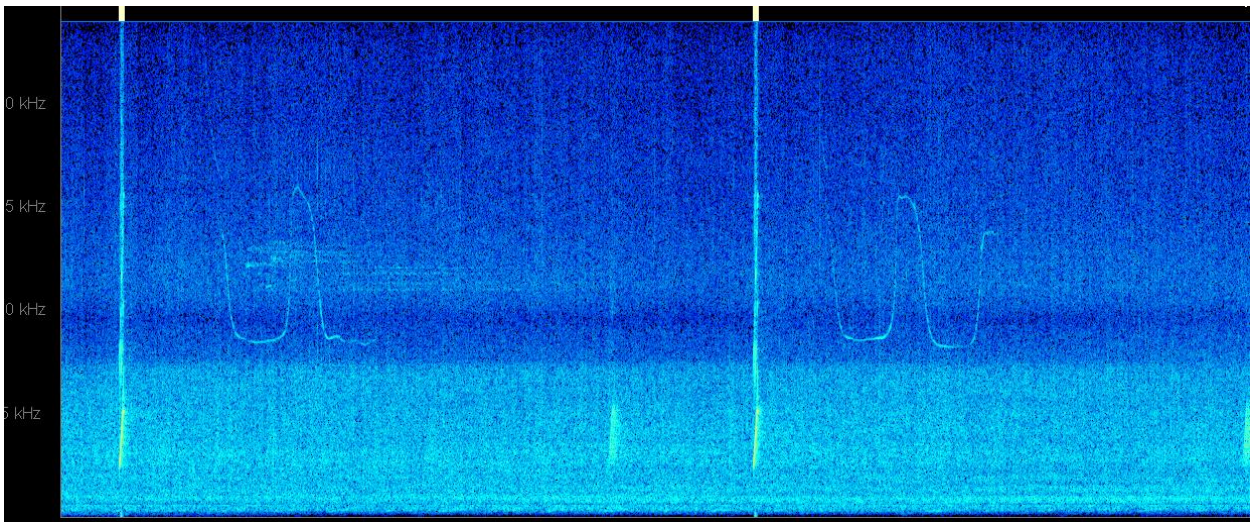

Figure 19: Unidentified delphinid whistles, sinusoidal whistles displayed on Spectrogram 16. AD #2, 30 April 2015

5.3. CONCURRENT VISUAL AND ACOUSTIC DETECTIONS

There were no correlated visual and acoustic detections occurring during this survey program.

6. MITIGATION ACTION SUMMARY

Operational mitigation measures were defined in the PEIS, NSF Final EA and FONSI, and USGS Final EA and FONSI, and the NMFS issued IHA and ITS, including: ramp-ups, power-downs, and shut-downs of the acoustic source, and vessel speed and course alterations.

There was one mitigation action implemented during the USGS ECS 2-D seismic survey due to a protected species observed within the 180 dB safety radius. This mitigation action consisted of a power down of the acoustic source for an unidentified dolphin which resulted in 15 minutes of mitigation downtime (Table 8).

Table 8. Number and duration of mitigation actions implemented during the USGS ECS 2-D seismic survey.

Mitigation Action	Cetaceans	
	Number	Duration
Delayed ramp-up	0	00:00
Power-down	1	00:15
Shut-down	0	00:00
Total	**1**	**00:15**

The one mitigation action implemented during the survey is described in detail below and summarized in Table 9:

On 26 April 2015, a single unidentified delphinid was sighted at 18:00 UTC approximately 15 meters off the port bow of the vessel and 270 meters from the acoustic source. The source was active at full volume 6600 in^3 at the time, and as the delphinid was within the predicted 180 dB exclusion zone, a power-down was requested and implemented at 18:01 UTC. The delphinid was sighted briefly at the surface, swimming near a balloon for one minute and was not observed again. As the delphinid was not observed exiting the 180 dB exclusion zone, the PSOs waited 15 minutes and when the delphinid was not observed again, informed the seismic technician that the acoustic source could be returned to full volume. The source resumed full volume at 18:16 UTC.

Table 9. Summary of each mitigation action implemented during the USGS ECS 2-D seismic survey.

Date	Visual Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Source / Source Volume	Mitigation Action	Total Duration of Mitigation Event
2015 April 26	5	Unidentifiable dolphin	1	Full volume (6,600 in^3)	270 meters / 6600 in^3	Power-down	0:15

6.1. MARINE MAMMALS OBSERVED WITHIN THE PREDICTED 160 DB ZONE DURING ACTIVE SEISMIC OPERATIONS

NMFS granted an IHA and ITS to L-DEO, USGS, and NMFS for a marine seismic survey allowing Level B harassment takes (exposure to sound pressure levels greater than or equal to 160 dB re: 1 µPa (rms)) for 30 marine mammal species: seven mysticetes (16 takes) and 23 odontocete species (9530 takes) for a total of 9546 authorized harassment takes. Direct visual observations recorded by PSOs of one species of marine mammals for which Level B harassment takes were granted in the IHA provide a minimum estimate of the actual number of cetaceans which may have been exposed to sound levels of >160 dB based on the predicted safety radii.

During the USGS ECS 2-D seismic survey, only one unidentifiable delphinid was visually observed within the 160 dB safety radius, where Level B harassment is expected to occur, while the acoustic source was active (Table 11).

This number may be an underestimate and provides the minimum number of animals actually exposed. It is possible that some animals were not seen, especially when observation conditions were less than favourable (for example, when the Beaufort sea state was rated greater than level three), or had moved away before they were observed. Besides night time hours, there were also several occasions during daytime visual watches that the entire 160 dB safety radius was not visible due to fog and rain. Additionally, there were two acoustic detection events of unidentified delphinids while the acoustic source was active where the animals were not also visually observed, but based upon detection characteristics, the PAM Operators were reasonably certain that the animals were located with the predicted 160dB zone of the active source. Table 10 describes the behavior of the unidentified species which were observed within the predicted 160 dB zone for the duration they were observed.

Table 10. Behavior of species observed within the predicted 160 dB zone.

Species	Detection No.	No. of Animals	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
Unidentifiable dolphin	5	1	Swimming	Parallel, opposite direction of the vessel	Swimming	Parallel, opposite direction of the vessel

Table 11. Level B Harassment Takes authorized by NMFS IHA and ITS for the USGS 2-D seismic survey and number of known individuals observed within the predicted 160 dB and 180 dB zones through visual observations.

Species	IHA Authorized Takes	Number of animals observed within the predicted 180 dB zone	Number of animals observed within the predicted 160 dB zone
Mysticetes			
North Atlantic right whale	1 or 2	0	0
Humpback whale	3~~2~~8	0	0
Minke whale	2	0	0
Bryde's whale	3	0	0
Sei whale	3	0	0
Fin whale	3	0	0
Blue whale	1	0	0
Odontocetes			
Sperm whale	83	0	0
Pygmy sperm whale	33	0	0
Dwarf sperm whale	33	0	0
Northern bottlenose whale	2	0	0
Cuvier's beaked whale and unidentified *Mesoplodon spp.*	84	0	0
Common bottlenose dolphin	255	0	0
Atlantic white-sided dolphin	33	0	0
Fraser's dolphin	100	0	0
Atlantic spotted dolphin	1,056	0	0
Pantropical spotted dolphin	724	0	0
Striped dolphin	4,916	0	0
Spinner dolphin	65	0	0
Clymene dolphin	341	0	0
Short-beaked common dolphin	203	0	0
Rough-toothed dolphin	16	0	0
Risso's dolphin	342	0	0
Melon-headed whale	100	0	0
Pygmy killer whale	25	0	0
False killer whale	15	0	0
Killer whale	6	0	0
Short-finned pilot whale	697	0	0
Long-finned pilot whale	697	0	0
Harbor porpoise	4	0	0
Unidentified pilot whale	-	0	0
Unidentified dolphin	-	1	1
Pinnipeds			
Harbor seal	0	0	0
Gray seal	0	0	0
Harp seal	0	0	0
Hooded seal	0	0	0

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

In order to minimize the potential impacts to and Level-B incidental taking of marine mammals and sea turtles during the USGS ECS 2-D seismic survey, mitigation measures were implemented whenever these protected species were seen approaching, entering, or within the safety radii designated in the IHA. All mitigation and monitoring measures specified in the IHA and ITS were implemented during the cruise, as described in this report. One mitigation action was implemented during this survey for small odontocetes. Only a power-down of the acoustic source was implemented, no shut-downs or ramp-up delays occurred during this survey. The confirmation of the implementation of each Term and Condition of the Biological Opinion's Incidental Take Statement are described within this report.

An additional mitigation measure specific to the USGS ECS 2-D seismic survey required that if a North Atlantic right whale (*Eubalaena glacialis*) was sighted, the acoustic source would be shut-down regardless of the distance of the animal(s) to the sound source and that the array would remain inactive until 30 minutes after the last documented sighting of the whale. No North Atlantic right whales were observed during the USGS ECS 2-D seismic survey and therefore no special mitigation measures were implemented.

Also, for this survey, per the IHA/ITS, concentrations of humpback (*Megaptera novaengliea*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and/or sperm whales (*Physeter macrocephalus*) were to be avoided when possible (i.e., exposing concentrations of animals to 160 dB), and the array was to be powered-down if necessary. For the purpose of the survey, NMFS defined a concentration of whales to be six or more individuals visually sighted that did not appear to be traveling (e.g., feeding, socializing, etc.). None of these species of whales, nor unidentified whales, were observed during the survey.

Passive acoustic monitoring was conducted throughout the survey program and the majority of acoustic monitoring was undertaken while the source was active. High levels of background noise on the hydrophone cable are experienced when the vessel travels at higher speeds (greater than 6 knots), which made it impractical to conduct monitoring for baseline acoustic data collection while the vessel was in transit to and from the survey site. Additionally, in order to minimize the risk of entanglement of the hydrophone cable with other seismic equipment, the hydrophone cable must be deployed after all seismic gear has already been deployed, and retrieved prior to the retrieval of the seismic equipment. This prevents some acoustic data from being collected on the survey site while visual monitoring is ongoing for baseline data collection purposes. Two acoustic detections were made during this cruise, both of which occurred while the source was active, and neither of which were also accompanied by a visual sighting.

Of the 19,428 marine mammals authorized for takes in the IHA, (including the 224 whales listed as endangered species), and the 4,698 endangered turtles authorized for takes in the ITS, for a total of 24,126 animals over two field programs, or 11,896 animals for the 2014 field program and 12,230 animals for the 2015 field program, only one unidentified dolphin was observed as potentially exposed to >160dB during this cruise. Only three unidentified dolphins were observed as potentially exposed to

>160dB during the 2014 survey. All potential marine mammal takes for both surveys combined (4) represents 0.02 percent of the total takes authorized for marine mammals for the survey. Observation conditions were highly variable during the survey, with some monitoring conducted during poor conditions, therefore it is unlikely that Protected Species Observers detected all animals during survey operations, especially given there were night time operations. However, in spite of this, the monitoring and mitigation measures required by the IHA and ITS appear to have been an effective means to protect the few marine species encountered during this survey.

APPENDIX A: **Incidental Harassment Authorization for the USGS ECS 2-D marine geophysical survey**

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

AUG 21 2014

Dr. Jonathan R. Childs
Geophysicist
Pacific Coastal and Marine Geology Science Center
U.S. Geological Survey
Mail Stop 999
345 Middlefield Road
Menlo Park, California 94025

Dear Dr. Childs:

Enclosed is an Incidental Harassment Authorization (IHA) issued to the U.S. Geological Survey, Lamont-Doherty Earth Observatory of Columbia University, and National Science Foundation, under the authority of section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*), to harass small numbers of marine mammals, by Level B harassment, incidental to the R/V *Marcus G. Langseth*'s marine geophysical survey in the northwest Atlantic Ocean off the Eastern Seaboard during August to September 2014 and April to August 2015.

You are required to comply with the conditions contained in the IHA which have also been included as Terms and Conditions for incidental take of endangered species in the Biological Opinion. In addition, you must submit a report to the National Marine Fisheries Service's (NMFS) Office of Protected Resources within 90 days of the completion of the cruise. The IHA requires monitoring of marine mammals by qualified individuals before, during, and after seismic activities and reporting of marine mammal observations, including species, numbers, and behavioral modifications potentially resulting from this activity.

If you have any questions concerning the IHA or its requirements, please contact Howard Goldstein, Jeannine Cody, or Jolie Harrison, Office of Protected Resources, NMFS, at 301-427-8401.

Sincerely,

Perry Gayaldo

for Donna S. Wieting
Director
Office of Protected Resources

Enclosures

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

Incidental Harassment Authorization

The National Marine Fisheries Service (NMFS) hereby authorizes the U.S. Geological Survey, Coastal and Marine Geology Program, 12201 Sunrise Valley Drive, Reston, Virginia 20192, Lamont-Doherty Earth Observatory of Columbia University (L-DEO), P.O. Box 1000, 61 Route 9W, Palisades, New York 10964-8000, and National Science Foundation, Division of Ocean Sciences, 4201 Wilson Boulevard, Suite 725, Arlington, Virginia 22230 (herein referred to collectively as USGS) under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)), to harass small numbers of marine mammals incidental to a high-energy marine geophysical (seismic) survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) in the northwest Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015.

1. *Effective Dates*

This Authorization is valid from August 21, 2014 through August 20, 2015. The seismic survey is scheduled to occur in two phases; the first phase during August to September 2014 (for approximately 17 to 18 days [not including transit]), and the second phase between April to August 2015 (for approximately 17 to 18 days [not including transit], specific dates to be determined).

2. *Specified Geographic Region*

This Authorization is valid only for the *Langseth*'s specified activities associated with seismic survey operations as specified in the USGS's Incidental Harassment Authorization (IHA) application and the associated *Environmental Assessment for Seismic Reflection Scientific Surveys during 2014 and 2015 in Support of Mapping the U.S. Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards* that shall occur in the following specified geographic area (bounded by the following geographical coordinates):

40.5694° North, -66.5324° West;
38.5808° North, -61.7105° West;
29.2456° North, -72.6766° West;
33.1752° North, -75.8697° West;
39.1583° North, -72.8697° West

The activities for 2014 will generally occur within the outer portions of the study area. The activities for 2015 will in-fill more of the study area. Water depths range from approximately 1,450 to 5,400 meters (m) (4,757.2 to 17,716.5 feet [ft]); no survey lines will extend to water depths less than 1,000 m (3,280.8 ft). The tracklines planned for both 2014 and 2015 would be in International Waters (approximately 80% in 2014 and 90% in 2015) and in the U.S. Exclusive

Economic Zone, as specified in USGS's IHA application and the associated USGS Environmental Assessment.

3. *Species Authorized and Level of Takes*

(a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in the waters of the northwest Atlantic Ocean off the Eastern Seaboard:

(i) Mysticetes – see Table 1 (attached) for authorized species and take numbers.

(ii) Odontocetes – see Table 1 (attached) for authorized species and take numbers.

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

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

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

(a) A 36 airgun array with a total volume of 6,600 cubic inches in^3 (or smaller);

(b) A multi-beam echosounder; and

(c) A sub-bottom profiler.

5. *Prohibited Take*

The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, NMFS, at 301-427-8401 and/or by e-mail to Jolie.Harrison@noaa.gov and Howard.Goldstein@noaa.gov.

6. *Mitigation and Monitoring Requirements*

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

Protected Species Observers and Visual Monitoring

(a) Utilize two, NMFS-qualified, vessel-based Protected Species Visual Observers (PSVOs) (except during meal times and restroom breaks, when at least one PSVO shall be on watch) to visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during ramp-ups of airguns day or night.

(i) The *Langseth*'s vessel crew shall also assist in detecting marine mammals, when practicable.

(ii) PSVOs shall have access to reticle binoculars (7 x 50 Fujinon), big-eye binoculars (25 x 150), optical range finders, night vision devices, and thermal imaging cameras.

(iii) PSVO shifts shall last no longer than 4 hours at a time.

(iv) When feasible, PSVOs shall also make observations during daytime periods when the seismic system is not operating for comparison of animal abundance and behavioral reactions during, between, and after airgun operations.

(v) PSVOs shall conduct monitoring while the airgun array and streamer(s) are being deployed or recovered from the water.

(b) PSVO(s) shall record the following information when a marine mammal is sighted:

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

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

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

Passive Acoustic Monitoring

(c) Utilize the passive acoustic monitoring (PAM) system, to the maximum extent practicable, to detect and allow some localization of marine mammals around the *Langseth* during all airgun operations and during most periods when airguns are not operating. One NMFS-qualified Protected Species Observer (PSO) and/or expert bioacoustician (i.e., Protected Species Acoustic Observer [PSAO]) shall monitor the PAM at all times in shifts no longer than 6 hours. An expert bioacoustician shall design and set up the PAM system and be present to operate or oversee PAM, and available when technical issues occur during the survey.

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

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

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

Buffer and Exclusion Zones

(e) Establish a 160 dB re 1 µPa (rms) buffer zone as well as 180 and 190 dB re 1 µPa (rms) exclusion zone for marine mammals before the 2-string airgun array (6,600 in^3) is in operation; and a 180 and 190 dB re 1 µPa (rms) exclusion zone before a single airgun (40 in^3) is in operation, respectively. See Table 2 (attached) for distances and exclusion zones.

Visual Monitoring at the Start of Airgun Operations

(f) Visually observe the entire extent of the exclusion zone (180 dB re 1 µPa [rms] for cetaceans; see Table 2 [attached] for distances) using NMFS-qualified PSVOs, for at least 30 minutes prior to starting the airgun array (day or night).

(i) If the PSVO observes a marine mammal within the exclusion zone, USGS must delay the seismic survey until the marine mammal(s) has left the area. If the PSVO sees a marine mammal that surfaces, then dives below the surface, the

PSVO shall wait 30 minutes. If the PSVO sees no marine mammals during that time, he/she should assume that the animal has moved beyond the exclusion zone.

(ii) If for any reason the entire radius cannot be seen for the entire 30 minutes (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or within the exclusion zone, the airguns may not be resume airgun operations.

(iii) If one airgun is already running at a source level of at least 180 dB re 1 µPa (rms), USGS may start the second airgun, and subsequent airguns, without observing the entire exclusion zone for 30 minutes prior, provided no marine mammals are known to be near the relevant exclusion zone (in accordance with Condition 6[h] below).

Ramp-up Procedures

(g) Ramp-up procedures at the start of seismic operations or after a shut-down - Implement a "ramp-up" procedure when starting up at the beginning of seismic operations or any time after the entire array has been shut-down for more than 10 minutes, which means start the smallest airgun first and add airguns in a sequence such that the source level of the array shall increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-up, the PSVOs shall monitor the 180 and 190 dB exclusion zone for cetaceans and pinnipeds, respectively, and if marine mammals are sighted within or about to enter the relevant exclusion zone, a power-down, or shut-down shall be implemented as though the full array were operational. Therefore, initiation of ramp-up procedures from a shut-down or at the beginning of seismic operations requires that the PSVOs be able to view the full exclusion zone as described in Condition 6(f) (above).

Power-down Procedures

(h) Power-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 2, attached). A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun, which reduces the exclusion zone to the degree that the animal(s) is no longer in or about to enter it for the full airgun array. When appropriate or possible, power-down of the airgun array shall also occur when the vessel is moving from the end of one trackline to the start of the next trackline.

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

odontocetes, including sperm [*Physeter macrocephalus*], pygmy sperm [*Kogia breviceps*], dwarf sperm [*Kogia sima*], killer [*Orcinus orca*], and beaked whales).

(j) Following a power-down and subsequent animal departure, the airgun operations may resume at full power. Initiation requires that the PSVOs can effectively monitor the full exclusion zones described in Condition 6(f). If the PSVO(s) sees a marine mammal within or about to enter the relevant zones, then a course/speed alteration, power-down or shut-down will be implemented.

Shut-down Procedures

(k) Shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 2, attached). A shut-down means all operating airguns are shut-down (i.e., turned off).

(l) Following a shut-down, if the PSVO has visually confirmed that the animal has departed the relevant exclusion zone (and is not likely to return) within a period less than or equal to 10 minutes after the shut-down, then the airgun operations may resume at full power. If the PSVO has not observed the marine mammal(s) exiting the exclusion zone, the airgun operations shall not resume for 15 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, killer, and beaked whales). Following a shut-down, the *Langseth* may resume airgun operations following ramp-up procedures described in Condition 6(g).

Speed or Course Alteration

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

Survey Operations at Night

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

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

Mitigation Airgun

(p) Use of small-volume airgun (i.e., mitigation airgun) during turns and maintenance shall be operated at approximately one shot per minute and would not be operated for longer than three hours in duration. During turns or brief transits between seismic tracklines, one airgun will continue operating.

Special Procedures for Situations or Species of Concern

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

(r) Concentrations of humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and/or sperm whales (*Physeter macrocephalus*) will be avoided if possible (i.e., exposing concentrations of animals to 160 dB), and the array will be powered-down if necessary. For purposes of the survey, a concentration or group of whales will consist of six or more individuals visually sighted that do not appear to be traveling (e.g., feeding, socializing, etc.).

7. *Reporting Requirements*

The USGS is required to:

(a) Submit a draft comprehensive report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *Langseth*'s cruise in the northwest Atlantic Ocean off the Eastern Seaboard after the end of phase 1 in 2014 and another draft comprehensive report after the end of phase 2 in 2015. This report must contain and summarize the following information:

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

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

(iii) An estimate of the number (by species) of marine mammals that: (A) are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 μPa (rms) and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on reported and corrected empirical values for the 36

airgun array and modeling measurements for the single airgun) to the seismic activity at received levels greater than or equal to 160 dB re 1 μPa (rms) and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

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

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

8. *Reporting Prohibited Take*

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), USGS shall immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by e-mail to Jolie.Harrison@noaa.gov, and Howard.Goldstein@noaa.gov and the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and NMFS Southeast Region Marine Mammal Stranding Network at 877-433-8299 (Blair.Mase@noaa.gov and Erin.Fougeres@noaa.gov). The report must include the following information:

(a) Time, date, and location (latitude/longitude) of the incident; the name and type of vessel involved; the vessel's speed during and leading up to the incident; description of the incident; status of all sound source use in the 24 hours preceding the incident; water depth; environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility); description of marine mammal observations in the 24 hours preceding the incident; species identification or description of the animal(s) involved; the fate of the animal(s); and photographs or video footage of the animal (if equipment is available).

USGS shall not resume its activities until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with USGS to determine what is necessary to

minimize the likelihood of further prohibited take and ensure MMPA compliance. USGS may not resume their activities until notified by NMFS via letter, e-mail, or telephone.

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

In the event that USGS discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), USGS will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov, and Howard.Goldstein@noaa.gov, and the NMFS Greater Atlantic Region Marine Mammal Stranding Network (866-755-6622) and/or by e-mail to the NMFS Greater Atlantic Regional Stranding Coordinator (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) and/or by e-mail to the Southeast Regional Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fougeres@noaa.gov). The report must include the same information identified in Condition 8(a) (above). Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with USGS to determine whether modifications in the activities are appropriate.

Reporting an Injured or Dead Marine Mammal Not Related to the Activities

In the event that USGS discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), USGS shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by e-mail to Jolie.Harrison@noaa.gov, and Howard.Goldstein@noaa.gov, and the NMFS Greater Atlantic Marine Mammal Stranding Network (866-755-6622) , and/or by e-mail to the Greater Atlantic Regional Stranding Coordinator (Mendy.Garron@noaa.gov), and the NMFS Southeast Regional Stranding Network 9877-433-8299), and/or by e-mail to the Southeast Regional Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fougeres@noaa.gov), within 24 hours of the discovery. USGS shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

Endangered Species Act Biological Opinion and Incidental Take Statement

9. USGS is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS's ESA Biological Opinion issued to both USGS and NMFS's Office of Protected Resources, Permits and Conservation Division (attached).

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

AUG 21 2014

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

Date

Attachments

Attachment

Table 1. Authorized take numbers, by Level B harassment, for each marine mammal species during USGS's marine seismic survey in the northwest Atlantic Ocean off the Eastern Seaboard, August to September 2014 and April to August 2015.

Species	Authorized Take in the Northwest Atlantic Ocean Study Area (2014/2015=Total)
Mysticetes	
North Atlantic right whale (*Eubalaena glacialis*)	1or2/1or2=3
Humpback whale (*Megaptera novaeangliae*)	3/38=41
Minke whale (*Balaenoptera acutorostrata*)	2/2=4
Bryde's whale (*Balaenoptera edeni*)	3/3=6
Sei whale (*Balaenoptera borealis*)	3/3=6
Fin whale (*Balaenoptera physalus*)	3/3=6
Blue whale (*Balaenoptera musculus*)	1/1=2
Odontocetes	
Sperm whale (*Physeter macrocephalus*)	83/83=166
Pygmy sperm whale (*Kogia breviceps*)	33/33=66
Dwarf sperm whale (*Kogia sima*)	33/33=66
Northern bottlenose whale (*Hyperoodon ampullatus*)	2/2=4
Cuvier's beaked whale (*Ziphius cavirostris*) and Unidentified *Mesoplodon* beaked whale (*Mesoplodon* spp. includes True's [*M. mirus*], Gervais' [*M. europaeus*], Sowerby's [*M. bidens*], and Blainville's [*M. densirostris*] beaked whale)	84/84=168
Bottlenose dolphin (*Tursiops truncatus*)	244/255=499

Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	33/33=66
Fraser's dolphin (*Lagenodelphis hosei*)	100/100=200
Atlantic spotted dolphin (*Stenella frontalis*)	1,056/1,056-2,112
Pantropical spotted dolphin (*Stenella attenuata*)	724/724=1,448
Striped dolphin (*Stenella coeruleoalba*)	4,916/4,916=9,832
Spinner dolphin (*Stenella longirostris*)	65/65=130
Clymene dolphin (*Stenella clymene*)	52/341=393
Short-beaked common dolphin (*Delphinus delphis*)	203/203=406
Rough-toothed dolphin (*Steno bredanensis*)	16/16=32
Risso's dolphin (*Grampus griseus*)	342/342=684
Melon-headed whale (*Peponocephala electra*)	100/100=200
Pygmy killer whale (*Feresa attenuata*)	25/25=50
False killer whale (*Pseudorca crassidens*)	15/15=30
Killer whale (*Orcinus orca*)	6/6=12
Short-finned pilot whale (*Globicephala macrorhynchus*)	697/697=1,394
Long-finned pilot whale (*Globicephala melas*)	697/697=1,394
Harbor porpoise (*Phocoena phocoena*)	4/4=8
Pinnipeds	
Harbor seal (*Phoca vitulina concolor*)	0
Gray seal (*Halichoerus grypus*)	0
Harp seal (*Phoca groenlandica*)	0
Hooded seal	0

(*Cystophora cristata*)	

Table 2. Modeled distances to which sound levels greater than or equal to 160, 180 and 190 dB could be received during the marine seismic survey in the northwest Atlantic Ocean off the U.S. Eastern Seaboard during August to September 2014 and April to August 2015. The buffer and exclusion zone radii are used for triggering mitigation.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Distances (m)		
			Shut-down Exclusion Zone for Pinnipeds 190 dB	Shut-down Exclusion Zone for Cetaceans 180 dB	Level B Harassment Zone 160 dB
Single Bolt Airgun 40 in^3	9	Deep (>1,000)	100	100	388
36 Airguns 6,600 in^3	9	Deep (>1,000)	286	927	5,780

APPENDIX B: Basic Data Summary Form

BASIC DATA FORM				
LDEO Project Number		MGL1506		
Seismic Contractor		Lamont-Doherty Earth Observatory of Columbia University		
Area Surveyed During Reporting Period		United States Eastern Seaboard		
		40.5694°N, 066.5324°W 38.5808°N, 061.7105°W 29.2456°N, 072.6766°W 33.1752°N, 075.8697°W 39.1583°N, 072.8697°W		
Survey Type		2-D surface seismic		
Vessel and/or Rig Name		R/V *Marcus G. Langseth*		
Permit Number		IHA granted by NMFS on 21 August 2014		
Location / Distance of Airgun Deployment		205 meters aft of PSO tower		
Water Depth	**Min**	1,445 meters		
	Max	6,144 meters		
Dates of project		10 April 2015	Through	2 May 2015
Total time airguns operating – all power levels:		404:21		
Time airguns operating at full power on survey lines:		395:22		
Time airguns operating at full power on line changes:		06:50		
Amount of time mitigation gun (40 in³) operations:		00:21		
Amount of time in ramp-up:		01:48		
Number daytime ramp-ups:		3		
Number of night time ramp-ups:		0		
Number of ramp-ups from mitigation source:		0		
Amount of time conducted in airgun testing:		00:00		
Duration of visual observations:		303:04		
Duration of observations while airguns firing:		237:42		
Duration of observation during airgun silence:		65:22		
Duration of acoustic monitoring:		379:42		
Duration of acoustic monitoring while airguns firing:		378:13		
Duration of acoustic monitoring during airgun silence:		01:29		
Duration of simultaneous acoustic and visual monitoring:		223:41		
Lead Protected Species Observer:		Amanda Dubuque		
Protected Species Observers:		Cassandra Frey		
		Amy Schmitt		
		Claudia Portocarrero		
Acoustic Observer:		Amy Piko		
Number of Marine Mammals Visually Detected:		7		
Number of Marine Mammals Acoustically Detected:		2		
Number of acoustic detections confirmed by visual sighting:		0		
Number of visual sighting confirmed by acoustic detection:		0		
Number of Sea Turtles detected:		1		
List Mitigation Actions (e.g. Power-downs, shut-downs, ramp-up delays)		26 April – power-down		
Duration of operational downtime due to mitigation:		00:15		

APPENDIX C: Passive Acoustic Monitoring System Specifications

Main cable and spare cable:

1.1 Hydrophone Cable
Cable serial number SM 4450
Mechanical Information
Length 250m
Diameter 14mm over cable 32mm over moldings 45mm over connectors
Weight 100kg
Connector Seiche 36 pin

Hydrophone elements
Hydrophone 1 Sphere 1 Broad band 200Hz to 200 kHz (3dB points)
Hydrophone 2 Sphere 2 Broad band 200Hz to 200 kHz (3dB points)
Hydrophone 3 Sphere 3 Standard 2 kHz to 200 kHz (3dB points)
Hydrophone 4 Sphere 4 Standard 2 kHz to 200 kHz

Depth Capability 100m
Spacing between elements 1 & 2 (for HF / LF detection) 2.0m 1.28mSecs
Spacing between elements 2 & 3 (for HF / LF detection) 13.0m 8.32mSecs
Spacing between elements 3 & 4 (for HF detection) 0.25m 0.16mSecs

Interface unit Array 1 outputs
Broad band channel sensitivity -166dB re 1V/uPa
Standard channel sensitivity -166dB re 1V/uPa

1.2 Deck cable
Deck serial number SM 1786
Mechanical Information
Length 100m
Diameter 14mm
Connectors ITT 19 pin 65mm over connectors
Weight 25kg

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

The hydrophone deployment procedure is a draft document and may be altered at any time to reflect changes in the deployment over time. The deployment requires the PAM operator and one additional person to complete.

Overview

A 250 meter conventionally towed linear array was used for the survey. The linear hydrophone array contained two broadband (200 Hz to 200 kHz) hydrophone elements, two low frequency hydrophone elements (2 kHz to 200 kHz), and a depth gauge (100m capacity) potted directly into the cable. Figure 1 shows the position of the four hydrophones and the depth gauge on the array cable. A 100 meter deck cable connected the hydrophone tow cable from a winch on the port gun deck to the data processing unit, located in the science lab.

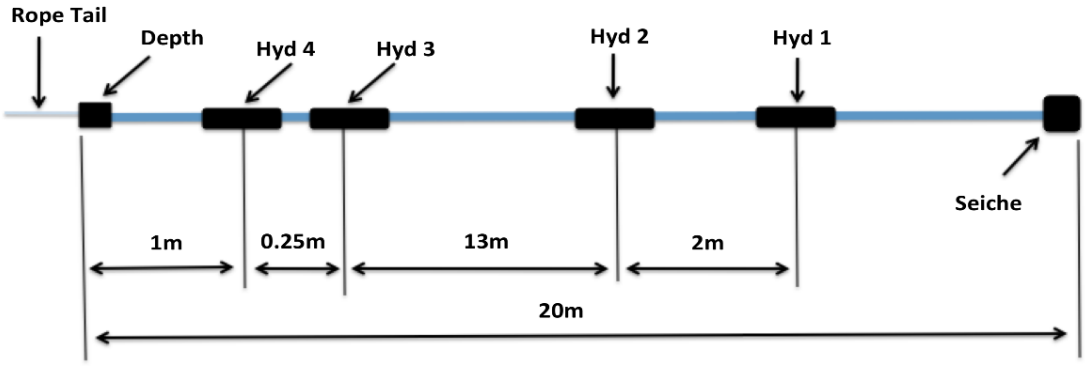

Figure 1: Diagram of the hydrophone array cable indicating the position and separation of the individual hydrophone elements.

The hydrophone cable was spooled onto a port hydraulic winch. The cable was deployed directed off the stern of the vessel, just aft of the winch. To help keep the cable from tangling with the seismic gear, the cable was attached via a Chinese finger to a lifting rope which offset the towing point of the PAM cable system approximately 2 meters to the port.

The hydrophone array was towed 130 meters from the stern and 45.5 meters forward of the seismic array, which was 175.5 meters astern of the vessel.

Pre-Deployment Tasks

The PAM data processing unit and laptops were setup in the main science lab and secured in the event of rough weather (Figure 5). A GPS feed (GNGGA string) was supplied by the ships navigation system Seapath 200.

Figure 5: Passive acoustic monitoring station located in the main science lab.

Two 100 meter deck cables were routed from the main science lab to the port gun deck winch. One deck cable was designated as the main cable and the other acted as a spare, for ease of replacement at sea.

The PAM cable was measured and marked in 10 meter increments for the first 150 meters. Prior to deployment a tap test was performed to the hydrophones and the depth gauge calibrated.

Deployment

- PAM electronics unit was powered down.
- The bridge was alerted of pending hydrophone deployment.
- The deck cable was disconnected from the hydrophone tow cable.
- The winch was powered on.
- 130m of the hydrophone cable was let out from the winch, deployed into the water on port side of the gun umbilicus.
- The winch was powered off.
- The deck cable was connected to the hydrophone cable.
- The electronics in the instrument room were powered up.

Retrieval

- Electronics in the instrument room were powered down.
- The bridge was alerted of pending hydrophone retrieval.
- The deck cable was disconnected from the hydrophone cable and both connectors were covered and taped to prevent corrosion.
- The cable was disconnected from the offsetting line.
- The winch was powered on.
- The hydrophone cable was retrieved and wound evenly onto the winch.
- The winch was powered off.

Health Safety and Environment (HSE) Requirements

Normal working deck Personal Protective Equipment (PPE) was required (hard hat, boots, gloves, eye protection, and coveralls). A life vest was required for any work involving items going over the side.

The operation carried relatively low risk. Hazards included working close to the side of the vessel, trip hazards, and pinch points at the winch.

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

APPENDIX E: Survey Lines Acquired

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced (UTC)	Date Acquisition Completed	Time Acquisition Completed (UTC)
MGL1506MCS01	2015-04-12	12:09	2015-04-13	04:03
MGL1506MCS02	2015-04-13	04:08	2015-04-14	10:43
MGL1506MCS03	2015-04-14	10:45	2015-04-15	01:45
MGL1506MCS04	2015-04-15	02:07	2015-04-15	14:24
MGL1506MCS05	2015-04-15	14:26	2015-04-15	22:04
MGL1506MCS06	2015-04-15	22:07	2015-04-17	02:17
MGL1506MCS07	2015-04-17	02:21	2015-04-17	10:40
MGL1506MCS08	2015-04-17	10:43	2015-04-18	12:10
MGL1506MCS09	2015-04-18	14:14	2015-04-20	04:54
MGL1506MCS10	2015-04-20	05:00	2015-04-20	22:06
MGL1506MCS11	2015-04-20	22:08	2015-04-21	08:03
MGL1506MCS12	2015-04-21	08:05	2015-04-22	10:54
MGL1506MCS13	2015-04-22	10:56	2015-04-23	00:55
MGL1506MCS14	2015-04-23	00:57	2015-04-24	00:29
MGL1506MCS15	2015-04-24	00:31	2015-04-24	05:35
MGL1506MCS16	2015-04-25	05:38	2015-04-25	04:37
MGL1506MCS17	2015-04-25	04:40	2015-04-25	12:19
MGL1506MCS18	2015-04-25	12:23	2015-04-26	12:38
MGL1506MCS18a	2015-04-26	13:56	2015-04-26	14:18
MGL1506MCS19	2015-04-26	14:20	2015-04-26	21:51
MGL1506MCS20	2015-04-26	21:55	2015-04-27	13:56
MGL1506MCS21	2015-04-27	16:22	2015-04-28	17:58
MGL1506MCS22	2015-04-28	18:36	2015-04-28	22:03
MGL1506MCS23	2015-04-29	18:16	2015-04-29	04:00

APPENDIX F: Summary of visual and acoustic detections of protected species observed from the R/V *Langseth* during phase 2 of the USGS ECS 2-D marine geophysical survey

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

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

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
1	10 April 2015	13:23	Unidentified delphinid	2	32.81168°N 79.91545°W	Silent	PE/AH	NS DV	50m/Silent	None	Acoustic source on-board.
2	10 April 2015	13:46	Unidentified delphinid	3	32.76750°N 079.88117°W	Silent	V	SA	1300m/Silent	None	Acoustic source on-board.
3	10 April 2015	14:08	Unidentified delphinid	3	32.73050°N 079.82783°W	Silent	V	NS MI SA	500m/Silent	None	Acoustic source on-board.
4	10 April 2015	18:15	Loggerhead sea turtle	1	32.51500°N 079.00633°W	Silent	PV/OD	NS DI	250m/Silent	None	Acoustic source on-board.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
5	26 April 2015	18:00	Unidentified delphinid	1	38.17168°N/ 066.73472°W	Full volume	PV/OD	NS	270 m/Full volume	Power down	Acoustic source powered down at 18:01 UTC when the delphinid was sighted within 180 dB EZ. Delphinid not observed exiting EZ. Source resumed full volume at 18:16 UTC.
6	30 April 2015	11:14	Short-beaked common dolphin	2	40.34600°N 067.19500°W	Silent	TV	PO/FT	250m/Silent	None	Acoustic source on board. Vessel in transit to dock.
7	30 April 2015	16:36	Bottlenose dolphin	10	40.49433°N 068.33883°W	Silent	TV	PO/FT /SS	200m/Silent	None	Acoustic source on board. Vessel in transit to dock.
8	30 April 2015	17:39	Short-beaked common dolphin	8	40.52383°N 068.55333°W	Silent	TV	PO/FT /SS/BR	250m/Silent	None	Acoustic source on board. Vessel in transit to dock.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Acoustic Detection Details	CPA Source / Source Activity	Mitigation Action	Comments
1	28 April 205	20:15	Unidentified delphinid	7	38.25802°N 65.20321°W	Reduced volume online (3300 in^3)	Dolphin whistles were observed on Pamguard spectrogram and click detector. Over the course of the detection, the pod's movement was variable; with click trains noted throughout the click detector display. Post detection analysis through Spectrogram 16 showed simultaneous whistles of at least seven individuals.	927m/ Reduced volume online	None	Visual observation could not confirm PAM detection
2	30 April 2015	2:02	Unidentified delphinid	2	39.98515°N 66.74112°W	Full volume online (6600 in^3)	Whistles were observed on Pamguard's low frequency spectrogram and detected aurally and click trains were observed on the HF click detector. Post detection analysis through Spectrogram 16 showed whistles and clicks of two individuals.	927m/Full volume online	None	Visual observation could not confirm PAM detection

APPENDIX G: Species of birds and other wildlife observed during the USGS ECS 2-D seismic survey

Common Name	Family	Genus	Species	Approximate Number Individuals Observed	Approximate Number of Days Species Was Observed
Barn swallow	Hirundinidae	*Hirundo*	*rustica*	20	7
Belted kingfisher	Alcedinidae	*Ceryle*	*alcyon*	1	1
Blue heron	Ardeidae	*Ardea*	*herodias*	2	1
Brown pelican	Pelecanidae	*Pelecanus*	*occidentalis*	3	1
Double crested cormorant	Phalacrocoracidae	*Phalacrocorax*	*herodias*	2	2
Herring gull	Laridae	*Larus*	*argentatus*	72	6
Laughing gull	Laridae	*Larus*	*atricilla*	3	1
Magnificent frigate bird	Fregatidae	*Fregata*	*magnificens*	3	1
Northern gannet	Sulidae	*Morus*	*bassanus*	25	2
Palm warbler	Parulidae	*Dendroica*	*palmarum*	1	1
Pomarine skua	Stercorariidae	*Stercorarius*	*pomarinus*	8	5
Purple martin	Hirundinidae	*Progne*	*subis*	1	1
Royal tern	Laridae	*Sterna*	*maxima*	3	1
UID gulls	Laridae	*n/a*	*n/a*	61	4
UID seabird	Charadriiformes	*n/a*	*n/a*	1	1
UID shearwater	Procellariidae	*n/a*	*n/a*	2	2
White-throated sparrow	Emberizidae	*Zonotrichia*	*albicolis*	1	1
White-faced storm petrel	Hydrobatidae	*Pelagodrama*	*marina*	1	1
White-tailed tropicbird	Phaethontidae	*Pathon*	*lepturus*	5	3
Worm-eating warbler	Parulidae	*Helmitheros*	*vermivorum*	1	1

Common Name	Family	Genus	Species	Approximate Number Individuals Observed	Approximate Number of Days Species Was Observed
Atlantic blacktip shark	Carcharhinidae	*Carcharhinus*	*limbatus*	1	1
Hammerhead shark	Sphymidae	*n/a*	*n/a*	1	1
Ocean Sunfish	Centrarchidae	*Mola*	*mola*	1	1
Portuguese man-o-war	Physaliidae	*Physalia*	*physalis*	133	17
Salp	Salpidae	*n/a*	*n/a*	4	2
Skipjack tuna	Scombridae	*Katsuwonus*	*pelamis*	6	1
UID fish	n/a	*n/a*	*n/a*	35	3
UID flying fish	Exocoetidae	*n/a*	*n/a*	117	9
UID puffer fish	Tetraodontidae	*n/a*	*n/a*	1	1
UID shark	Carcharhinidae	*n/a*	*n/a*	1	1