Draft 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 1

20 August 2014 – 13 September 2014

R/V *Marcus G. Langseth*

Prepared for

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for submission to

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES:

Appendix	*Description*
Appendix A	**Incidental Harassment Authorization for the USGS ECS 2-D marine geophysical survey**
Appendix B	**Basic Data Summary Form**
Appendix C	**Summary of program mitigations**
Appendix D	**Passive acoustic monitoring system specifications on R/V *Langseth***
Appendix E	**PAM hydrophone deployment on R/V *Langseth***
Appendix F	**Survey Lines Acquired**
Appendix G	**Summary of visual and acoustic detections of protected species observed from the R/V *Langseth* during the USGS ECS 2-D marine geophysical survey**
Appendix H	**Species of birds and other wildlife observed from the R/V *Langseth* during the USGS ECS 2-D marine geophysical survey**

1. EXECUTIVE SUMMARY

The United States Geological Survey (USGS), Coastal and Marine Geology Program conducted a two dimensional (2-D) seismic survey in the northwest Atlantic Ocean on the National Science Foundation (NSF) owned research vessel, *Marcus G. Langseth* (R/V *Langseth*), operated by Lamont-Doherty Earth Observatory (L-DEO), a part of Columbia University.

USGS submitted an application to the National Marine Fisheries Service (NMFS) for a permit to harass marine mammals, incidental to the marine geophysical survey. An Incidental Harassment Authorization (IHA) was granted on 21 August 2014 (Appendix A) with multiple mitigation measures that stipulated conditions for which non-lethal harassment to marine mammals would be allowed. Mitigation measures were implemented to minimize potential impacts to marine mammals throughout the duration of the survey. Mitigation measures included, but were not limited to, the use of NMFS approved Protected Species Observers (PSOs) for both visual and acoustic monitoring, establishment of safety radii, and implementation of ramp-up, power-down and shut-down procedures.

This report serves to comply with the reporting requirements pursuant to the Marine Mammal Protection Act and Endangered Species Act for Phase 1. L-DEO submitted an application to the National Marine Fisheries Service (NMFS) for an Incidental Harassment Authorization (IHA) that would allow for the potential harassment of marine mammals that may occur during the marine geophysical survey. An Incidental Harassment Authorization (IHA) (Appendix A) and an Incidental Take Statement (ITS) were granted on 21 August 2014. US Fish and Wildlife Service (USFWS) issued a Letter of Concurrence (LOC) on 11 August 2014 that the proposed action may affect but was not likely to adversely affect the roseate tern and Bermuda petrel. In addition, NMFS officially adopted the USGS-NSF Final EA and issued its own Finding of No Significant Impact (FONSI) on August 21, 2014 for this project. Mitigation measures were implemented to minimize potential impacts to marine mammals and endangered or threatened sea turtles and sea birds throughout the duration of the survey. Mitigation measures included, but were not limited to, the use of NMFS approved Protected Species Observers (PSOs) for both visual and acoustic monitoring, establishment of safety radii, and implementation of ramp-up, power-down and shut-down procedures.

RPS was contracted by L-DEO to provide continuous protected species observation coverage. Pursuant to the contract, PSOs monitored and reported on the presence and behavior of marine species, and directed the implementation of the mitigation measures for the research activity as described in the NSF Final Environmental Assessment (EA) and FONSI (prepared pursuant to the National Environmental Policy Act), A Letter of Concurrence (LOC) issued by USFWS, and the USGS-NSF Final EA and associated agency FONSI's, IHA (Appendix A) and ITS issued by NMFS. Additionally, PSO activities were consistent with the PSO standards identified in the Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey and Record of Decision (referred to herein as the NSF-USGS PEIS), to which the USGS-NSF Final EA tiered.

Four PSOs and one dedicated Passive Acoustic Monitoring (PAM) Operator were present on board the R/V *Langseth* throughout the survey in this capacity. PSOs undertook a combination of visual and acoustic watches, conducting a total of 325 hours 07 minutes of visual observations (212 hours while the source was active, 65% of all visual monitoring effort; 113 hours and 07 minutes while the source was

silent, 35% of all visual monitoring effort) and 358 hours 01 minutes of acoustic monitoring (all except 49 minutes of which was conducted while the source was active) over the course of the survey.

The acoustic source was active for a total of 357 hours and 12 minutes over the course of the survey program.

Visual monitoring effort, during both seismic and non-seismic operations, produced a project total of 20 protected species detections, 16 of small odontocetes, two detections of large odontocetes and two marine turtle sightings. Only one detection of protected species occurred while the seismic source was active. The single detection occurring while the acoustic source was active resulted in the implementation of a power-down of the acoustic source. This resulted in a total of 12 minutes of mitigation downtime. Passive acoustic monitoring effort did not result in any acoustic detections. Three cetaceans (unidentified dolphins) were observed to have been exposed to received sound levels equal to or greater than 160 dB from the acoustic source, constituting level B harassment takes, as defined by NMFS. No sea turtles were observed to be exposed to received sound levels equal to or greater than 160 dB re 1 µpa.

Of the 19,433 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 24,131 animals over two field programs, or 12,066 animals for the 2014 field program, only 3 unidentified dolphins were observed as potentially exposed to >160dB during this cruise. 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 protected species monitoring and mitigation as well as seismic survey operations conducted as part of Phase 1 of the USGS Extended Continental Shelf (ECS) 2-D marine geophysical survey on board the R/V *Langseth* from 20 August to 13 September 2014 in the northwest Atlantic Ocean.

This document serves to meet the reporting requirements as described in the IHA and ITS issued to USGS,L-DEO, and NSF by NMFS on 21 August 2014 and valid through August 2015. 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)) could potentially disturb marine mammals, temporarily disrupting behavior, such that they could be considered as non-lethal takes of these exposed animals. Potential consequences of Level B harassment taking could include effects such as temporary hearing threshold shifts, behavior modification and other reactions. A safety or exclusion zone is 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 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 requires that provisions such as safety radii, power-downs and shut-downs be implemented to mitigate for these potentially adverse effects. Although the ITS did not define reporting requirements for sea turtles, monitoring and mitigation information for sea turtles would have been included in this report along with mitigation actions if there had been any.

US Fish and Wildlife Service issued a LOC on August 11, 2014 that the proposed action may affect but was not likely to adversely affect the roseate tern and Bermuda petrel. Mitigation for endangered seabirds would include shutdowns in the event the seabirds were observed diving within the exclusion zone. No specific reporting requirements were identified for encounters with endangered sea birds; however, they would have been included in this report along with mitigation actions if there had been any.

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 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 modelling their origin and extent.

This survey is to be conducted in two phases. For phase 1, the *Langseth* departed Brooklyn, New York on 20 August 2014 and began the survey on 23 August 2014. Phase 1 of the survey was completed on 11 September 2014 and the R/V *Langseth* arrived in Norfolk, Virginia on 13 September 2014. The second

phase is planned for approximately 21 days between April and August 2015 (dates are yet to be determined).

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 1,445 meters to 6,144 meters. The survey area was bounded by the following geographic coordinates:

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 an array 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 1 survey lines consisted primarily of the track lines that ran along the periphery of the survey area, including several internal track lines. During Phase 2 in 2015 the survey will include dip, strike, and tie lines. (Dip lines are lines that are perpendicular to the north-south trend of the continental margin. Strike lines are parallel to the margin and tie lines are any line that connects other lines.) The 2015 survey may be modified based on the 2014 results. A total of 2,742.875 kilometers of transect lines were surveyed in Phase I. The R/V *Langseth*'s cruising speed was about 10 to 12 knots during transits and varied between 3 and 5 knots during the seismic survey. Seismic acquisition began on 23 August and continued until 26 August when all seismic gear was retrieved and the R/V *Langseth* left the survey area to wait for tropical storm Cristobal to pass. Seismic operations were briefly resumed for several hours on 29 August before seismic gear was once more retrieved due to a medical emergency and the R/V *Langseth* once again stopped surveying so that a medical evacuation could be performed. The transits away from hurricane Cristobal and for the medevac were both still within the region identified as the study area in the IHA. Seismic acquisition was resumed on 31 August and continued until the end of the project on 11 September.

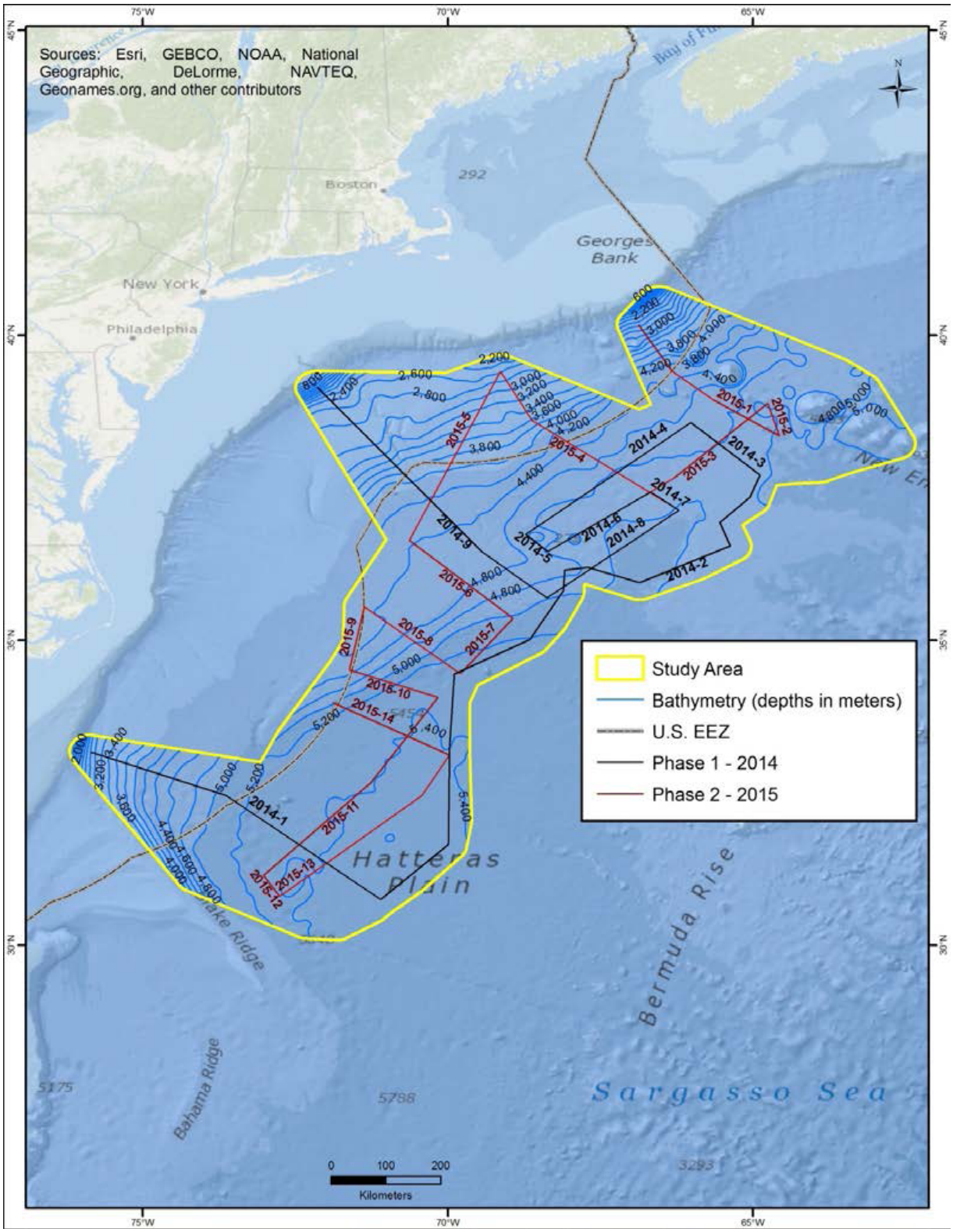

Figure 1. Location and survey lines of the USGS ECS 2-D marine geophysical survey in the Northwest Atlantic Ocean.

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 213 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 first survey line (MGL1407MCS01) was acquired at a shot interval of 25 meters.

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 emits brief pulses of sound (also called a ping) (10.5 to 13.0 kilohertz (kHz)) in a fan-shaped beam that extends downward and to the sides of the ship. The nominal source level for the MBES is 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 is capable of reaching water depths of 10,000 meters and penetrating tens of meters into the sediments. The hull-mounted SBP emits a ping with a dominant frequency component at 3.5 kHz. The nominal source level for the profiler is 222 dB re: 1 µPa.

3. MITIGATION AND MONITORING METHODS

The PSO monitoring and mitigation program on the R/V *Langseth* was established to meet the standards set forth in the NSF-USGS PEIS, NSF Final EA and FONSI, USFWS LOC, NMFS Final EA and FONSI, and the IHA and ITS requirements that were issued by NMFS. The survey monitoring and 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 protocols were followed to meet these objectives. A complete list of monitoring and mitigation procedures can be found in Appendix C.

- Visual observations were established to provide real-time sighting data, allowing for the implementation of mitigation procedures as necessary.
- Operation of a Passive Acoustic Monitoring system to 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 for cetaceans and sea turtles and the 190 dB re 1 µPa (rms) for pinnipeds.

In addition to the mitigation objectives outlined in the NSF-USGS PEIS, NSF Final EA and FONSI, USFWS LOC, NMFS Final EA and FONSI, IHA, and ITS, PSOs collected and analyzed necessary data mandated by the IHA 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 to the 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 a maximum of every 30 minutes or sooner if 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, and standards set forth in the NSF-USGS PEIS, NSF Final EA and FONSI, USFWS LOC, NMFS Final EA and FONSI. 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 5:38 to 6:30 local time, while end of observation times ranged from 19:15 to 20:06 local time.

A visual monitoring schedule was established by the PSOs where each person completed visual watches which varied in length 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, however, 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, who was located in the main science lab, that there was an animal inside or outside of the safety radius. If the animal was observed inside the safety radius and a mitigation action was necessary, the PAM operator would relay the message to the seismic technician who sits nearby. Table 1 describes the various safety radii applied to cetaceans/sea turtles and pinnipeds, as well as what constituted the Level-B harassment zone. The PAM operator was also notified of all marine mammal sightings as soon as possible in order 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. Mitigation radii

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 (m)
Single Bolt Airgun (40 in³)	9	Deep (>1,000)	100	100	388
36 Airguns (6,600 in³)	9	Deep (>1,000)	286	927	5,780

PSOs recorded the following information for each protected species detected:

I. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (initial and final), 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.
II. Time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or power-down), Beaufort sea state and wind speed, visibility, and sun glare.

During or immediately after each sighting event PSOs recorded the event. Each sighting event was linked to an entry on a datasheet such that environmental conditions and vessel activity were available for each sighting event.

When a protected species was observed, range estimations were made using reticle binoculars, the naked eye, and by relating the animal to an object at a known distance, such as the acoustic array located 213 meters from the PSO tower. Specific species identifications were made whenever distance, length of sighting and visual observation conditions allowed. PSOs observed anatomical features of animals sighted with the naked eye, through the big-eyes and reticule binoculars and noted behavior of the animal or group. Photographs were taken during most sightings, although in some cases photographs were not taken due to the brevity of a sighting. The camera used was a Canon EOS 60D with a 300-millimeter telephoto lens. Marine mammal identification manuals were consulted and photos were examined during observation breaks to confirm identifications.

3.2. PASSIVE ACOUSTIC MONITORING SURVEY METHODOLOGY

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

Three of the five PSOs were trained and experienced with the use of PAM, one of which was designated as the PAM operator to oversee and conduct the PAM operations. All PSOs completed a PAM training provided by the PAM Operator in the initial days of the hydrophone deployment during which basic PAM system operation was covered. To achieve 24-hours of monitoring, the PSOs and the PAM operator rotated through acoustic monitoring shifts with a trained PAM operator monitoring many of the night time hours when PSOs were not making visual observations and PAM was the only system in use for detecting cetaceans. Monitoring shifts lasted one to six hours. In the event of an acoustic detection during the nighttime, the PAM operator would notify an “on-call” PSO so that they could monitor for the animals visually and request mitigation if necessary. During daylight hours, acoustic operators were in communication with visual PSOs in the tower relaying sighting and seismic activity information. The PAM system was located in the main science lab to provide adequate space for the system, allow a quick exchange of communications with the visual PSOs on watch and seismic technicians, and to provide access to the vessel’s instrumentation. The vessel’s position, water depth, heading and speed, vessel and acoustic source activity were recorded at least once an hour.

In the event of an acoustic detection of a protected species the PAM operator would record the following information: 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, 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 with *Sennheiser* headphones and visually with *Pamguard Beta 1.12.05*. Delphinid whistles, clicks, and burst pulses as well as sperm whale

and baleen whale vocalizations may be viewed on a spectrogram display within *Pamguard*. Sperm whale, beaked whale, *Kogia* species, and delphinid echolocation clicks may be viewed on low and high frequency click detector displays. The Spectrogram's amplitude range and appearance were adjusted as needed to suit the operator's preference to maximize the vocalizations appearance above the pictured background noise.

3.2.1. Passive Acoustic Monitoring Parameters

Passive acoustic monitoring was carried out using a PAM system developed by Seiche Measurements Limited. PAM system specifications can be found in Appendix C. The PAM system consists of seven main components: a 20 meter hydrophone cable, a 230 meter hydrophone tow cable, a 100 meter deck cable, a data processing unit, a rack-mounted computer with two monitoring screens, an acoustic analysis software package, and headphones for aural monitoring.

The hydrophone cable contains four hydrophone elements and a depth gauge molded into a 20m section of the cable. The first two hydrophones are designated as the low frequency channels; these are broadband elements (200 Hertz (Hz) to 200 kHz). The third and fourth hydrophones are considered the standard elements, and sample high frequencies (2 kHz to 200 kHz). The four-element linear hydrophone array permits a large range for sampling marine mammal vocalizations.

The electronic processing unit contained a buffer processing unit with USB output, and an *RME Fireface 800 ADC* processing unit with firewire output. The electronic processing unit and a rack-mounted computer with two monitors were set-up in the main lab. One of the computer's monitors displayed a high frequency range (HF system), using the signal from two hydrophones, and the low frequency range was displayed on the other computer's monitor (LF system), receiving signal from all four hydrophones. A GPS feed of GNGGA strings was supplied from the ship's Seapath navigation system and connected to the computer and routed to the LF system, reading data every 10 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* can use the difference between the time that a sound signal arrived at each of the two hydrophones to calculate and display the bearing to the source of the sound. A scrolling bearing time display in *Pamguard* also can display the detected clicks within the HF envelope band pass filter in real time, which would allow the identification and directional mapping of detected animal click trains.

The LF system was used to detect sounds produced by marine mammals in the human audible band between approximately three kilohertz and 24 kilohertz. A baleen whale decimator module was added to the LF system to assist the operator in detecting low frequency calls in the range of zero to three kilohertz. The LF system used four hydrophones; the signal was interfaced via a firewire cable to a computer, where it was digitized at 48 kilohertz per channel. The LF hydrophone signal was further processed within the *Pamguard* monitoring software by applying Engine Noise Fast Fourier Transform

(FFT) filters including click suppression and spectral noise removal filters (median filter, average subtraction, Gaussian kernel smoothing and thresholding). In addition to the Spectrogram available for each of the four hydrophones, modules for Click Detector, Mapping, Sound Recording and Radar displays for bearings of whistles and moans were configured. The bearings and distance to detected whistles and moans 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 vessel had a winch installed on the port stern deckhead of the gun deck for deployment of the PAM hydrophone cable. Two deck cables, the main cable and a spare, were installed along the gun deck deckhead running from the winch to the science lab.

Figure 3 shows the position of the PAM hydrophone deployed in relation to the vessel and seismic equipment. Photos of the hydrophone deployment methods and equipment discussed above can be found in Appendix D.

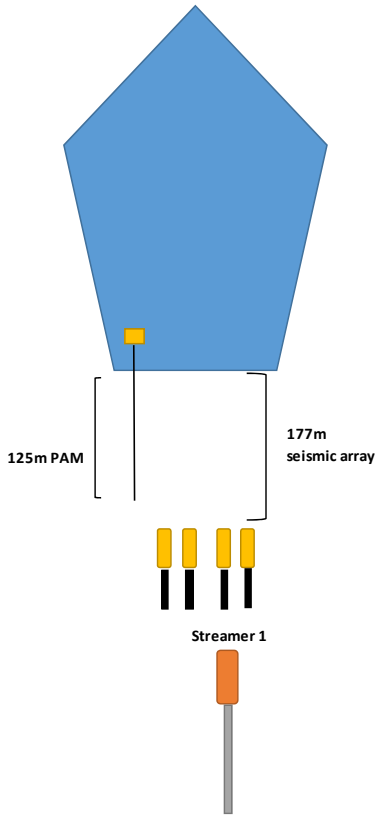

Figure 3. Location of the PAM cable in relation to the seismic gear.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

The R/V *Langseth* departed Brooklyn, New York at 17:00 UTC on 20 August 2014 in order to conduct a series of tests following recent repairs to one of the ship's engines. The IHA was received on 21 August 2014 and the vessel began the transit to the survey site. The seismic gear was deployed and the acoustic source was initiated for the first time at 13:14 UTC on 23 August 2014. Acquisition began on the first survey line at 14:07 UTC on 23 August 2014. Acquisition was suspended at 21:55 UTC on 26 August 2014 due to an approaching hurricane. All seismic equipment was retrieved and the vessel transited to the northwest until the weather system had passed by. When the vessel returned to the survey area the equipment was re-deployed. The acoustic source was initiated at 11:25 UTC on 29 August 2014 and acquisition continued until 14:37 UTC when the source was disabled due to a medical emergency. All seismic gear was retrieved and the vessel transited west to conduct a medical evacuation. Acquisition resumed at 10:34 UTC on 31 August 2014 and continued until 19:53 UTC on 11 September 2014. The seismic equipment was retrieved and R/V *Langseth* began the transit to Norfolk, Virginia arriving at 12:45 UTC on 13 September. The dates and times of acquisition for each survey line can be found in Appendix F.

The acoustic source was active for a total of 357 hours 12 minutes including ramp-up of the airguns, full power firing both online and during line changes, and operation of a single 40 in^3 mitigation airgun (Figure 4). The mitigation source was used during mitigation power-downs initiated for protected species inside the safety radius and was active for 12 minutes during the survey. Full power source operations, while online, accounted for 98.8% (352 hours 55 minutes) of airgun activity during the project. Line changes were undertaken at full volume, each lasting between three to 22 minutes, for a total duration of 2 hours 09 minutes of full volume line change activity. Over the course of the survey the full volume of the array ranged from 6,460 in^3 to 6,600 in^3, most often with 36 airguns active, but occasionally with 35 airguns active. Additionally, on two occasions during airgun maintenance while remaining "online" the volume ranged from 5,230 in^3 to 5,490 in^3 (30 airguns firing) for a duration of 3 hours 27 minutes. On one other occasion during airgun maintenance where two arrays were disabled, the source volume was 3,660 in^3 (20 airguns firing) for 36 minutes.

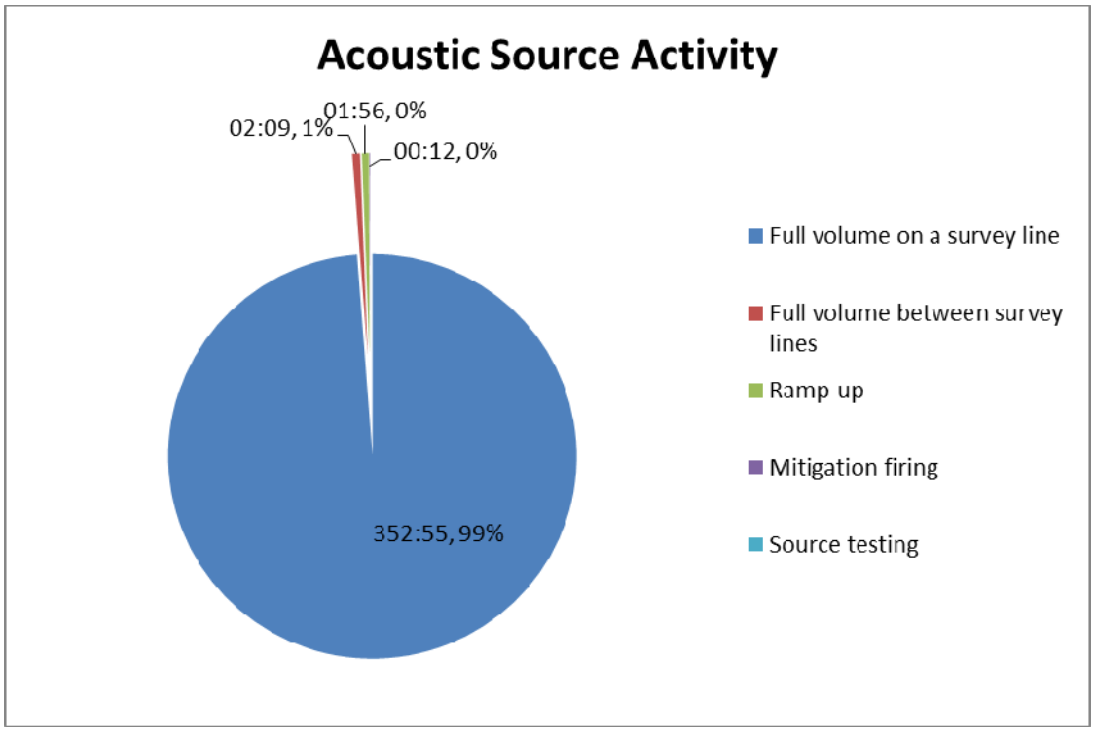

Figure 4. Total acoustic source operations over the course of the USGS ECS 2-D seismic survey

The acoustic source was ramped up three times over the course of the survey in order to commence full volume survey operations from silence (Table 2). One ramp-up was conducted at the beginning of the survey and the other two ramp-ups were conducted after extended periods of acoustic source silence (longer than 8 minutes). Each source ramp-ups was either 38 or 39 minutes in duration. 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. 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**	**01:56**
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		**352:55**
Full volume line changes		**02:09**
Single airgun (40 in³)		**00:12**
Total time acoustic source was active		**357:12**

4.2. VISUAL MONITORING SURVEY SUMMARY

The PSOs began conducting visual monitoring as the vessel departed New York at 17:03 UTC on 20 August 2014 and continued observation while the vessel was in transit to the survey site. This was undertaken to collect baseline data about protected species abundance in the area. Visual monitoring was conducted during all daylight hours during all survey operations throughout the program. Visual monitoring ended at 12:45 UTC on 13 September 2014 when the vessel arrived in Norfolk after the completion of the project.

Visual monitoring during this survey program was conducted over a period of 24 days for a total of 325 hours and 7 minutes. Monitoring was conducted by two PSOs each day between just before nautical twilight dawn until just after nautical twilight dusk, when it was too dark for the entire safety radius to be visible, averaging approximately 13 hours 45 minutes of visual observation per day.

Visual watches were held by two PSOs, except during the scheduled meal hours when a single PSO continued visual monitoring, in addition to acoustic monitoring conducted by the PAM operator on duty while each PSO rotated for a meal break. Visual observations were conducted by a single PSO on watch for a total of 36 hours 44 minutes (11% of total visual effort) over the course of the survey. If a sighting event occurred during a single PSO watch a second PSO would be notified and would immediately return to assist observations. Two PSOs were always on watch for at least 30 minutes prior to the initiation of the acoustic source and throughout all ramp-ups of the acoustic source.

The majority of visual monitoring was performed while the acoustic source was active (212 hours of the total 325 hours and 7 minutes of visual observations conducted, or 65% of total visual effort during the program) (Figure 5). A significant amount of visual monitoring was also undertaken while the source was silent (113 hours and 7 minutes, 35% of visual effort). The total visual monitoring effort while the source was active and during source silence 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	212:00	65.2%	59.3%
Total monitoring while acoustic source silent	113:07	34.8%	-
Total monitoring effort	**325:07**	-	-

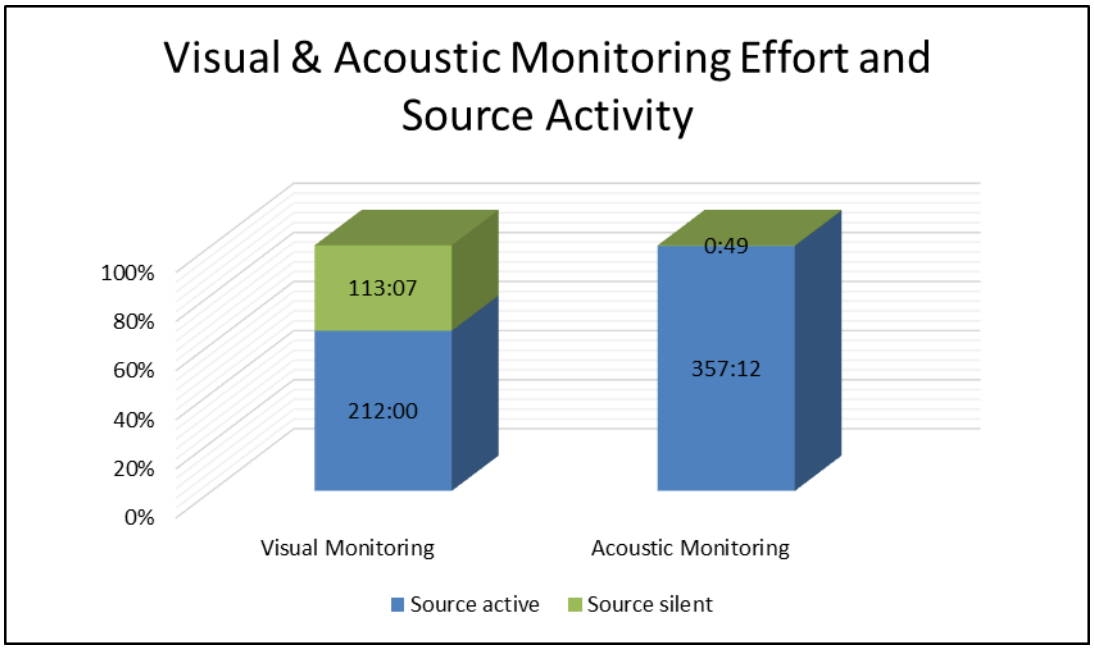

Figure 5. Visual and acoustic monitoring effort while the acoustic source was active and silent

Visual observations were preferentially conducted from the PSO tower, which provided the PSOs with a 360° view of the water around the vessel and acoustic source. Visual watches could also be conducted from other locations including the catwalk or bridge if monitoring could not be undertaken from the tower. The majority (280 hours and 11 minutes, 86%) of all visual monitoring was conducted from the PSO tower during the USGS ECS 2-D seismic survey program.

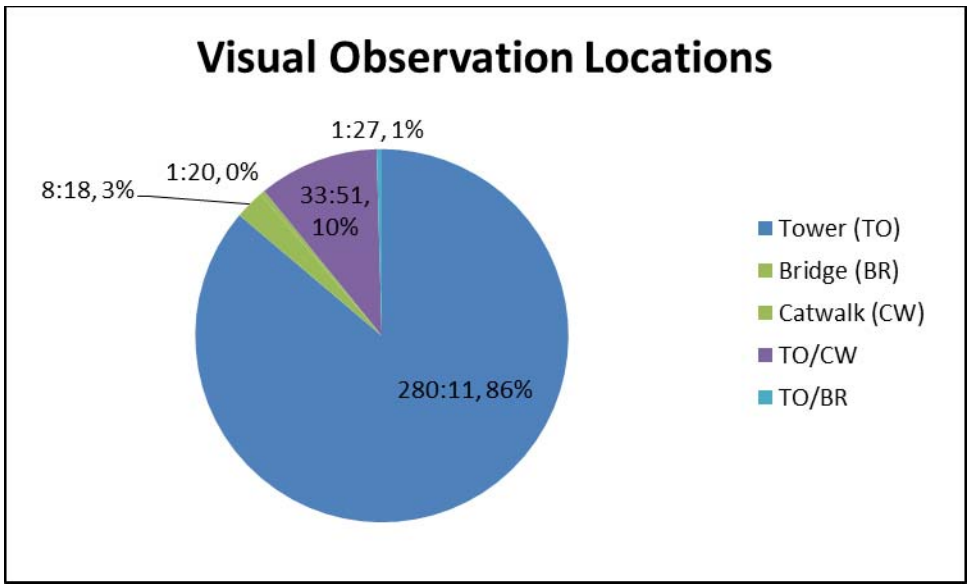

Figure 6. Total visual effort from observation locations during the USGS ECS program

4.3. PASSIVE ACOUSTIC MONITORING SURVEY SUMMARY

The hydrophone cable was deployed for the first time on 23 August 2014 after the vessel had completed deployment of the seismic gear. Passive acoustic monitoring began at 13:13 UTC that day and continued throughout the seismic program, both day and night, suspended only for operational reasons, detailed below. Passive acoustic monitoring for the project ended at 20:03 UTC on 11 September 2014 and the hydrophone cable was retrieved following completion of the last survey line. Over the course of the project, PSOs conducted 358 hours 01 minutes of acoustic monitoring, the majority (all but 49 minutes) of which occurred while the acoustic 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	**145:12**
Total day time monitoring	**212:49**
Total monitoring while acoustic source active	**357:12**
Total monitoring while acoustic source silent	**00:49**
Total acoustic monitoring	**358:01**

Passive acoustic monitoring was suspended for two separate operational situations during the survey program, both times where the seismic source was also disabled: once due to severe weather conditions, and once during a medical evacuation situation on the vessel for a total duration of 104 hours and 49 minutes (Table 5). In both situations the seismic source was shut down prior to the cessation of acoustic monitoring and monitoring resumed prior to re-initiation of the soruce. Both situations are described in detail below:

On 26 August 2014 seismic operations were suspended at 21:55 UTC and then acoustic monitoring was suspended at 21:59 UTC so that the hydrophone cable could be retrieved prior to retrieval of the seismic gear allowing the vessel to maneuver out of range of a hurricane approaching the survey area. The hydrophone cable remained on board until the sea state had decreased to a sufficient level to ensure the cable could be safely deployed on 29 August 2014. Acoustic monitoring resumed at 11:20 UTC on 29 August 2014. Seismic operations resumed at 11:25 UTC with a ramp-up of the source.

Monitoring was suspended for the second time during the program again that same day, 29 August 2014, at 14:57 UTC (seismic operations were ceased at 14:37 UTC) when a medical situation necessitated that a crew member be evacuated from the vessel. The hydrophone cable was retrieved so that the seismic equipment could be retrieved and the vessel moved out of the survey area to perform the evacuation. Acoustic monitoring resumed on 31 August at 10:17 UTC. Seismic operations resumed at 10:34 UTC with a ramp-up of the source.

Table 5. Passive acoustic monitoring (PAM) downtime during the USGS ECS survey program

Passive Acoustic Monitoring Downtime	Duration (hh:mm)
Weather	**61:24**
Medical evacuation	**43:25**
Total Passive Acoustic Monitoring Downtime	**104:49**

4.4. SIMULTANEOUS VISUAL AND ACOUSTIC MONITORING SUMMARY

Acoustic monitoring was undertaken during both the day and night during the USGS ECS survey program. During the day, a total of 212 hours and 49 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.

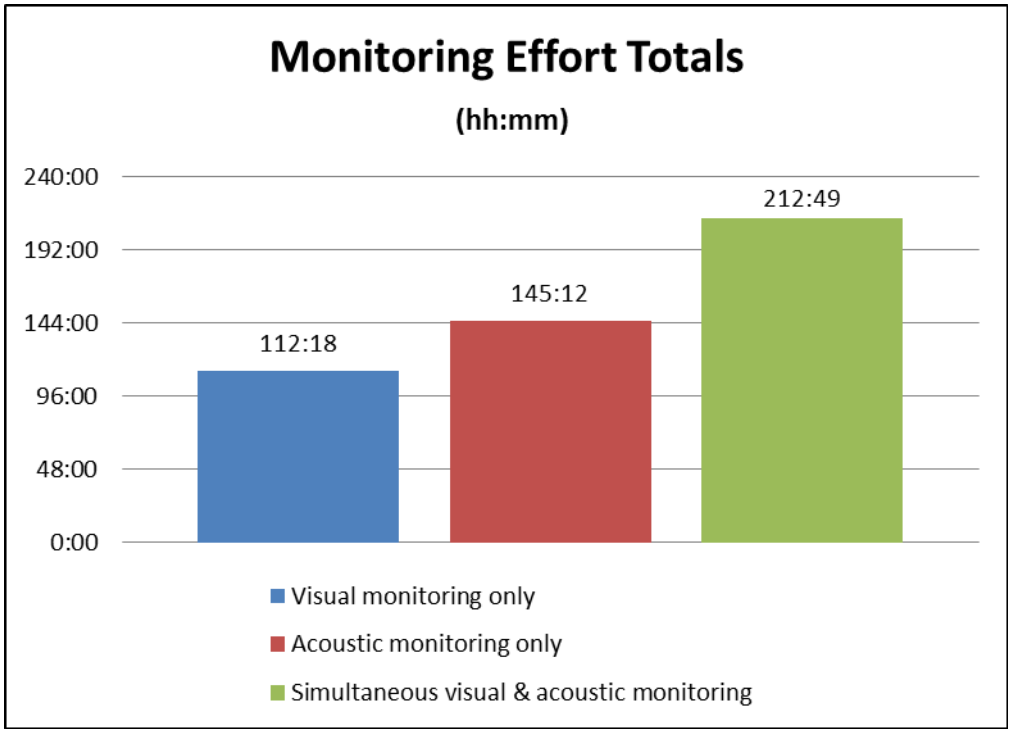

Figure 7. Total acoustic and visual monitoring effort

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 generally favourable. Visibility was classified as 'excellent' if it extended to 10 kilometers or greater. A total of 126 hours and 50 minutes (39% of total effort) of visual monitoring effort was undertaken while visibility extended to 10 kilometers or greater. Periods of fog and light to heavy rain were intermittently present throughout the survey and did at times affect visual observations. A total of 52 hours 24 minutes of precipitation were recorded during the survey, as well as 82 hours 52 minutes of fog. These weather conditions resulted in a total of 34 hours and 50 minutes of visual observations being conducted while visibility extended to less than 2 kilometers.

The Beaufort sea state recorded during visual monitoring ranged from level 0 to level 7 over the course of the survey. The majority of visual monitoring was undertaken while the Beaufort sea state was level 3 or less (196 hours and 59 minutes, 61% of total time of visual monitoring). Beaufort sea state levels of greater than 6 were experienced during only 36 hours and 50 minutes of monitoring and accounted for less than 12% of total visual monitoring effort (Figure 8, Figure 9).

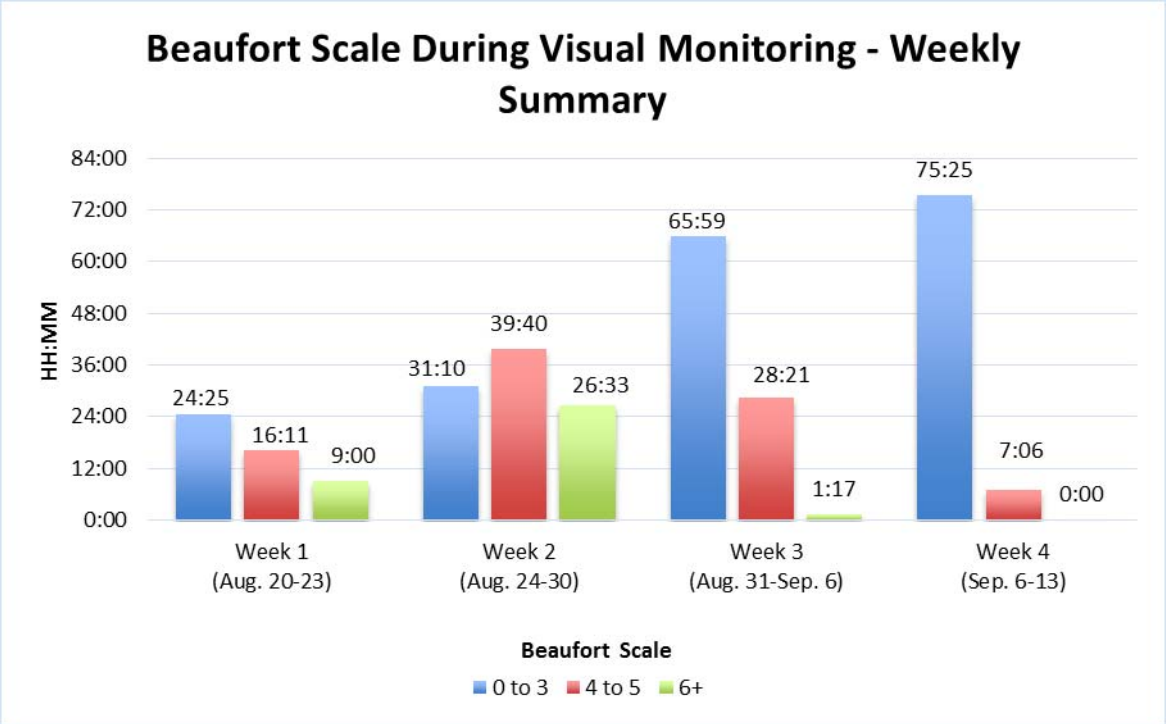

Figure 8. Weekly summary of the Beaufort scale during visual monitoring.

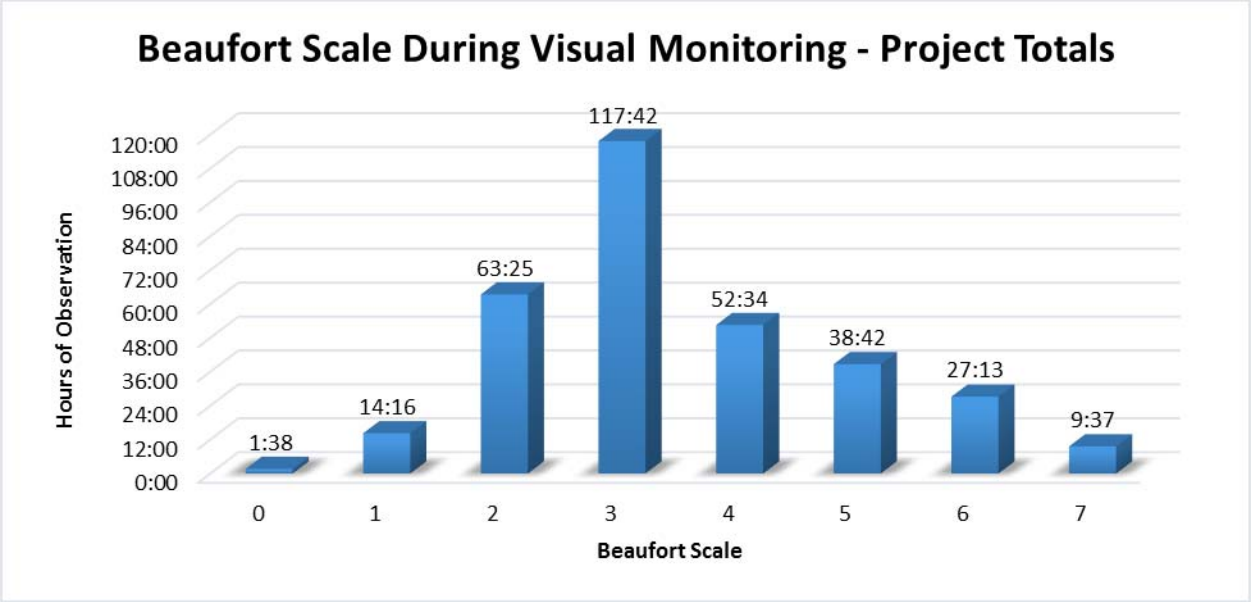

Figure 9. Total hours of observation at each Beaufort scale over the duration of the USGS ECS 2-D survey.

The majority of visual monitoring was undertaken while wind speeds were measured at 10 knots or less (174 hours and 29 minutes, 54%). Wind speeds measured between 11 and 21 knots were present for a total of 109 hours 46 minutes of monitoring. Wind speeds greater than 22 knots were recorded for only 40 hours 52 minutes (Figure 10).

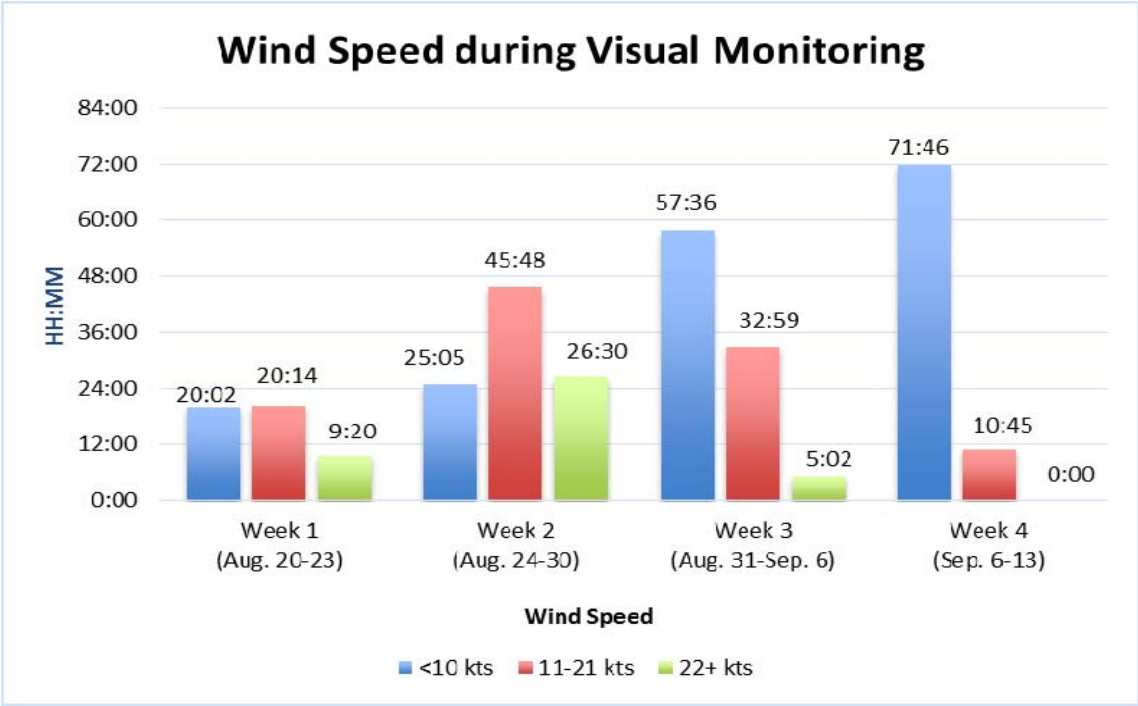

Figure 10. Average wind speed each week during visual monitoring.

Swell heights during visual observations were generally low, with swells of less than two meters recorded for over 81% of total visual effort. Only 6 hours and 26 minutes of visual observations were undertaken while swells were recorded at heights of greater than four meters.

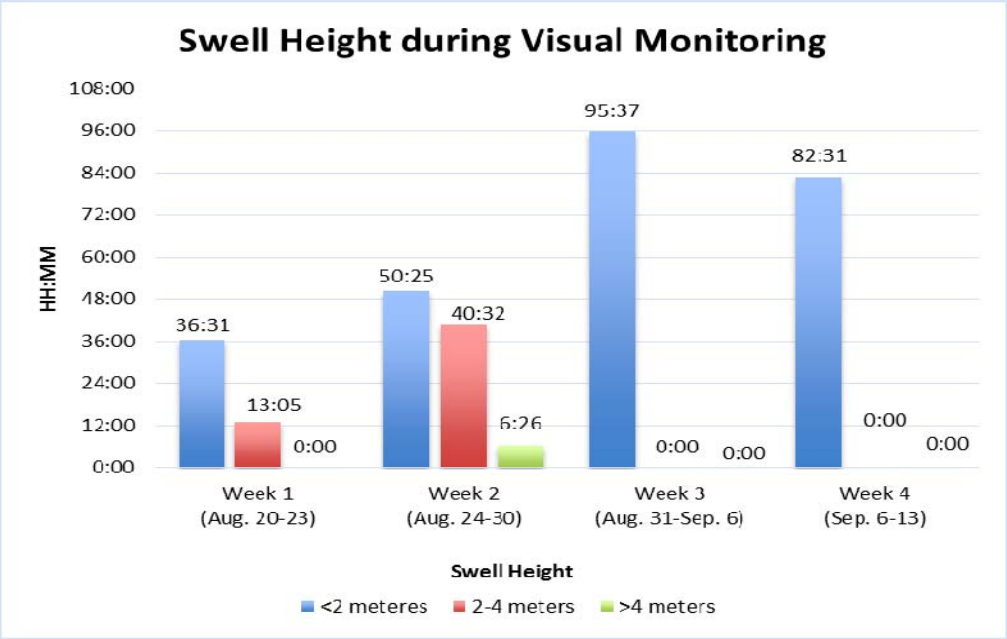

Figure 11. Swell heights while visual monitoring was conducted.

Moderate to severe glare was present during 199 hours 05 minutes (61%) of visual monitoring during the survey, possibly encumbering to some extent the detection of protected species in areas of glare. Figure 12 describes the amount and severity of glare present during visual observations.

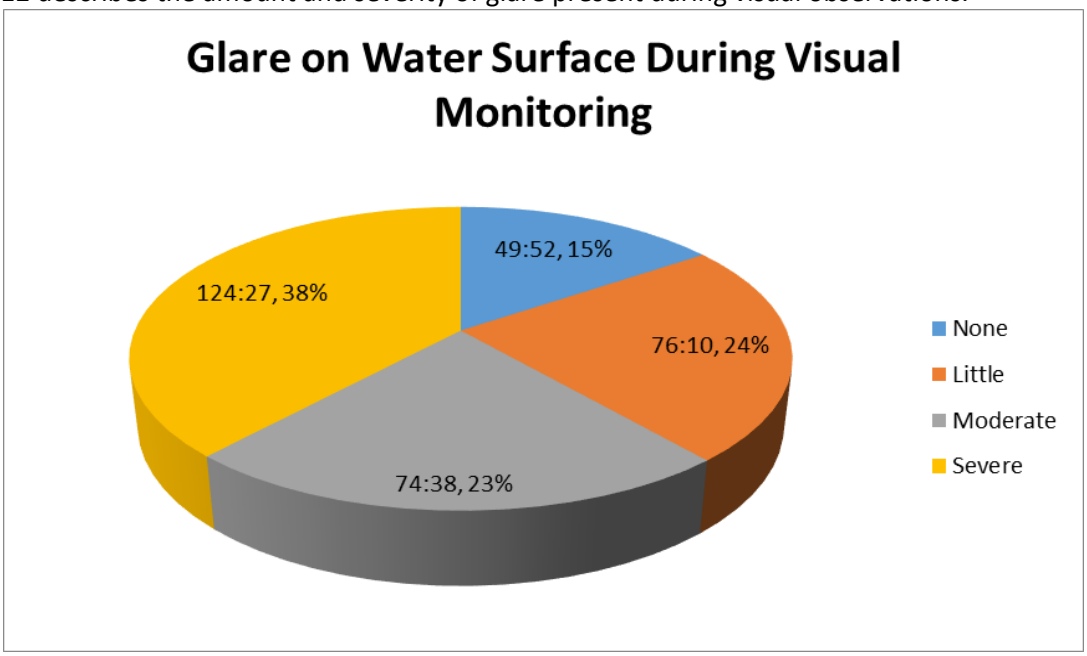

Figure 12. Total hours of glare present throughout visual monitoring.

5. MONITORING AND DETECTION RESULTS

5.1. VISUAL DETECTIONS

Visual monitoring conducted during the USGS Atlantic ECS 2-D seismic survey resulted in the collection of 20 visual records of detection for protected species by observers on the R/V *Langseth* during time periods when the acoustic source was active and inactive (summarized in Appendix G). Four species of marine mammals were positively identified and unidentified pilot whales, unidentified dolphins, and unidentified shelled sea turtles were also observed. 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
Unidentifiable shelled sea turtle	1	1
Odontocetes		
Sperm whale	2	4
Short-beaked common dolphin	3	45
Common bottlenose dolphin	7	55
Unidentifiable pilot whale	2	45
Unidentifiable dolphin	4	8
TOTAL	**20**	**159**

There were few protected species sightings inside the survey area during the USGS Atlantic ECS 2-D seismic survey (Figure 13). Several detections were made while the vessel was in the initial transit to the survey site and while gear was initially being deployed (Figure 14), while the vessel was performing a medical evacuation and during the transit back to port following completion of the survey (Figure 15).

The greatest number of detections in one day of observations occurred on 13 September when five common bottlenose dolphin detections were made as the vessel transited through the ship channel into port at the end of the survey (Figure 16).

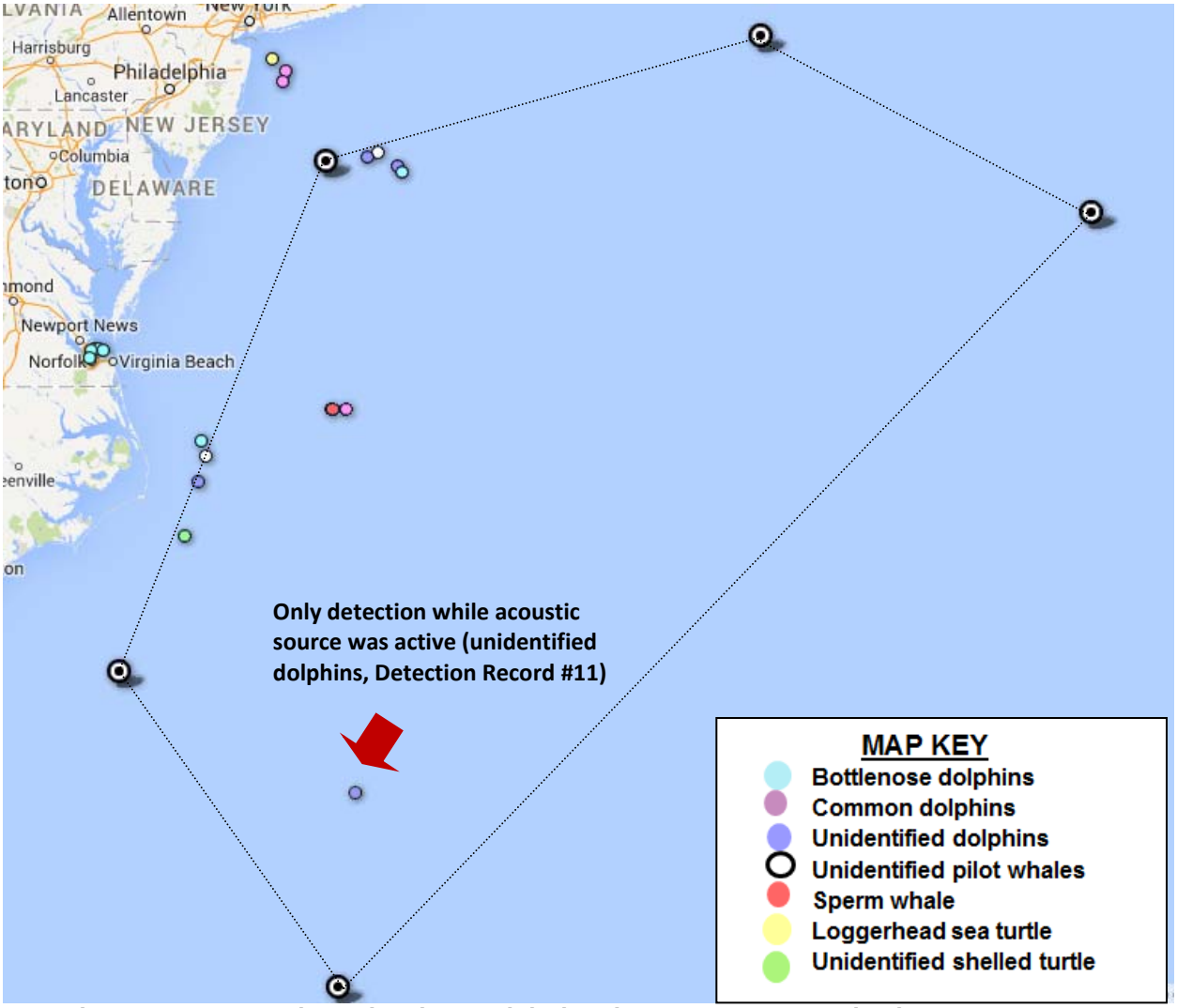

Figure 13. Protected species detected during the USGS ECS 2D seismic survey program

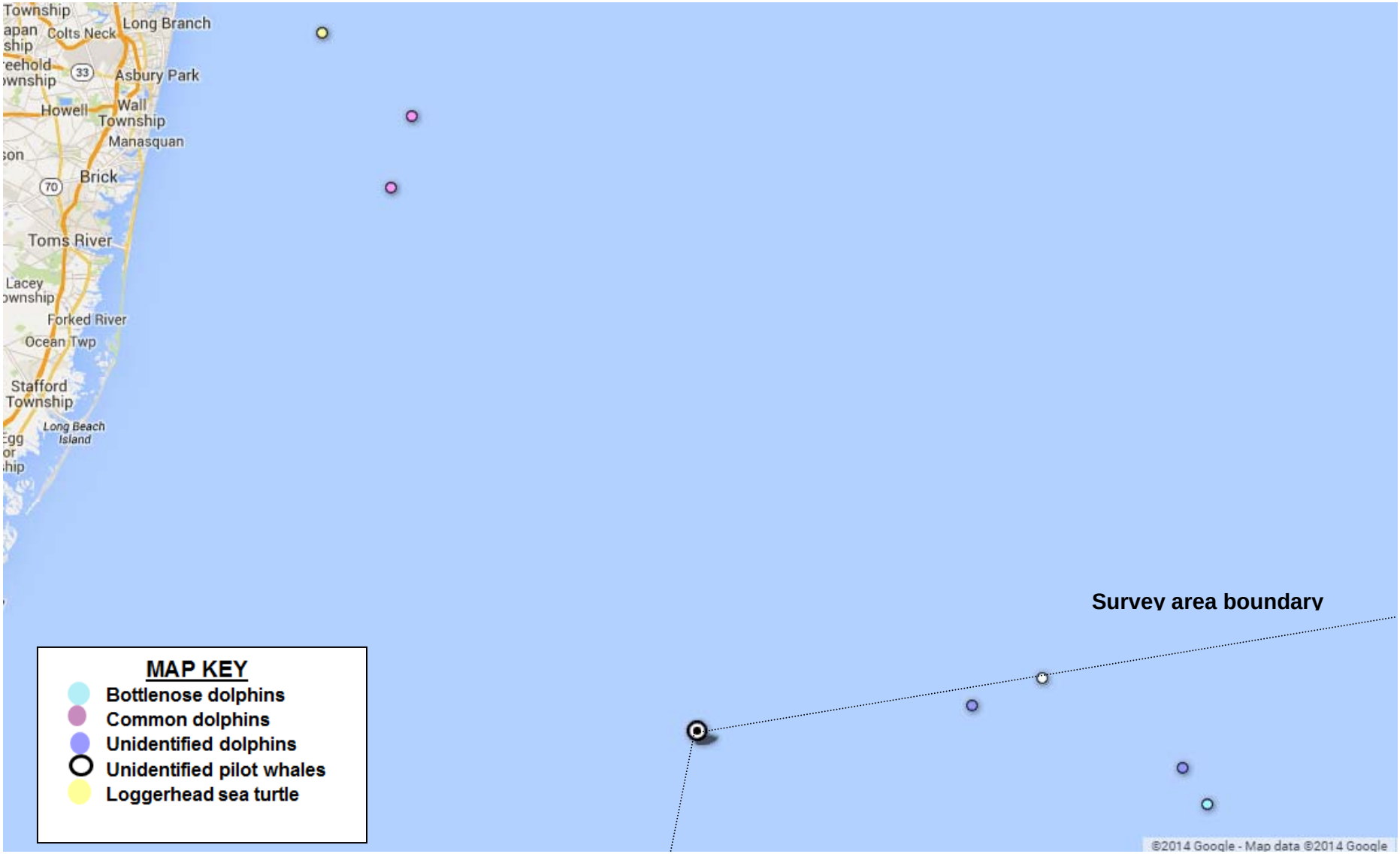

Figure 14. Protected species detections during transit out of port at start of survey program and while deploying seismic equipment

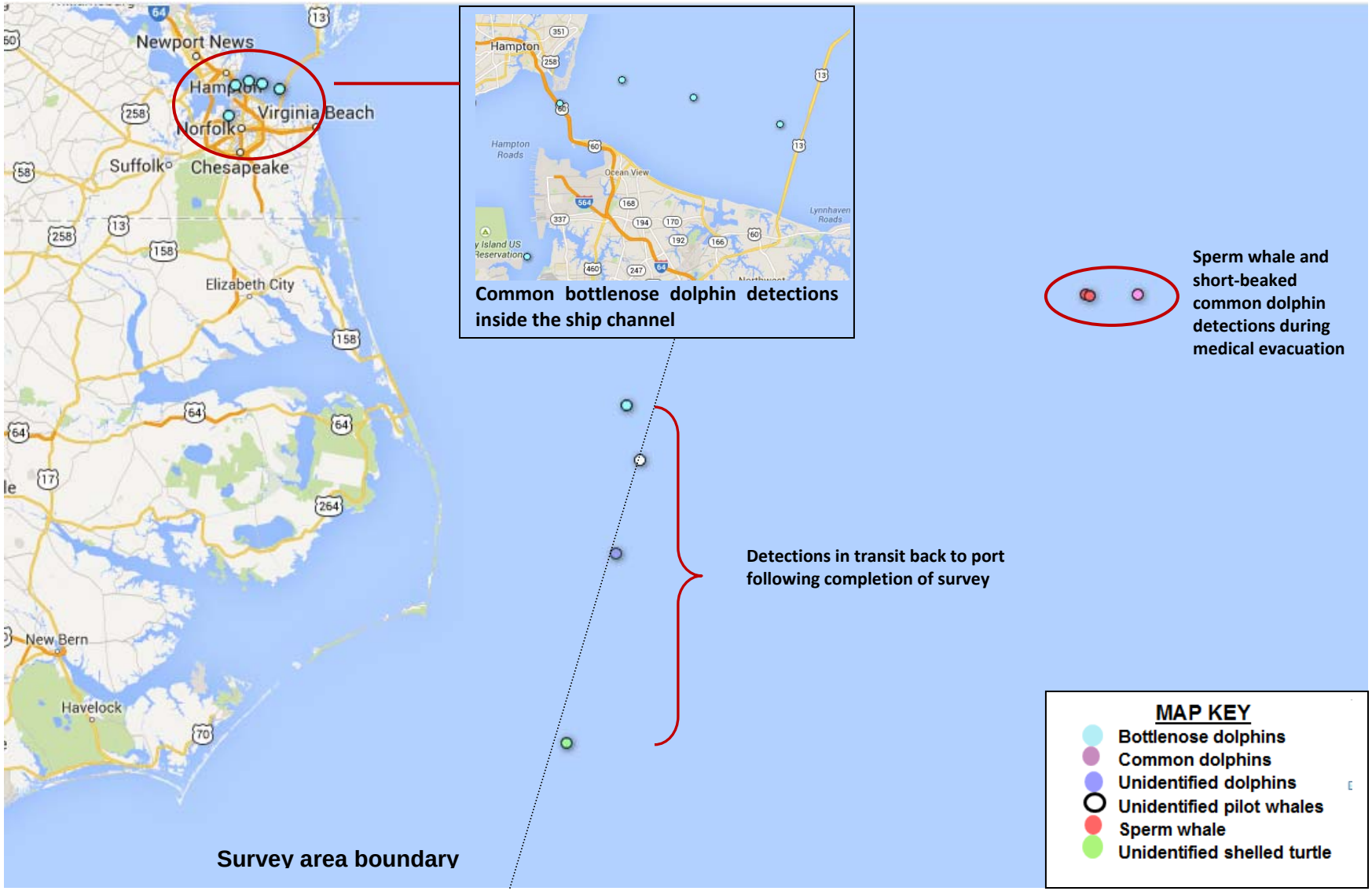

Figure 15. Protected species detections in transit to port and during off-site operations

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L-DEO/NMFS
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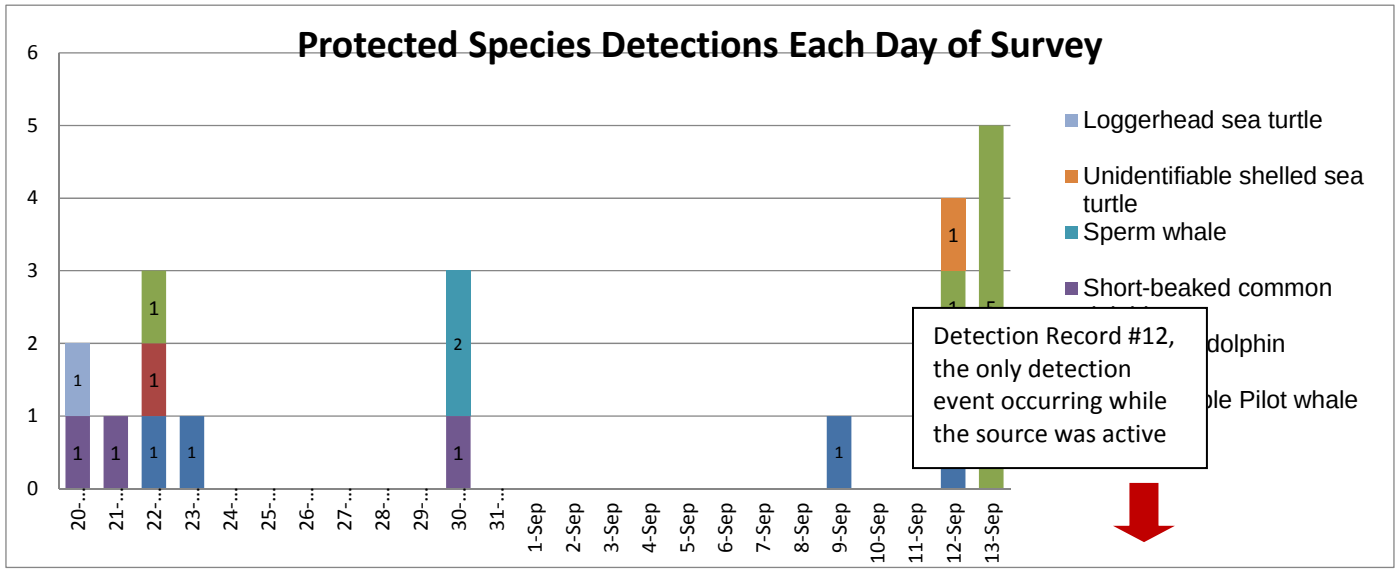

Figure 16. Number of protected species detections each day during the USGS ECS 2-D seismic survey

Of the 20 protected species detection events that occurred during the program, only one detection of an unidentified delphinid occurred while the acoustic source was active. All of the other 19 detections of protected species occurred while the acoustic source was silent. During the single detection event occurring during source activity, a pod of unidentified dolphins were observed at a closest distance of 1,100 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.

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	35
Unidentifiable shelled sea turtle	-	-	-	-	-	-	1	180
Sperm whale	-	-	-	-	-	-	2	475
Short-beaked common dolphin	-	-	-	-	-	-	3	192
Common bottlenose dolphin	-	-	-	-	-	-	7	157
Unidentifiable pilot whale	-	-	-	-	-	-	2	490
Unidentifiable dolphin	1	1100	-	-	-	-	3	160

Common bottlenose dolphins were observed in the greatest numbers, with approximately 55 animals observed during seven different detections events followed by short-beaked common dolphins and unidentified pilot whales, with approximately 45 animals of each species observed during three and two detection events respectively (Figure 17).

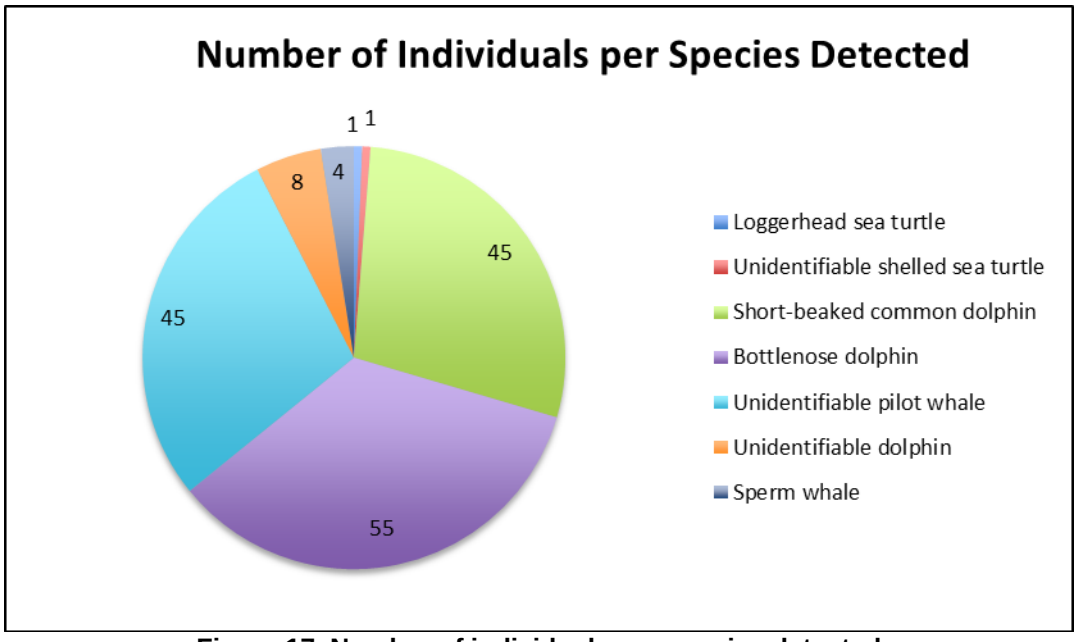

Figure 17. Number of individuals per species detected

5.1.1. Cetacean Detections

5.1.1.1. Short-beaked common dolphin

There were three sightings of short-beaked common dolphins (*Delphinus delphis*) during the survey on three different days totaling 45 individuals. Pods ranged in size from 9 animals to 25 animals and juveniles were observed during two of the three detection events. Detection events ranged from 8 minutes in duration (21 August 2014) to 24 minutes (20 August 2014) where behaviors observed included moderate to fast travel and jumping. Water depths were not available for two of the detection events, and water depth during the third detection was 3705 meters. The closest approach of the animals to the airguns, which were inactive at the time, was 15 meters on 20 August 2014. The source was not active during any of the detections and no mitigation actions were implemented for any of the detections.

5.1.1.2. Common bottlenose dolphin

Common bottlenose dolphins (*Tursiops truncatus*) were observed seven times on three different days, once on 22 August 2014, once on 12 September 2014 and three times on 13 September 2014. Pod ranged in size from a single animal to the largest pod observed, 21 animals, on 22 August 2014. A single juvenile was observed with the adults during two of the detections. Behaviors observed including slow, moderate and fast swimming, leaping, porpoising and splashing. The source was not active during any of the detections. During each detection event, the animals approached the vessel to within 100 meters or less. The closest approach of the animals to the silent source varied from 50 meters to 260 meters. No mitigation actions were implemented for any of these detections.

5.1.1.3. Sperm whale

Sperm whales (*Physeter macrocephalus*) were observed on two occasions during this cruise, both on 30 August 2014. Water depths at the time of detections were 3617 meters and 3625 meters. Each group of whales included three adults and one juvenile, and the second detection was likely a duplicate detection of the first sighting event. At 11:20 UTC, the vessel was in transit and heading toward shore when the whales were observed for the first time approximately 600 meters off port, logging and blowing. Following an airlift by the Coast Guard, the vessel then turned and headed back out to sea, when a group (possibly the same as previously observed) of sperm whales was initially sighted 300 meters from the bow at 11:57 UTC. Severe glare ahead of the vessel likely contributed to the animals not being observed earlier. The vessel initiated avoidance maneuvers, turning 5 degrees to port, as soon as the whales were detected. The whale made shallow dives to the starboard side of the vessel as it passed by. Once the vessel had passed, the whales surfaced after several minutes and continued traveling slowly in their original direction. At the time of both detections, the vessel was in transit and the sound source was onboard. No mitigation actions were implemented for either detection.

5.1.1.4. Unidentified pilot whale

There were two sightings of unidentifiable pilot whales (*Globicephala spp.*) during the program on two different days. The first detection on 22 August 2014 consisted of 10 adults, and the second detection on 12 September 2014 included 29 adults and six juveniles, totaling 45 animals during both detections. Water depth at the time of the first detection was 864 meters, and depth was unavailable during the second sighting as the vessel was in transit and not collecting depth data. During the second detection,

the animals were initially observed at 21:32 UTC, approximately 450 meters from the stern, traveling parallel to and in the opposite direction of the vessel. The dolphins were widely spread out and were observed grouped together in several smaller groups over the course of the detection. The detection ended at 22:28 UTC when the animals were last observed continuing in the same direction and behind the vessel. The closest approach of the animals to the vessel was 280 meters. The animals were observed primarily surfacing, blowing, and traveling. Leaps were noted occasionally, as well. The source was silent during both detections. No mitigation actions resulted from either detection.

5.1.1.5. Unidentified dolphin

There were four detections of unidentifiable dolphins on four different days during the survey. A total of eight individuals were observed where individual detections ranged from a single dolphin to three dolphins observed. All dolphins were observed to be adult animals. Water depth during the sightings ranged from 724 meters to 5378 meters and depth information was unavailable during one of the sighting events. The closest approach of unidentified dolphins to the vessel varied from 10 meters to 750 meters. The source was silent during all but one detection event and that event (Detection Record #11, consisting of three dolphins) occurred while the source was at full volume and resulted in a power-down of the full volume source when the dolphins were observed entering the 180dB mitigation radius around the source. The dolphins first observed more than two kilometers directly ahead of the bow, crossing perpendicular to the vessel, where they were also observed engaging in what appeared to be feeding behavior. The acoustic source was powered down when the dolphins were approximately 1100 meters from the acoustic source and looked likely to enter the 180 dB radius. The source was returned to full volume after the dolphins were observed to have been clear of the 180dB radius and were later observed swimming ahead of the vessel.

5.1.2. Sea Turtle Detections

5.1.2.1. Loggerhead sea turtle

There was a single sighting of a loggerhead sea turtle (*Caretta caretta*) during the survey on 20 August 2014The animal was detected at 20:32 UTC approximately 20 meters from port, swimming toward the vessel and then diving abruptly. . At the time of the detection the vessel was in transit to the survey area, with the source on board. No mitigation action was implemented.

5.1.2.2. Unidentified shelled sea turtle

On 12 September, there was a single sighting of a juvenile unidentifiable shelled sea turtle at 16:03 UTC, approximately 40 meters off the starboard side of the vessel. The vessel was in transit from the survey area, so mitigation actions were not necessary. The animal was lost in the glare at approximately 60 meters off starboard, swimming vigorously away from the vessel.

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

There were no acoustic detections made during this survey program.

5.3. CONCURRENT VISUAL AND ACOUSTIC DETECTIONS

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

6. MITIGATION ACTION SUMMARY

There was only one mitigation action implemented during the USGS ECS 2-D seismic survey due to a protected species detection close to the 180 dB safety radius. This mitigation action consisted of power-down of the acoustic source which resulted in 12 minutes of mitigation downtime (Table 8). The power-down of the acoustic source was implemented for unidentifiable dolphins.

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	0:00
Power-down	1	0:12
Shut-down	0	0:00
Total	**1**	**0:12**

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

Unidentified dolphins were first observed at 22:23 UTC on 9 September approximately 2100 meters directly ahead of the bow, crossing perpendicular to the path of the vessel. The dolphins were next sighted at 22:30 UTC approximately 1400 meters off the starboard bow of the vessel where they appeared to be feeding. The dolphins had changed direction and were on a heading to cross back in front of the vessel. The acoustic source was powered-down at 22:34 UTC when the dolphins at a distance of approximately 1,100 meters to the center of the source when it appeared that they would soon enter the 180 dB safety radius of the source. The dolphins were last observed inside the 180 dB safety radius at 22:36 UTC approximately 900 meters from the source where only a single airgun was active in the powered down state. The dolphins were next sighted at 22:46 UTC 1500 meters directly off the bow of the vessel. This was the final sighting of the pod and the acoustic source returned to full volume at this time. Although the dolphins were not identified to species they were thought to be a *Stenella spp.*

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
9-Sep-14	11	Unidentifiable dolphin	3	Full volume (6,560 in³)	900 meters / 40 in³	Power-down	0:12

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

NMFS granted an IHA and ITS to L-DEO and USGS 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 exposed to received sound levels of 180 dB and 160 dB.

During the USGS Atlantic ECS 2-D seismic survey, only three unidentifiable dolphins were observed within the 160 dB safety radius, where Level B harassment is expected to occur, while the acoustic source was active (Table 11). It is possible that estimated numbers of animals recorded during a sighting event were underestimates due to some animals not being seen or having moved away before they were observed. Besides night time hours, there were occasions during daytime visual watches that the entire 160 dB safety radius was not visible due to fog and rain. Table 10 describes the behavior of the unidentified species, which were exposed to 160 dB for the duration they were observed.

Table 10. Behavior of species observed to be exposed to 160 dB.

Species	Detection No.	No. of Animals	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
Unidentifiable dolphin	11	3	Leaping	Perpendicular, ahead of vessel	Feeding	Perpendicular, ahead of vessel

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

Species	IHA Authorized Takes	Number of animals observed to be exposed to 180 dB	Number of animals observed to be exposed to 160 dB
Mysticetes			
North Atlantic right whale	1 or 2	0	0
Humpback whale	3	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	244	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	52	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	-	0	3
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 Level-B incidental taking of marine mammals and sea turtles during the USGS Atlantic 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 significant 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.

Additional mitigation measures 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, 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 while the acoustic source was active.

Passive acoustic monitoring was undertaken 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 is traveling at higher speed (greater than 6 knots), which makes it impractical to conduct monitoring for baseline acoustic data collection while the vessel is in transit to and from the survey sites. Additionally, in order to minimize the risk of entanglement of the hydrophone cable with other seismic equipment, the hydrophone cable must deployed after all seismic gear has already been deployed, and retrieved prior to the retrieval of the seismic equipment. This prevents baseline acoustic data from being collected on the survey site while visual monitoring is ongoing for baseline data collection purposes. No acoustic detections were made during this cruise.

Of the 19,433 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 24,131 animals over two field programs, or 11,367 animals for the 2014 field program, only three unidentified dolphins were observed as potentially exposed to >160dB during this cruise. 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.

7. ACKNOWLEDGEMENTS

We would like to thank the following individuals for their considerable help:

- Dr. Deborah Hutchinson from USGS and Holly Smith from NSF for their assistance
- Matthew Dellinger from RPS for providing logistical support for the project.
- We also thank Stephanie Milne, the RPS Program Manager for this survey, for project support

8. LITERATURE CITED

NOAA, 2014. Endangered Species Act Section 7 Consultation Biological Opinion for a seismic survey by the USGS and L-DEO along the U.S. East Coast and Issuance of an IHA.

USGS-NSF. 2014. Final EA for Seismic Reflection Scientific Research Surveys During 2014 and 2015 in Support of Mapping the US Atlantic Seaboard Extended Continental Margin and Investigating Tsunami Hazards. Prepared for the U.S. Geological Survey by RPS- Evan – Hamilton Inc. (EHI) an RPS Group Company. August 2014. Accessed on 23 December 2014 at http://www.nsf.gov/geo/oce/envcomp/usgssurveyfinalea2014.pdf.

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http://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis-with-appendices.pdf.

APPENDIX A:

Incidental Harassment Authorization for the USGS Atlantic ECS 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		MGL1407		
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		213 meters aft of PSO tower		
Water Depth	**Min**	1,445 meters		
	Max	6,144 meters		
Dates of project		20 August 2014	THROUGH	13 September 2014
Total time airguns operating – all power levels:		357 hours 12 minutes		
Time airguns operating at full power on survey lines:		352 hours 55 minutes		
Time airguns operating at full power on line changes:		2 hours 09 minutes		
Amount of time mitigation gun (40 in³) operations:		12 minutes		
Amount of time in ramp-up:		1 hour 56 minutes		
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:		None		
Duration of visual observations:		325 hours 07 minutes		
Duration of observations while airguns firing:		212 hours		
Duration of observation during airgun silence:		113 hours 07 minutes		
Duration of acoustic monitoring:		358 hours 01 minute		
Duration of acoustic monitoring while airguns firing:		357 hours 12 minutes		
Duration of acoustic monitoring during airgun silence:		49 minutes		
Duration of simultaneous acoustic and visual monitoring:		212 hours 49 minutes		
Lead Protected Species Observer:		Heidi Ingram		
Protected Species Observers:		Leslie Curran		
		Cassandra Frey		
		Laurie Dugan		
Acoustic Observer:		Laura Marcella		
Number of Marine Mammals Visually Detected:		18		
Number of Marine Mammals Acoustically Detected:		0		
Number of acoustic detections confirmed by visual sighting:		0		
Number of visual sighting confirmed by acoustic detection:		0		
Number of Sea Turtles detected:		2		
List Mitigation Actions (e.g. Power-downs, shut-downs, ramp-up delays)		1 Power-down		
Duration of operational downtime due to mitigation:		12 minutes		

APPENDIX C: Summary of monitoring and mitigation measures from IHA, ITS, and USFWS documents.

Mitigation Document	Mitigation action
IHA	Utilize two NMFS- qualified PSOs during daytime airgun operations. - PSVOs shall have access to reticle binoculars (7 x 50 Fujinmy, big-eye binoculars (25 x 150), optical range finders, night vision devices, and thermal imaging cameras. - PSVO shifts shall last no longer than 4 hours at a time. -PSVOs shall also make observations during daytime periods when the seismic system is not operating for comparison of animal abundance and behavioral reactions during, between, and after airgun operations. - PSVOs shall conduct monitoring while the air6run array and streamers are being deployed or recovered from the water.
IHA	PSVO(s) shall record the following information when a marine mammal is sighted: - 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; - 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; - The data listed above shall also be recorded at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.
IHA	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. When an animal is detected by PAM, the on-duty PSO shall be notified and the above data collected for the detection event.
IHA	Establish a 160 dB re 1 ~tPa (m1s) buffer zone as well as 180 and 190 dB re 1 ~Pa (nns) exclusion zone for marine mammals before the 2-string airgun array (6,600 in3) is in operation; and a 180 and 190 dB re 1 ~tPa (nns) exclusion zone before a single airgun (40 in3) is in operation, respectively.
IHA	Visually observe the entire extent of the exclusion zone for cetaceans using NMFS-qualified PSVOs, for at least 30 minutes prior to starting the airgun array (day or night). - If the PSVO observes a marine mammal within the exclusion zone, 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 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.

Mitigation Document	Mitigation action
IHA	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. Start the smallest airgun first and add airguns in a sequence such that the source level of the array increases in steps not exceeding approximately 6 dB per 5-minute period. 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.
IHA	Power-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone. 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, pygmy sperm, dwarf sperm, killer, and beaked whales)
IHA	Shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone. 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, pygmy sperm, dwarf sperm, killer, and beaked whales)
IHA	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.
	No initiation of airgun array operations is permitted from a shut-doJ1 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.
	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.
	If a North Atlantic right whale 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.
	Concentrations (6 or more whales) of humpback, sei, fin, blue, and/or sperm whales will be avoided if possible
	Submit a report on all activities and monitoring to NMFS within 90 days of the completion of the program.
	Cease survey activity in the event of an unauthorized take
	Report injured or dead marine mammals with an unknown cause of death to NMFS
ITS	Authorized takes for 4,698 sea turtles (1076 green turtles, 180 hawksbill turtles, 212 Kemp's Ridley turtles, 1502 leatherback turtles, 1728 loggerhead turtles)
USFWS	Powering or shutting down the airguns if a roseate tern or Bermuda petrel is seen diving in the area

APPENDIX D: Passive Acoustic Monitoring System Specifications

Main cable and spare cable:

1.1 Outline Array
Array serial number SM.4961
Mechanical Information
Length 20m
Diameter 14mm over cable 32mm over moldings 45mm over connectors
Weight 10kg
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 Heavy tow cable
Tow serial number SM.4635
Mechanical Information
Length 230m
Diameter 17mm over cable 32mm over moldings
Connector Tail end Seiche 36 pin 45mm over connectors
Head end ITT 19 pin 65mm over connectors
Weight 100kg

1.3 Deck cable
Deck serial number SM.1035
Mechanical Information
Length 100m
Diameter 14mm
Connectors ITT 19 pin 65mm over connectors
Weight 25kg

APPENDIX E: 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 20-meter hydrophone array cable and a 230-meter hydrophone tow cable have been supplied for the survey. The linear hydrophone array contains two broadband (200 Hz to 200 kHz), two low frequency hydrophone elements (2 kHz to 200 kHz) and a depth gauge (100m capacity) potted directly into the cable. The four hydrophones and their positions on the array cable are shown in Figure 1. A 100-meter deck cable connects the hydrophone tow cable from a winch on the port gun deck to the data processing unit located in the science lab.

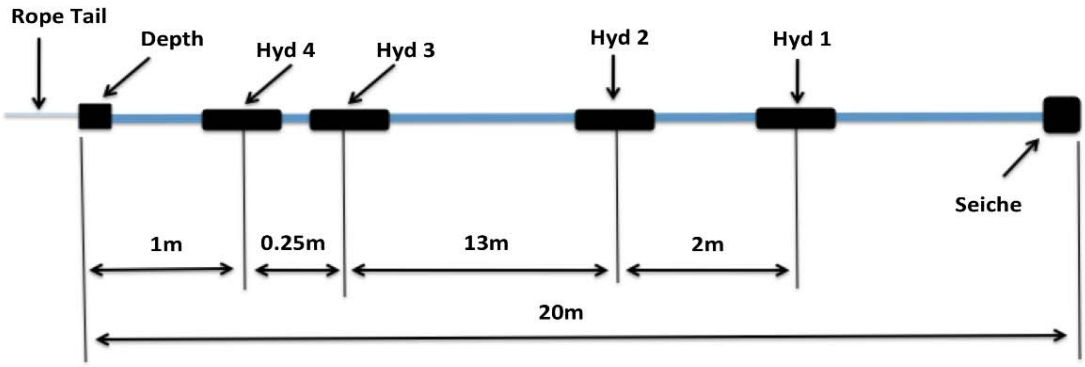

Figure 1: Diagram of the hydrophone array cable indicating the position and separation of the individual hydrophone elements.

The hydrophone array cable, connected to the tow cable, is spooled onto a port hydraulic winch (Figure 2). The adjoined cables are deployed directed off the stern of the vessel, just aft of the winch. It was attached via a Chinese finger to an offset lifting rope to help keep the cable from tangling with the seismic gear and this is the towing point of the PAM cable system (Figure 3; Left).

Figure 2: PAM tow cable spooled onto the winch and running aft.

Figure 3: The PAM tow cable connecting to the offset rope via shackle.

When deployed 125 meters of the PAM cable system is dispensed, 105 meters of tow cable and the 20 meter hydrophone cable. The gun array is placed 177 meters astern of the vessel, this places the separation between the end of the PAM hydrophone cable and the seismic array at 53 meters. The PAM cable is off set to port due to the deployment location.

Pre-Deployment Tasks

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

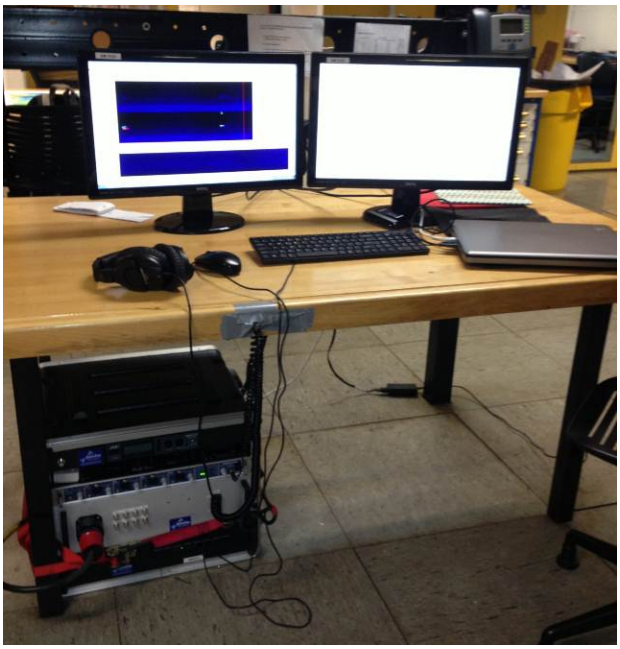

Figure 5: Passive acoustic monitoring station located in the instrument room.

Two 100-meter deck cables are routed from the instrument room to the port gun deck winch, one of which acts as a spare for ease of replacement at sea.

The hydrophone tow cable was measured and marked in 10-meter increments for the first 120 meters from the hydrophone array-tow cables' connection point.

Prior to deployment a tap test was performed to the hydrophones and the depth gauge calibrated.

Deployment

- Ensure that the PAM electronics unit is powered down.
- Alert the bridge of pending hydrophone deployment.
- Ensure the deck cable is disconnected from the hydrophone tow cable.
- Power on winch.
- Pay out 125m of the hydrophone cable from the winch, dispensing the cable into the water on port side of gun umbilicus.

- Power off winch.
- Connect the deck cable to the hydrophone cable.
- Power up electronics in the instrument room.

Retrieval

- Power down electronics in the instrument room.
- Alert the bridge of pending hydrophone retrieval.
- Ensure the deck cable is disconnected from the hydrophone cable (tape both connectors to prevent corrosion).
- Disconnect cable from towing point shackle.
- Retrieve the hydrophone cable and wind evenly on winch

Always ensure the deck cable is disconnected from the tow cable before operating the winch.

Health Safety and Environment (HSE) Requirements

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

The operation carries a relatively low risk. Hazards include working close to the side of the vessel, trip hazards, and pinch points at the winch, shackles, and collar.

A Job Safety Analysis (JSA) has been completed for this task. The JSA will also require further review upon any additional modifications.

APPENDIX F: Survey Lines Acquired

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced (UTC)	Date Acquisition Completed	Time Acquisition Completed (UTC)
MGL1407MCS01 Seq001	23-Aug-14	14:07	25-Aug-14	01:29
MGL1407MCS02 Seq002	25-Aug-14	01:36	25-Aug-14	14:49
MGL1407MCS03 Seq003	25-Aug-14	14:53	26-Aug-14	02:52
MGL1407MCS06 Seq004	26-Aug-14	02:59	26-Aug-14	21:55
MGL1407MCS03A Seq005	29-Aug-14	12:11	29-Aug-14	14:37
MGL1407MCS03B Seq006	31-Aug-14	11:15	01-Sep-14	03:30
MGL1407MCS07 Seq007	01-Sep-14	03:35	02-Sep-14	22:02
MGL1407MCS08 Seq008	02-Sep-14	22:08	03-Sep-14	04:01
MGL1407MCS06A Seq009	03-Sep-14	04:03	04-Sep-14	11:53
MGL1407MCS09 Seq010	04-Sep-14	11:55	05-Sep-14	02:05
MGL1407MCS10A Seq011	05-Sep-14	02:18	05-Sep-14	16:49
MGL1407MCS10B Seq012	05-Sep-14	16:54	06-Sep-14	01:23
MGL1407MCS10C Seq013	06-Sep-14	01:28	06-Sep-14	23:27
MGL1407MCS11A Seq014	06-Sep-14	23:44	07-Sep-14	16:14
MGL1407MCS12A Seq015	07-Sep-14	16:19	08-Sep-14	12:26
MGL1407MCS12B Seq016	08-Sep-14	12:33	09-Sep-14	02:22
MGL1407MCS13 Seq017	09-Sep-14	02:27	09-Sep-14	17:30
MGL1407MCS14 Seq018	09-Sep-14	17:37	10-Sep-14	14:48
MGL1407MCS15 Seq019	10-Sep-14	14:52	11-Sep-14	17:00
MGL1407MCS16 Seq020	11-Sep-14	17:04	11-Sep-14	19:53

APPENDIX G: Summary of visual detections of protected species during the USGS ECS 2-D seismic 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	20-Aug	20:32	Loggerhead sea turtle	1	40.28952°N 073.66510°W	Silent	TV	ST DI	35 m / Silent	None	Acoustic source onboard.
2	20-Aug	21:52	Short-beaked common dolphin	11	40.15500°N 073.47727°W	Silent	TV	NS	15 m / Silent	None	Acoustic source onboard.
3	21-Aug	10:05	Short-beaked common dolphin	25	40.03947°N 073.51987°W	Silent	PV/OD	NS	300 m / Silent	None	Acoustic source onboard.
4	22-Aug	10:03	Unidentifiable pilot whale	10	39.24237°N 072.14362°W	Silent	PV/OD	NS	700 m / Silent	None	Acoustic source onboard.
5	22-Aug	11:59	Common bottlenose dolphin	21	39.03553°N 071.79450°W	Silent	TV	FT PO SA	50 m / Silent	None	Acoustic source onboard.
6	22-Aug	19:36	Unidentifiable dolphin	2	39.09580°N 071.84832°W	Silent	PV/SD	PO FT	150 m / Silent	None	Acoustic source onboard.
7	23-Aug	11:03	Unidentifiable dolphin	1	39.19837°N 072.29283°W	Silent	PV/OD	DV ST	300 m / Silent	None	Gear being deployed.
8	30-Aug	10:24	Short-beaked common dolphin	9	36.29987°N 072.59912°W	Silent	PV/SD	PO	260 m / Silent	None	Away from survey area. Seismic gear onboard.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behaviour		CPA Source / Source Activity	Mitigation Action	Comments
9	30-Aug	11:20	Sperm whale	4	36.30170°N 072.80955°W	Silent	PV/OD	BA BV	700 m / Silent	None	Away from survey area. Seismic gear onboard.
10	30-Aug	11:57	Sperm whale	4	36.29885°N 072.79332°W	Silent	PE/AH	BA DI	250 m / Silent	None	Same animals as detection 9. Away from survey area. Seismic gear onboard.
11	9-Sep	22:23	Unidentifiable dolphin	3	31.66500°N 072.46442°W	Full volume	PE/AH	SA FF	900 m / Mitigation firing	Power down	Acoustic source powered down before animals entered 180 dB safety radius. Last observed outside of 180 dB safety radius.
12	12-Sep	16:03	Unidentifiable shelled sea turtle	1	34.79963°N 074.94913°W	Silent	AV	FT	180 m / Silent	None	Vessel in transit. Seismic gear on board.
13	12-Sep	19:22	Unidentifiable dolphin	2	35.44000°N 074.74667°W	Silent	TV	PO	30 m / Silent	None	Vessel in transit. Seismic gear on board.
14	12-Sep	21:32	Unidentifiable pilot whale	35	35.75010°N 074.64785°W	Silent	PV/OD	ST SB	80 m / Silent	None	Vessel in transit. Seismic gear on board.
15	12-Sep	23:08	Common bottlenose dolphin	8	35.93193°N 074.69997°W	Silent	AV	NS	250 m / Silent	None	Vessel in transit. Seismic gear on board.
16	13-Sep	10:46	Common bottlenose dolphin	5	36.97887°N 076.12933°W	Silent	TV	NS	150 m / Silent	None	Vessel in transit. Seismic gear 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
17	13-Sep	11:03	Common bottlenose dolphin	4	36.99678°N 076.19967°W	Silent	TV	PO	240 m / Silent	None	Vessel in transit. Seismic gear on board.
18	13-Sep	11:24	Common bottlenose dolphin	1	37.00787°N 076.25843°W	Silent	TV	SA	160 m / Silent	None	Vessel in transit. Seismic gear on board.
19	13-Sep	11:37	Common bottlenose dolphin	2	36.99280°N 076.30903°W	Silent	TV	PO	150 m / Silent	None	Vessel in transit. Seismic gear on board.
20	13-Sep	12:22	Common bottlenose dolphin	14	36.89218°N 076.33587°W	Silent	TV	NS	100 m / Silent	None	Vessel in transit. Seismic gear on board.

APPENDIX H: 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
American redstart	Parulidae	*Setophaga*	*ruticilla*	2	2
Belted kingfisher	Alcedinidae	*Ceryle*	*alcyon*	1	1
Blue-winged teal	Anatidae	*Anas*	*discors*	1	1
Bobolink	Icteridae	*Dolichonyx*	*oryzivorus*	1	1
Double-crested cormorant	Phalacrocoracidae	*Phalacrocorax*	*auritus*	20+	1
Greater shearwater	Procellariidae	*Puffinus*	*gravis*	90+	7
Herring gull	Laridae	*Larus*	*argentatus*	50+	3
Laughing gull	Laridae	*Larus*	*atricilla*	3	2
Masked booby	Sulidae	*Sula*	*dactylatra*	1	1
Mourning dove	Columbidae	*Zenaida*	*macroura*	1	1
Nashville warbler	Parulidae	*Vermivora*	*ruficapilla*	1	1
Northern rough-winged swallow	Hirundinidae	*Stelgidopteryx*	*serripennis*	3	2
Osprey	Accipitridae	*Pandion*	*haliaetus*	1	1
Prairie warbler	Parulidae	*Dendroica*	*discolor*	1	1
Red-footed booby	Sulidae	*Sula*	*sula*	2	2
Trinidade petrel	Procellariidae	*Pterodroma*	*arminjoniana*	1	1
White-tailed tropicbird	Phaethontidae	*Phaethon*	*lepturus*	27	10
Wilson's plovers	Charadriidae	*Charadrius*	*wilsonia*	2	2
Yellow-throated warbler	Parulidae	*Dendroica*	*dominica*	1	1
UID Petrel	Procellariidae	-	-	4	2
UID Plover	Charadriidae	-	-	102+	2
UID Sandpiper	Scolopacidae	-	-	1	1
UID Shearwater	Procellariidae	-	-	6	1
UID Storm petrel	Hydrobatidae	-	-	6	3
UID Tern	Laridae	-	-	5	3
UID Tropicbird	Phaethontidae	-	-	1	1

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
Mahi-mahi	Coryphaenidae	*Coryphaena*	*hippurus*	23	8
Manta ray	Myliobatidae	*Manta*	-	1	1
Moon jellyfish	Ulmaridae	*Aurelia*	*aurita*	3	2
Ocean sunfish	Centrarchidae	*Mola*	*mola*	2	2
Oceanic triggerfish	Balistidae	*Canthidermis*	-	8	1
Flying fish	Exocoetidae	-	-	2636+	21
Pufferfish	Tetraodontidae	-	-	2	2
Tuna	Scombridae	-	-	1	1