Protected Species Mitigation and Monitoring Report

East North American Margin (ENAM) 2-D Seismic Survey in the Atlantic Ocean off the coast of Cape Hatteras, North Carolina

16 September – 18 October 2014

R/V *Marcus G. Langseth*

Prepared for

Lamont-Doherty Earth Observatory of Columbia University
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for submission to

National Marine Fisheries Service, Office of Protected Resources
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1 EXECUTIVE SUMMARY

The National Science Foundation (NSF) owned research vessel, *Marcus G. Langseth* (R/V *Langseth*), operated under a Cooperative Agreement by Lamont-Doherty Earth Observatory (L-DEO), of Columbia University, conducted a two dimensional (2-D) seismic survey in the Atlantic ocean, off Cape Hatteras. The operational activities conducted were in support of a research survey led by Principal Investigators (PIs), Drs. H. Van Avendonk and G. Christeson (University of Texas at Austin), B. Magnani (University of Memphis), D. Shillington, A. Bécel, and J. Gaherty (L-DEO), M. Hornbach (Southern Methodist University), B. Dugan (Rice University), M. Long (Yale University), M. Benoit (The College of New Jersey), and S. Harder (University of Texas at El Paso), with funding from the U.S National Science Foundation (NSF). The purpose of the survey was to image geological structures involved in the breakup of Pangea and early seafloor spreading during the opening of the Atlantic Ocean ~170 million years ago and to gain insight into more recent evolution of the continental margin by submarine landslides. Assessing slope stability is important for estimating the risk of future landslides, which can result in tsunamis. The R/V *Langseth* departed Norfolk, Virginia on 16 September 2014 and began the survey on 17 September 2014. The survey was completed on 17 October 2014 and R/V *Langseth* arrived back in Norfolk, Virginia on 18 October 2014.

This report serves to comply with the reporting requirements pursuant to the Marine Mammal Protection Act and Endangered Species Act. L-DEO submitted an application to the National Marine Fisheries Service (NMFS) for an Incidental Harassment Authorization (IHA) that allows for the potential harassment of marine mammals that may occur during the marine geophysical survey. An Incidental Harassment Authorization (IHA) and an Incidental Take Statement (ITS) was granted on 12 September 2014 (Appendix A) with multiple mitigation measures that stipulated conditions for which non-lethal harassment to marine mammals would be allowed. U.S. Fish and Wildlife issued a Letter of Concurrence (LOC) on September 12, 2014, that the proposed actions may affect, but were not likely to adversely affect, the marine seabirds: roseate tern, Bermuda petrel, and piping plover. In addition, NMFS issued its Final Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) 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 an exclusion zone (EZ) 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 EA and FONSI (prepared pursuant to the National Environmental Policy Act), LOC issued by USFWS, and the IHA 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 PEIS), to which the NSF Final EA tiered. Five PSOs, including 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 403 hours and 01 minute of visual observations and 684 hours 59 minutes of acoustic monitoring over the course of the survey.

Visual monitoring effort resulted in 57 protected species detection records for cetaceans and sea turtles, the majority (42 detections) of which were of small odontocetes. There were four detections of sperm

whales, and two detections of unidentified whales. Sea turtles were observed nine times. There were also four acoustic detections, all dolphin species, two of which were correlated with visual sightings. Thirteen detections were made while the vessel was in transit to and from the survey site including one of the sperm whale detections, nine of the dolphin detections and three of the sea turtle detections.

Detections of protected species resulted in 18 mitigation actions being implemented: 16 power-downs and two shut-downs of the acoustic source. This resulted in a total of 5 hours 44 minutes of mitigation downtime.

A known 248 cetaceans and four sea turtles were observed to be within the predicted 160 dB re 1 µPa zone around the acoustic source and therefore potentially exposed to received sound levels equal to or greater than 160 dB re 1 µPa. Cetaceans observed within the predicted 160 dB zone included 147 unidentifiable pilot whales, 27 bottlenose dolphins, 64 unidentifiable dolphins, seven sperm whales, and three unidentifiable whales. Sea turtles observed within the predicted 166 dB re 1 µPa zone included four unidentifiable shelled sea turtles, one loggerhead sea turtle, and one leatherback sea turtle. A project summary sheet of observation, detection, and operational totals for the survey 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 the East North American Margin (ENAM) 2-D marine geophysical survey on board the R/V *Langseth* from 16 September through 18 October 2014 in the Atlantic Ocean, off the coast of Cape Hatteras, North Carolina.

This document serves to meet the reporting requirements dictated in the IHA and ITS issued by NMFS on 12 September 2014. The IHA and ITS authorized non-lethal 'takes' of Level B harassment of specific marine mammals and sea turtles, incidental to a marine seismic survey. NMFS has stated that seismic source received sound levels greater than 160 dB re 1 µPa (rms) could potentially disturb marine mammals, temporarily disrupting behavior, such that they could be considered as 'takes'. Potential consequences of Level B harassment takes could include effects such as temporary hearing threshold shifts and behavior modification. A safety or EZ was established for sound levels greater than 180 dB re 1 µPa (rms) for which the sound source must be powered down or shut down to avoid exposing cetaceans to these higher sound levels, where permanent hearing threshold shifts might occur. It is unknown to what extent cetaceans exposed to seismic noise of either 160- or 180 dB re 1 µPa (rms) level would express these effects, and in order to take a precautionary approach, NMFS required that provisions such as EZ radii, power-downs and shut-downs be implemented to mitigate for these potentially adverse effects. Although the ITS did not define reporting requirements for sea turtles, monitoring and mitigation information for sea turtles has been included in this report.

U.S. Fish and Wildlife Service issued a LOC on September 12, 2014, that the proposed actions may affect, but were not likely to adversely affect, the endangered and threatened marine seabirds: roseate tern, Bermuda petrel, and piping plover. Mitigation for the endangered and threatened seabirds would include shutdowns in the event the seabirds were observed diving within the 180 dB zone. No specific reporting requirements were identified for encounters with the endangered and threatened seabirds; 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 survey was conducted in the Atlantic Ocean between approximately 32 to 37° North and 71.5 to 77° West, approximately 17 to 422 kilometers off the coast of Cape Hatteras, North Carolina (Figure 1). The seismic survey was conducted outside of state waters, mostly within federal waters of the U.S. Exclusive Economic Zone (EEZ) and partly within International Waters. The water depth in the survey area ranged from 15 meters to 5,418 meters.

The R/V *Langseth* deployed two arrays of either 18 or 36 airguns as an energy source (or "source elements") during the survey. The receiving systems consisted of one eight-kilometer hydrophone streamer and 90 ocean bottom seismometers (OBSs). The OBSs were deployed and retrieved by a second vessel, the R/V *Endeavor,* which is operated by the University of Rhode Island's Graduate School of Oceanography. 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 OBSs recorded the returning acoustic signals internally for later analysis.

The goal of the survey was to collect and analyze data along the mid-Atlantic coast of the ENAM. The study area covered a portion of the rifted margin of the eastern U.S., from unextended continental

lithosphere onshore to mature oceanic lithosphere offshore. The data set will allow scientists to investigate how the continental crust stretched and separated during the opening of the Atlantic Ocean, and what the role of magmatism was during continental breakup. The study also covered several features representing the post-rift modification of the margin by slope instability and fluid flow.

A total of 4,798.71 kilometers of transect lines were surveyed (Figure 2). A total of 3,416.58 kilometers of multichannel seismic (MSC) lines were surveyed with 36 source elements at a volume of 6,600 in³ and 1,382.13 kilometers of OBS lines were surveyed using 18 source elements at a volume of 3,300 in³. The R/V *Langseth*'s cruising speed was about 10-12 knots during transits and varied between approximately 2 and 6 knots during the seismic survey. Seismic acquisition began on 17 September and continued until 17 October when all seismic gear was retrieved at the completion of the survey.

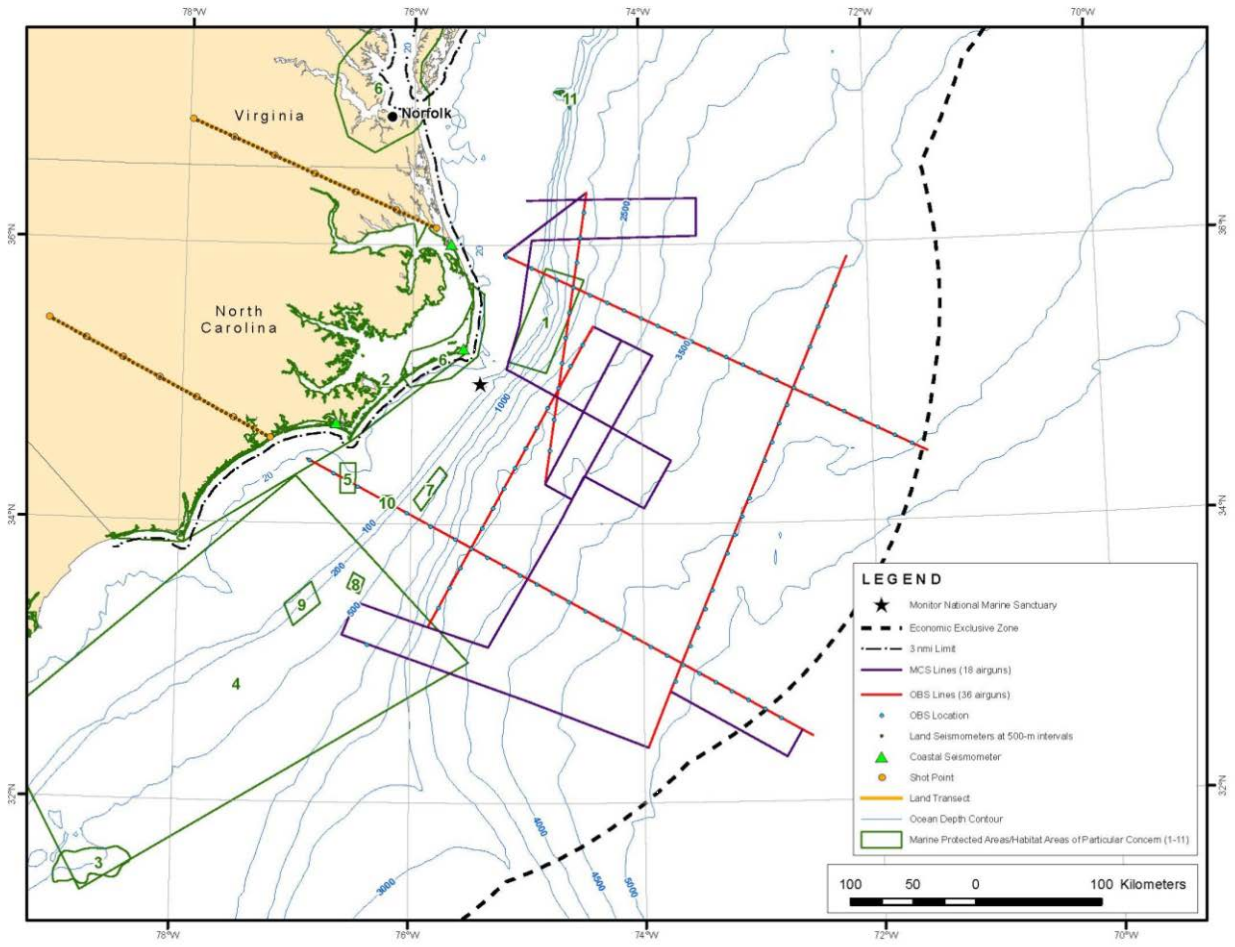

Figure 1. Proposed location of onshore and offshore instruments and marine seismic survey lines (~5300km) of the ENAM 2-D marine geophysical survey in the Atlantic Ocean off Cape Hatteras, NC

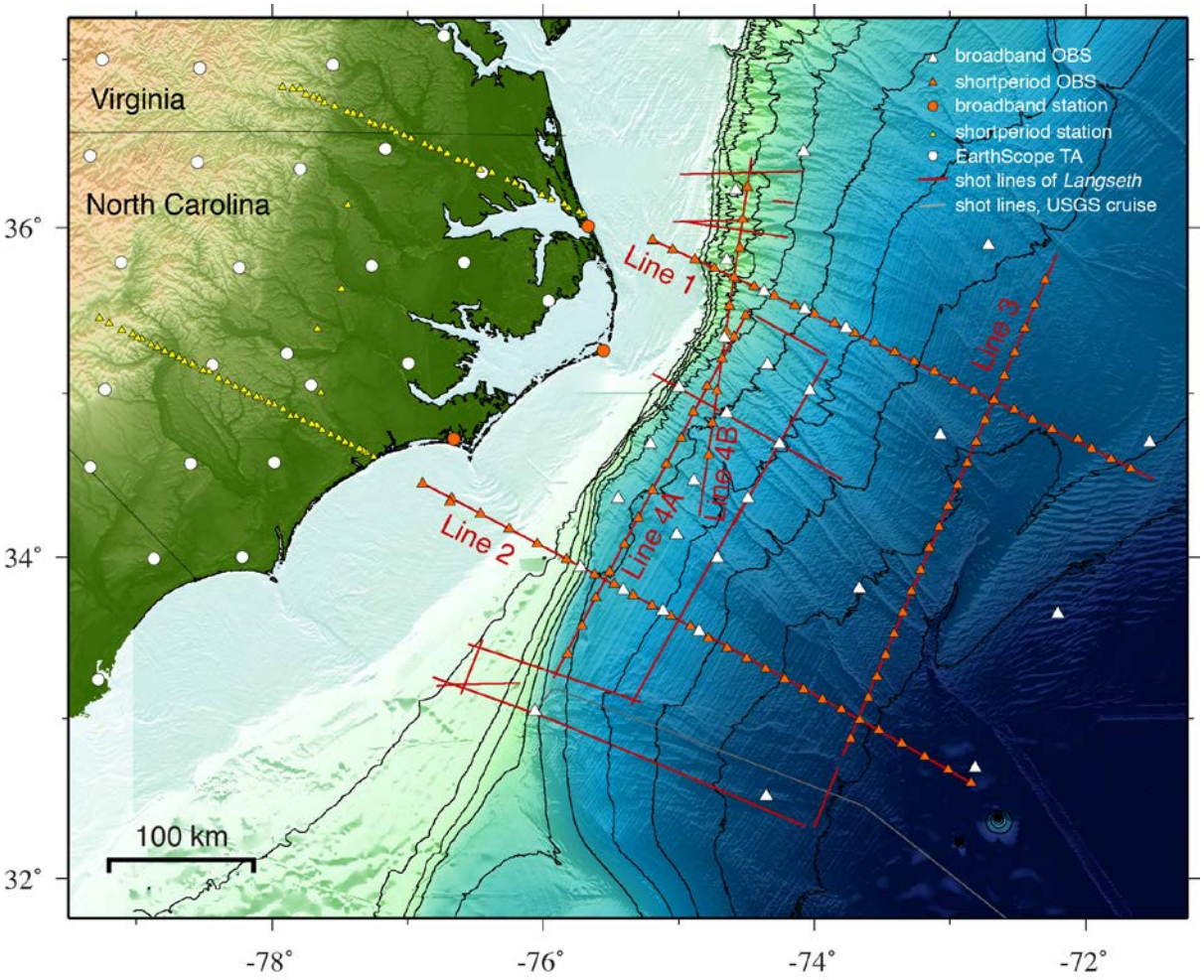

Figure 2: Actual completed marine seismic survey tracks (~5000km) and instrument locations

As part of an effort to address and avoid other potential impacts related to ship traffic, fishing, and local dive operations, LDEO took on additional efforts in an outreach plan to contact local scuba diving operators, coordinate with an marine science research team from University of North Carolina, and issue Notice to Mariners via the US Coast Guard (USCG). All of these groups were provided our proposed operational plans and a daily update during the survey. This outreach was particularly relevant for the shelf areas at the westernmost end of Lines I and 2 noted in Figure 2.

2.1.1 Acoustic Sources

The seismic acoustic source consisted of either 18 or 36 source elements on four towed sub-arrays. The sub-arrays were deployed in two pairs located approximately eight meters apart, within each pair the arrays were separated by approximately six meters. When using 18 source elements, only two of the four sub-arrays were in use. The source elements were towed at a depth of nine meters while using the 36 source element array, six meters while using the 18 source element array, 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 source element of 40 in^3 to 360 in^3. Each sub-array contained ten elements, with the first

and last spaced 16 meters apart. Only nine source elements on each sub-array operated during survey acquisition, with the tenth element 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 source elements) had a total discharge volume of 6,600 in^3 and a pressure of 2,000 psi; the half array power source of two sub-arrays (18 source elements) had a total discharge volume of 3,300 in^3 and a pressure of 2,000 psi. Each discharge of the source array consisted of a single brief pulse of sound (duration of approximately 0.1 second) with the greatest energy output occurring in the two to 188 hertz frequency range.

The shot interval for the multi-channel seismic (MCS) survey was usually 50 meters, equating to a shot approximately every 22 seconds at typical survey speed. The shot point interval for the ocean-bottom seismic (OBS) survey lines was 225 meters, equating to approximately 60-90 seconds between shots (depending on currents). 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. The hydrophone streamer was deployed throughout the survey, even while surveying OBS lines. Due to the length and placement of the cables, the maneuverability of the vessel was limited while the gear was being towed.

The OBSs used during the cruise were provided by Woods Hole Oceanographic Institute (WHOI) and Scripps Institution of Oceanography (SIO). The WHOI OBSs had a height of approximately 1 meter and a maximum diameter of 50 cm. The anchor was made of hot-rolled steel and weighs 23 kg. The anchor dimensions were 2.5 × 30.5 × 38.1 cm. The SIO OBSs had a height of approximately 0.9 meters and a maximum diameter of 97 cm. The anchors were 36 kg iron grates with dimensions 7 × 91 × 91.5 cm. Once an OBS was ready to be retrieved, an acoustic release transponder pinged the instrument at a frequency of 9 to 11 kHz, and a response was received at a frequency of 10 to12 kHz. The burn-wire release assembly then activated, and the instrument was released from the anchor to float to the surface.

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

3 MITIGATION AND MONITORING METHODS

The PSO monitoring program on the R/V *Langseth* was established to meet the standards set forth in the PEIS, NSF Final EA, USFWS LOC, and the IHA and ITS requirements that were issued to the L-DEO by NMFS, which included both monitoring and mitigation objectives. Additional monitoring and mitigation protocols were also requested by NC under the Coastal Zone Management Act (CZMA). The survey mitigation program was designed to minimize potential impacts of the R/V *Langseth*'s seismic program on sea turtles, marine mammals, and other protected species of interest. The following monitoring protocols were followed to meet these objectives.

- Visual observations protocols were established to provide real-time sighting data, allowing for the implementation of mitigation procedures as necessary.
- A Passive Acoustic Monitoring system was operated to augment visual observations and provide additional marine mammal detection data.
- Effects of marine mammals and marine turtles exposed to sound levels constituting take were observed and documented; the nature of the probable consequences were discussed when possible.

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

3.1 VISUAL MONITORING SURVEY METHODOLOGY

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

Figure 3. 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 to conduct night-time observations for nighttime ramp-ups of the acoustic source and was used once during the survey. 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. Two PSOs watched for marine mammals and sea turtles at all times during daylight periods while the acoustic source operated and whenever the vessel was underway when the source was not operating.

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 civil twilight dawn, beginning as soon as the mitigation radii were visible, and continued past sunset until the mitigation became obscured at civil twilight dusk. Start of observation times ranged from 6:22 to 6:52 local time, while end of observation times ranged from 18:44 to 19:30 local time. Because PSOs monitored during daylight periods, most initiations of the source occurred following monitoring periods greater than 30 minutes, typically one hour or more.

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 three 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.

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, sea turtle or sea bird) to determine which mitigation 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 EZ radius and whether a mitigation action was necessary. The PAM operator would relay the message to the seismic technician who sits nearby. Table 1 describes the various mitigation radii applied to cetaceans/sea turtles and pinnipeds, as well as the predicted Level-B harassment zone. The PAM operator was also notified of all marine mammal sightings as soon as possible in order for recordings to be made for additional analysis later by one of the more experienced acoustic operators. Specifically, the analysis would be performed to determine whether vocalizations had been detected on the PAM system during the sighting.

Table 1. Mitigation Radii/Zones implemented

Source and Volume	Array Tow Depth (m)	Water Depth (m)	Power/Shut-down radii for Pinnipeds (m)		Power/Shut-down radii for Cetaceans / Sea turtles (m)		Level-B Harassment Zone 160 dB (cetaceans) / 166 dB (sea turtles) (m)
			190 dB with buffer	190 dB	180 dB with buffer	180 dB	
Single Bolt Source element (40 in³)	6 or 9	<100	37	27	121	86	938 / 464
		100-1,000	-	-	100	100	582 / 278
		>1,000	-	-	100	100	388 / 185
18–Source element array (3,300 in³)	9	<100	436	294	1,628	1,097	15,280 / 6,950
		100-1,000	-	-	-	675	5,640 / 3,291
		>1,000	-	-	-	450	3,760 / 2,194
36–Source element array (6,600 in³)	9	<100	877	645	2,838	2,060	22,600 / 11,100
		100-1,000	-	-	-	1,391	8,670 / 5,610
		>1,000	-	-	-	927	5,780 / 3,740

PSOs recorded the following information for each protected species detection:

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 acoustic source 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 source elements 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 per the requirements of the IHA and ITS. Each sighting event was linked to an entry on a datasheet such that environmental conditions and vessel activity are 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

PAM 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 or low visibility when visual monitoring might not be applicable or effective. The PAM system was monitored to the maximum extent possible, 24 hours a day during seismic operations, and the times when monitoring was possible while the acoustic source was not in operation. High levels of background noise on the hydrophone cable are experienced when the cable is deployed while the vessel is traveling at transit speeds (greater than 6 knots), which makes it impractical to conduct monitoring for baseline acoustic data collection during these periods. 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 in PAM, one of whom 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 were viewable on a spectrogram display within *Pamguard*. Sperm whale, beaked whale, *Kogia* species, and delphinid echolocation clicks could be viewed on low and high frequency click detector displays. The Spectrogram's amplitude range and appearance were adjusted as needed to suit the operator's preference to maximize the vocalizations appearance above the pictured background noise.

3.2.1 Passive Acoustic Monitoring Parameters

Acoustic monitoring was carried out using a PAM system developed by Seiche Measurements Limited. PAM system specifications can be found in Appendix C. The PAM system consisted 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 contained four hydrophone elements and a depth gauge moulded into a 20m section of the cable. The first two hydrophones were designated as the low frequency channels; these were broadband elements (200 Hz to 200 kHz). The third and fourth hydrophones were considered the standard elements, and sampled high frequencies (2 kHz to 200 kHz). The four-element linear hydrophone array permitted 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 35 kilohertz (Butterworth 4th order). *Pamguard* used the difference between the time that a sound signal arrived at each of the two hydrophones to calculate and display the bearing to the source of the sound. A scrolling bearing time display in *Pamguard* also displayed 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 and allowed delphinid whistles and other cetacean vocalizations to be plotted onto a map module where bearing and range to the vocalizing animal's actual position could be obtained. A mixer unit enabled the operator to adjust stereo signal levels from each of the four hydrophones. The PAM Operator 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.

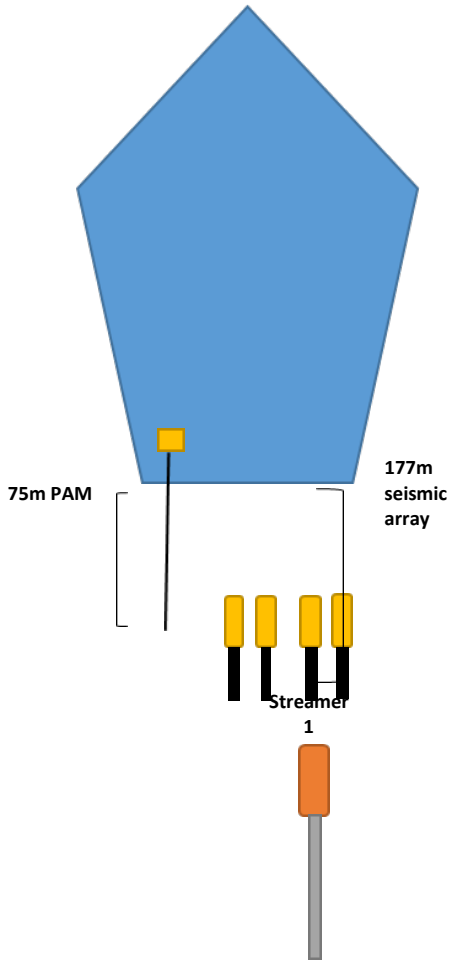

Figure 4. Location of the PAM cable in relation to the seismic gear

4 MONITORING EFFORT SUMMARY

4.1 SURVEY OPERATIONS SUMMARY

The R/V *Langseth* departed Norfolk, Virginia at 13:00 UTC on 16 September and began transit to the survey area. The seismic gear was deployed and use of the acoustic source commenced at 22:57 UTC on 17 September. Acquisition began on the first survey line at 5:35 UTC on 18 September. Acquisition continued with short breaks for equipment maintenance until the end of the survey on 17 October, when the acoustic source was disabled at 8:00 UTC and all seismic gear was retrieved. The R/V *Langseth* began the transit to Norfolk, Virginia arriving at 13:55 UTC on 18 October. The dates and times of acquisition for each survey line can be found in Appendix E.

The acoustic source was active throughout the survey, with few periods of source silence, for a total of 644 hours 28 minutes of source activity. This includes ramp-up of the acoustic source, full volume both online and during line changes, and operation of a single 40 in³ mitigation source (Figure 4). Full power source operations while on a survey line accounted for 87% (559 hours 45 minutes) of source activity during the project. Full volume source operations between survey lines (line changes) accounted for 68 hours and 57 minutes of array activity. Line changes with a duration of greater than three hours (the maximum allowable operation time of the mitigation source, as per the IHA), where the start of line was scheduled to occur during hours of reduced visibility were undertaken at full volume but the shot interval was reduced from 18 seconds to every 60 seconds in order to reduce the sound output in the water. The source was silenced during line changes longer than three hours where the start of line was scheduled to begin during daylight hours. The mitigation source was used during line changes lasting less than three hours and during mitigation power-downs initiated for protected species inside or approaching the EZ radius. The mitigation source was active for 10 hours 58 minutes during the program.

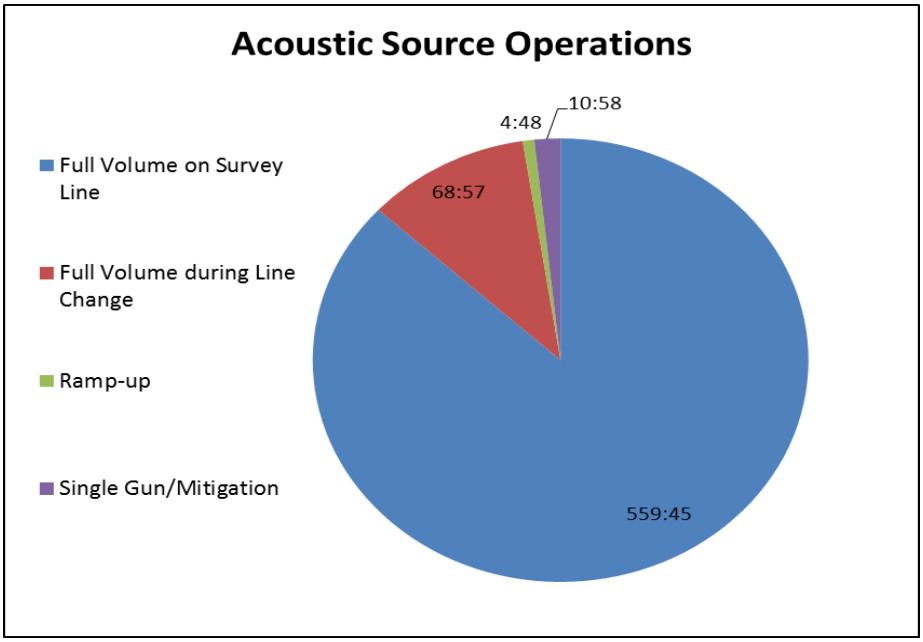

Figure 5. Total acoustic source operations over the course of the ENAM 2-D seismic survey

Over the course of the survey, the full volume of the array for MCS survey lines ranged from 6,420 in³ to 6,600 in³, with 36 source elements active. The full volume of the array for OBS survey lines ranged from

3,220 in³ to 3,300 in³, with 18 source elements active. At the very end of the survey while remaining "online" the volume was reduced to 2,860 in³ (17 source elements) for a total of 1 hour 48 minutes when a single source element ceased functioning.

The acoustic source was ramped up eight times over the course of the survey in order to commence full volume survey operations (Table 2). One ramp-up was conducted at night from the active mitigation source on 18 September in order to commence survey operations at the start of the program. PSOs conducted a 30 minute visual watch using D-300 Night Vision Monoculars prior to initiation of ramp-up and throughout the ramp-up until the source attained full volume. One ramp-up was conducted during the day from the mitigation gun, and the remaining six ramp-ups were conducted after extended periods of source silence (longer than 8 minutes). The ramp-ups ranged between 34 and 38 minutes in length. 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 source element and adding elements 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 source elements is typically equal to a 6 dB increase in sound level, the array was not ramped up if more than half of the source elements in the array were already active.

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

Acoustic Source Operations	Number	Duration (hh:mm)
Source Tests		**00:00**
Ramp-up	**8**	**04:48**
Day time ramp-ups from source silence	**6**	
Day time ramp-ups from mitigation source	**1**	
Night time ramp-ups from mitigation source	**1**	
Full volume survey acquisition		**559:45**
Full volume line changes		**68:57**
Single source element (40 in³)		**10:58**
Total time acoustic source was active		**644:28**

4.2 VISUAL MONITORING SURVEY SUMMARY

The PSOs began visual observations immediately upon departure from Norfolk at 13:02 UTC on 16 September and continued while in transit to the survey site. This was done to collect baseline data about protected species abundance in the area. Visual monitoring was conducted during all daylight hours, regardless of vessel activity, throughout the entire survey. Visual monitoring ended at 13:55 UTC on 18 October when the vessel arrived in Norfolk after the completion of the project. Visual monitoring was conducted over a period of approximately 33 days. Monitoring was conducted by two PSOs each day between just before dawn until just after dusk, when it was too dark for the entire EZ radius to be visible, averaging approximately 12 hours 33 minutes of visual observations per day.

The acoustic source was active during the majority of visual monitoring undertaken (84%) as well as the majority of acoustic monitoring performed (93%), as shown in Figure 5.

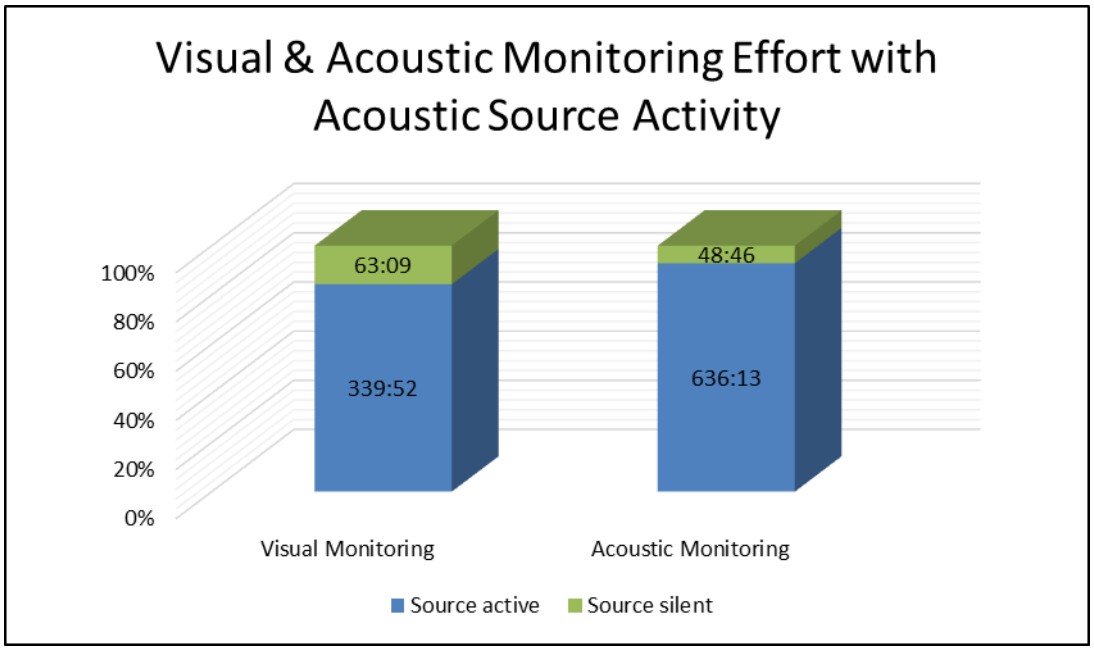

Figure 6. Duration of visual and acoustic monitoring effort while the acoustic source was active vs. silent

Total visual monitoring effort, divided by monitoring effort while the acoustic source was active and monitoring effort while the source was silent, is listed in Table 3.

Table 3. Total visual monitoring effort

Visual Monitoring Effort	Duration (hh:mm)
Total monitoring while acoustic source active	339:52
Total monitoring while acoustic source silent	63:09
Total monitoring effort	**403:01**

The PSOs preferentially conducted visual observations from the PSO tower, which provided a 360° view of the water around the vessel and acoustic source. However, visual watches would be conducted from the catwalk or bridge for any health or safety reason, such as during periods of high winds, large swells, heavy rain, and during periods when the ship's exhaust was blowing on the tower. As Figure 6 demonstrates, 78% of visual monitoring was conducted from the PSO tower during the ENAM 2-D seismic survey.

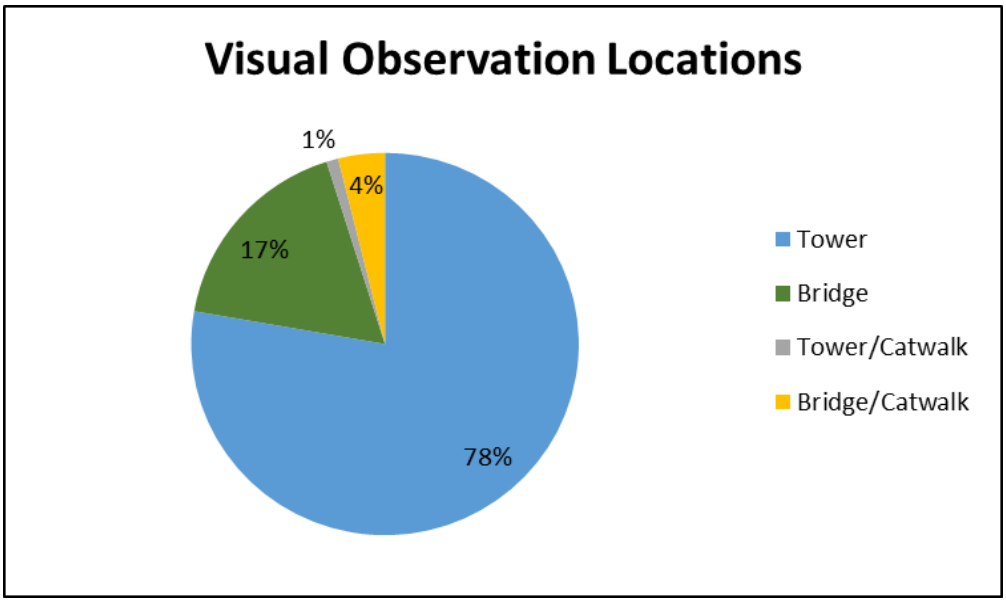

Figure 7. Total visual effort from observation locations

4.3 PASSIVE ACOUSTIC MONITORING SURVEY SUMMARY

The hydrophone cable was deployed for the first time on 18 September after the vessel had completed deployment of the source arrays and streamer. Acoustic monitoring began at 00:34 UTC on 18 September and continued throughout the project with PSOs monitoring the hydrophones aurally and with the Pamguard detection software visually both day and night. Acoustic monitoring for the project ended at 8:00 UTC on 17 October when the hydrophone cable was retrieved, just after completion of the final survey line. Over the course of the project, PSOs conducted 684 hours 59 minutes of acoustic monitoring, most of which occurred while the acoustic source was active (Table 4).

Table 4. Total passive acoustic monitoring effort

Passive Acoustic Monitoring Effort	Duration (hh:mm)
Total night time monitoring	**331:27**
Total day time monitoring	**353:32**
Total monitoring while acoustic source active	**636:13**
Total monitoring while acoustic source silent	**48:46**
Total acoustic monitoring	**684:59**

Acoustic monitoring was suspended for a total of 18 hours 27 minutes on eight separate occasions during the survey program for cleaning, equipment malfunction, equipment adjustments and seismic gear maintenance (Table 5). A description of each instance of acoustic monitoring downtime is located in Appendix F.

Table 5. Passive acoustic monitoring downtime

Cause of Downtime	Duration (hh:mm)

Debris removal and maintenance hydrophone cable	**1:32**
Replacement of damaged PAM equipment	**2:34**
Adjustments to PAM equipment	**1:47**
Seismic gear maintenance	**12:34**
Total Passive Acoustic Monitoring Downtime	**18:27**

The majority of this downtime (12 hours 34 minutes) occurred during a single instance of seismic gear maintenance. On 7 October the vessel suspended acquisition to perform streamer maintenance. In order to minimize the risk of entanglement with other seismic equipment, the hydrophone cable was retrieved prior to the retrieval of the seismic equipment and it remained on board until the seismic gear was re-deployed.

Two other significant periods of acoustic monitoring downtime occurred on 19 September and 7 October when a damaged hydrophone cable was replaced with a spare hydrophone. Other occurrences of minimal monitoring downtime occurred when the cable was retrieved for removal of accumulated sargassum and in order to make adjustments to the towing depth of the cable.

4.4 SIMULTANEOUS VISUAL AND PASSIVE ACOUSTIC MONITORING SUMMARY

Visual observations began at 13:02 UTC on 16 September, but acoustic monitoring did not begin until 0:34 UTC on 18 September, as the hydrophone cable could not be deployed until the source arrays were deployed in order to minimize for potential entanglement. Of the total observation effort performed by PSOs during this survey, visual monitoring accounted for 37% (403 hours 01 minutes) while acoustic monitoring accounted for 63% (684 hours 59 minutes). There were 353 hours 32 minutes of simultaneous visual and acoustic observations conducted during this survey (Figure 7). Acoustic monitoring was conducted simultaneously during 88% of visual observations and visual monitoring was conducted during 52% of acoustic monitoring.

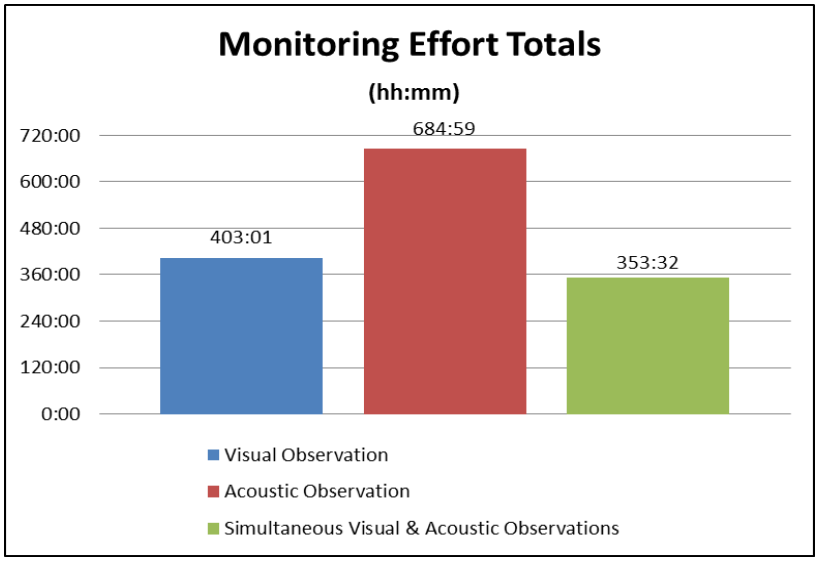

Figure 8. Total acoustic and visual monitoring effort

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 moderate to favorable.

Visibility was classified as 'excellent' if it extended to 10 kilometers or greater. A total of 332 hours and 55 minutes (83% of total effort) of visual monitoring effort was undertaken while visibility extended to 10 kilometers or greater (Figure 8). Periods of fog, light to heavy rain, and squalls were intermittently present throughout the survey and occasionally resulted in reduced visibility. A total of 32 hours 55 minutes of precipitation were recorded during periods of visual monitoring (8% of all monitoring effort) in addition to 1 hour 5 minutes of fog and 32 minutes of squalls. Only 6 hours 55 minutes of monitoring was undertaken while visibility extended to less than 2 kilometers. The entirety of the 180 dB radius was not visible during visual monitoring, while the acoustic source was active, on multiple brief occasions during the survey for a total duration of 5 hours. The entire 160 dB radius was not visible during visual monitoring, while the acoustic source was active, on multiple occasions throughout the survey for a total of 34 hours 27 minutes. Much of this occurred while the vessel was surveying in water shallower than 100 meters when the predicted 160 dB radius ranged from approximately 15 to 22 kilometers, a greater distance than can be monitored by the naked eye.

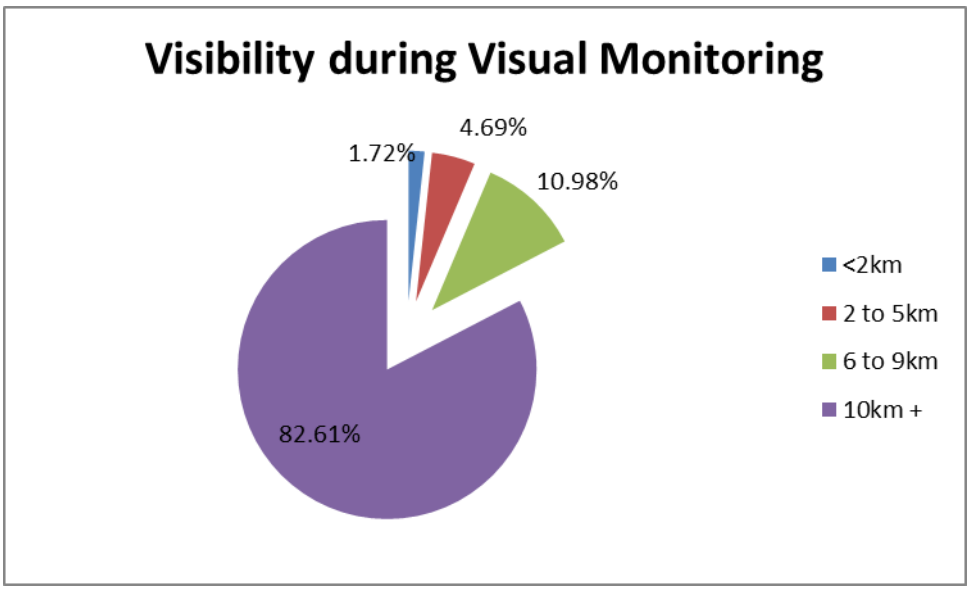

Figure 9. Visibility during visual monitoring

The Beaufort Sea state recorded during visual monitoring ranged from level 1 to level 7 over the course of the survey. Figure 9 shows a general breakdown of the Beaufort scale during each observation week of the survey. A total of 111 hours 32 minutes (27%) of visual observations were undertaken in conditions where the Beaufort state was rated level three or less, good conditions for the detection of protected species.

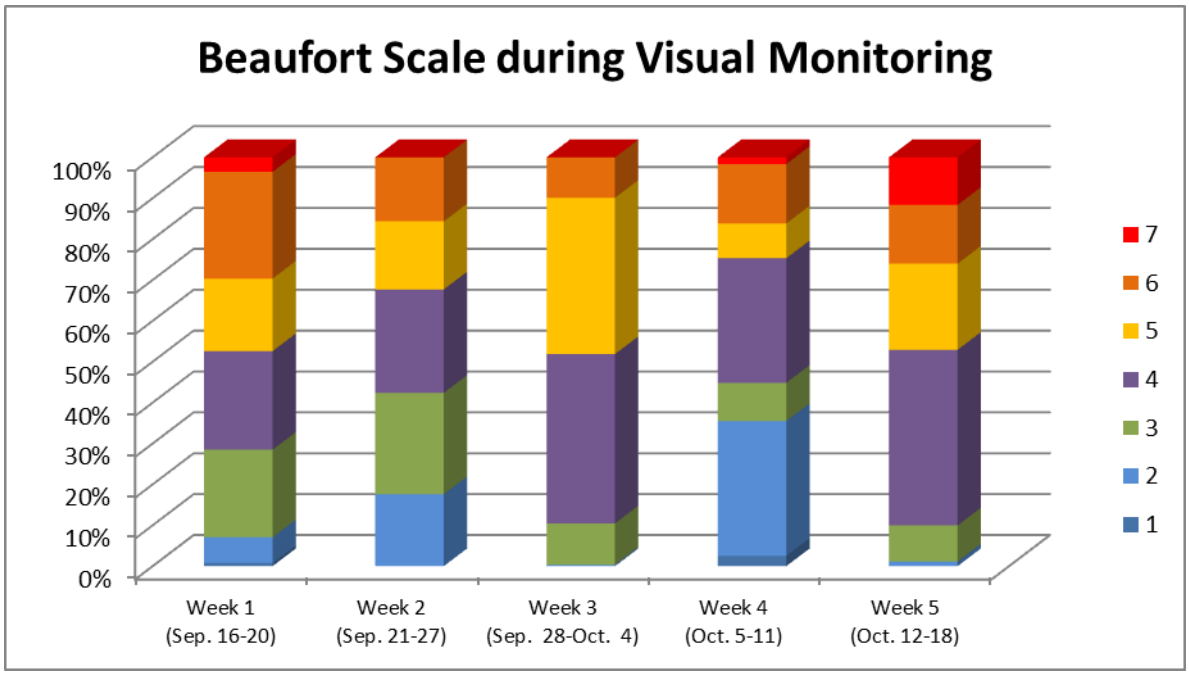

Figure 10. Weekly summary of the Beaufort scale during visual monitoring

The majority of visual monitoring was undertaken while wind speeds were measured between 11 and 16 knots (131 hours 45 minutes, 33% of effort) (Figure 10).

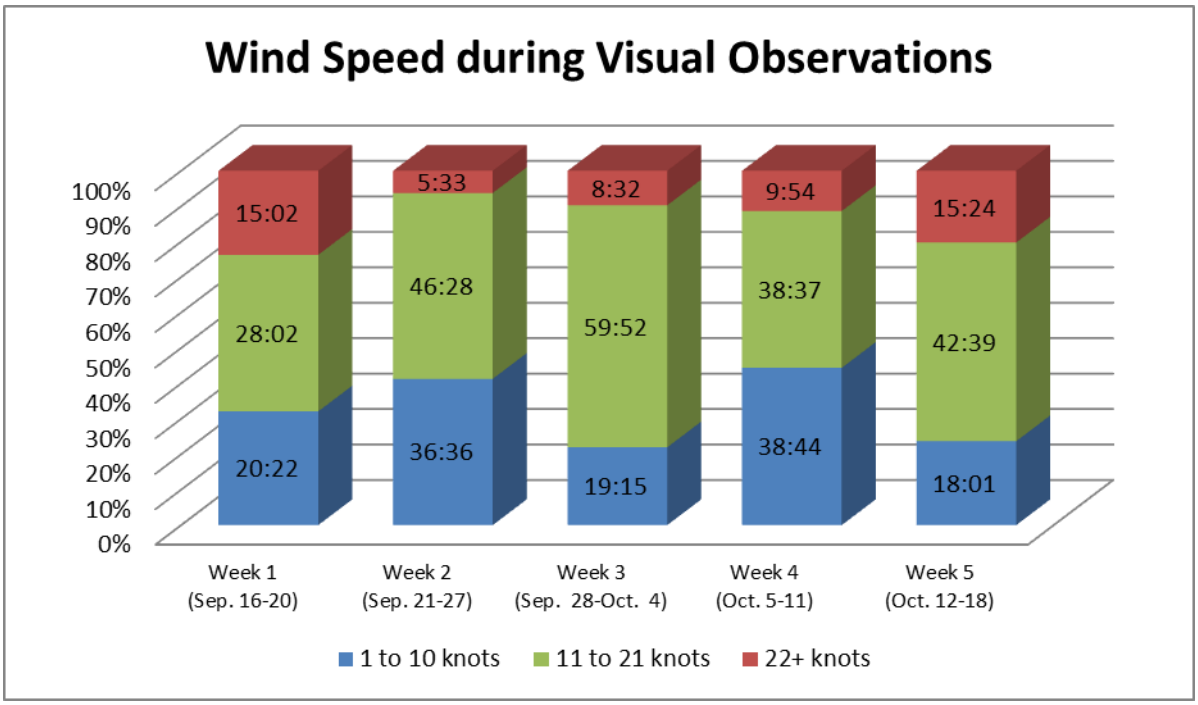

Figure 11. Average wind speed each week during visual monitoring

Swell heights during visual observations were generally low, with swells of less than two meters recorded for over 68% of total visual effort. Only 2 hours 30 minutes (less than 1%) of visual observations were undertaken while swells were recorded at heights of greater than four meters, all of which occurred during week four of the survey program.

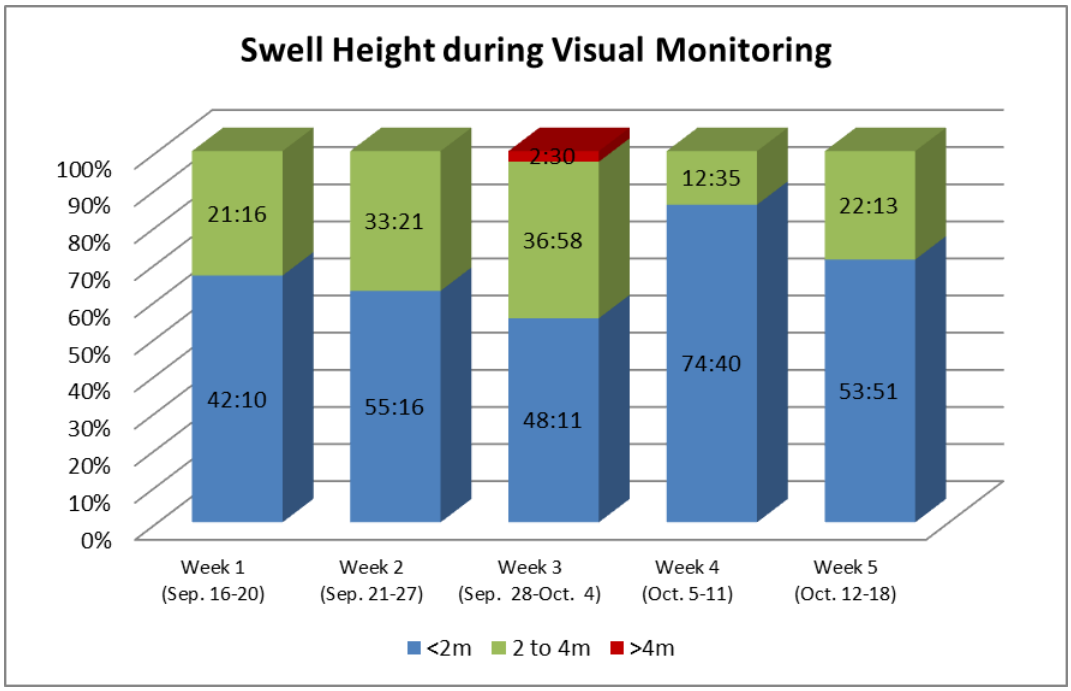

Figure 12. Swell heights while visual monitoring was conducted

Moderate glare was present during 83 hours 52 minutes (21%) and severe glare was present for 123 hours 27 minutes (31%) of visual monitoring during the survey, possibly hindering the detection of protected species in areas of glare (Figure 12).

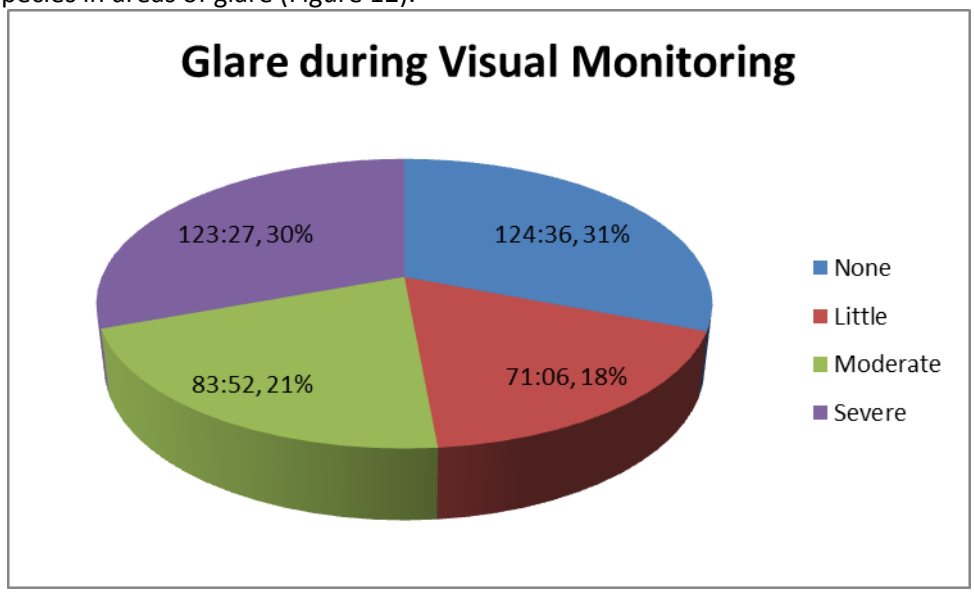

Figure 13. Glare present during visual monitoring throughout the ENAM 2-D survey

5 MONITORING AND DETECTION RESULTS

5.1 VISUAL DETECTIONS

Visual monitoring conducted during the ENAM 2-D seismic survey resulted in the collection of 57 visual records of detection for protected species (summarized in Appendix G). The spatial distribution of marine mammal detections on the R/V *Langseth* can be seen in Figure 13 and Figure 14. All detections made during the cruise are depicted, including those made during transits to and from the survey site. The vessel tracklines while the acoustic source was active are also shown in this figure. Six species of marine mammals were positively identified and observations were also made of unidentified whales, an unidentified baleen whale, unidentified pilot whales, unidentified dolphins, and unidentified shelled sea turtles. The total number of detection events and total number of animals recorded by species is described in Table 6. 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.

Table 6. Number of detection records collected and number of animals observed for each protected species

	Total Number of Detection Records	Total Number of Animals Recorded
Sea Turtles		
Loggerhead sea turtle	4	7
Leatherback sea turtle	1	1
Unidentifiable shelled sea turtle	4	4
Mysticetes		
Unidentifiable baleen whale	1	1
Odontocetes		
Sperm whale	4	8
Short-beaked common dolphin	1	6
Bottlenose dolphin	9	67
Atlantic spotted dolphin	1	6
Unidentifiable pilot whale	18	182
Unidentifiable dolphin	13	68
Unidentifiable whale	1	2
TOTAL	**57**	**352**

There were multiple protected species sightings in the survey area during the ENAM 2-D seismic survey. Many detections also occurred while the vessel was in transit to or from the survey area and closer to shore. On 10 October, 22 detections were made while the vessel surveyed a line parallel to the edge of the continental shelf. Many of the other detections also occurred as the vessel travelled near the continental shelf. Figure 15 shows the species and number of detections during each day of the survey.

Of the 57 protected species detection events during the ENAM 2-D seismic survey, 39 detections (68%) occurred while the acoustic source was active and 18 detections (32%) occurred while the acoustic source was silent. Of the 39 detections occurring while the source was active, all except one (which occurred while the mitigation source was active) occurred while the source was active at full volume (Figure 16). No detections occurred while the source was in ramp-up.

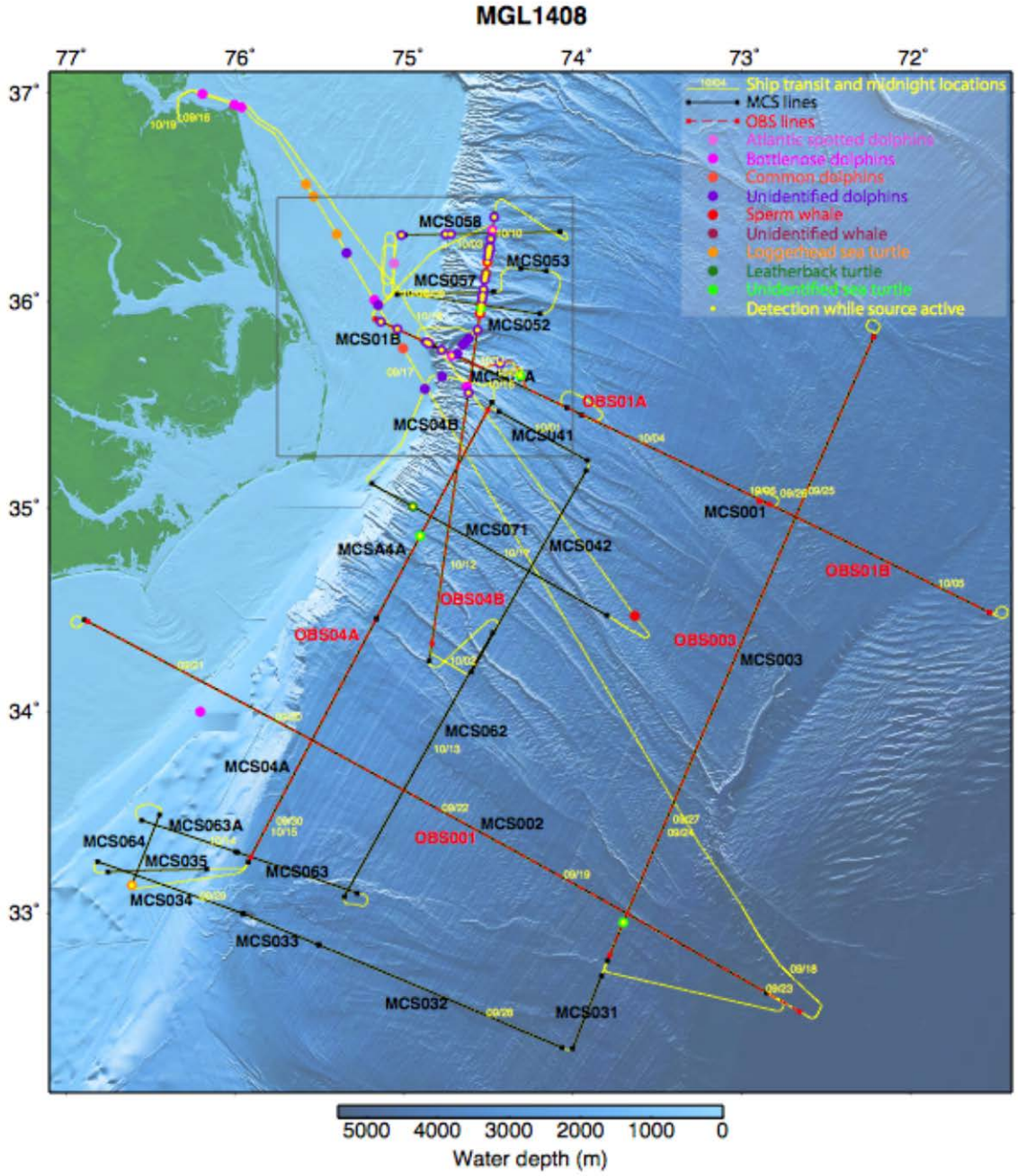

Figure 14: Protected species detections during the ENAM survey program and vessel track lines. Detections outlined by green square are shown in greater detail in Figure 14.

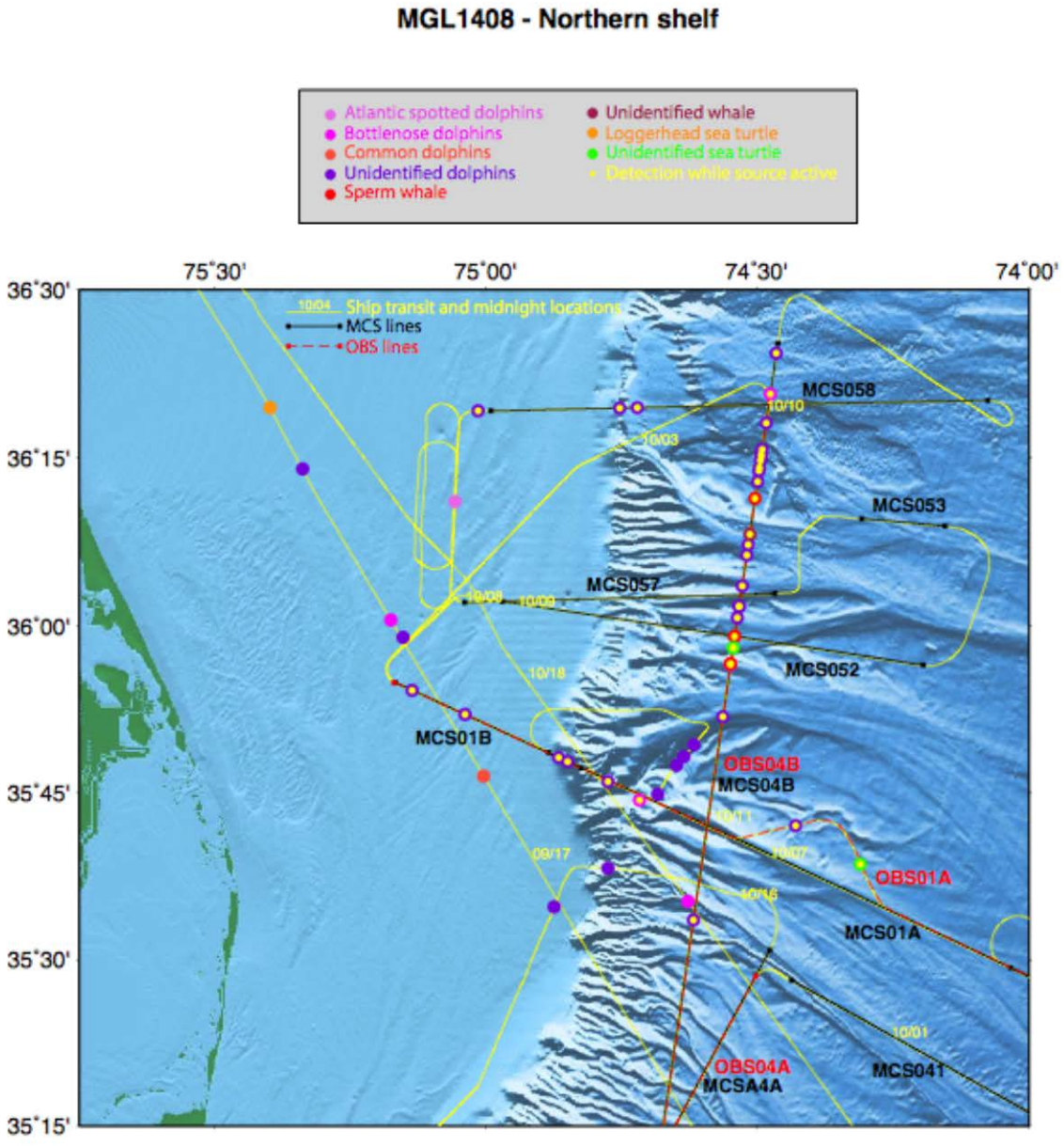

Figure 15: Detailed view of closely-grouped detections in the northern section of the survey area.

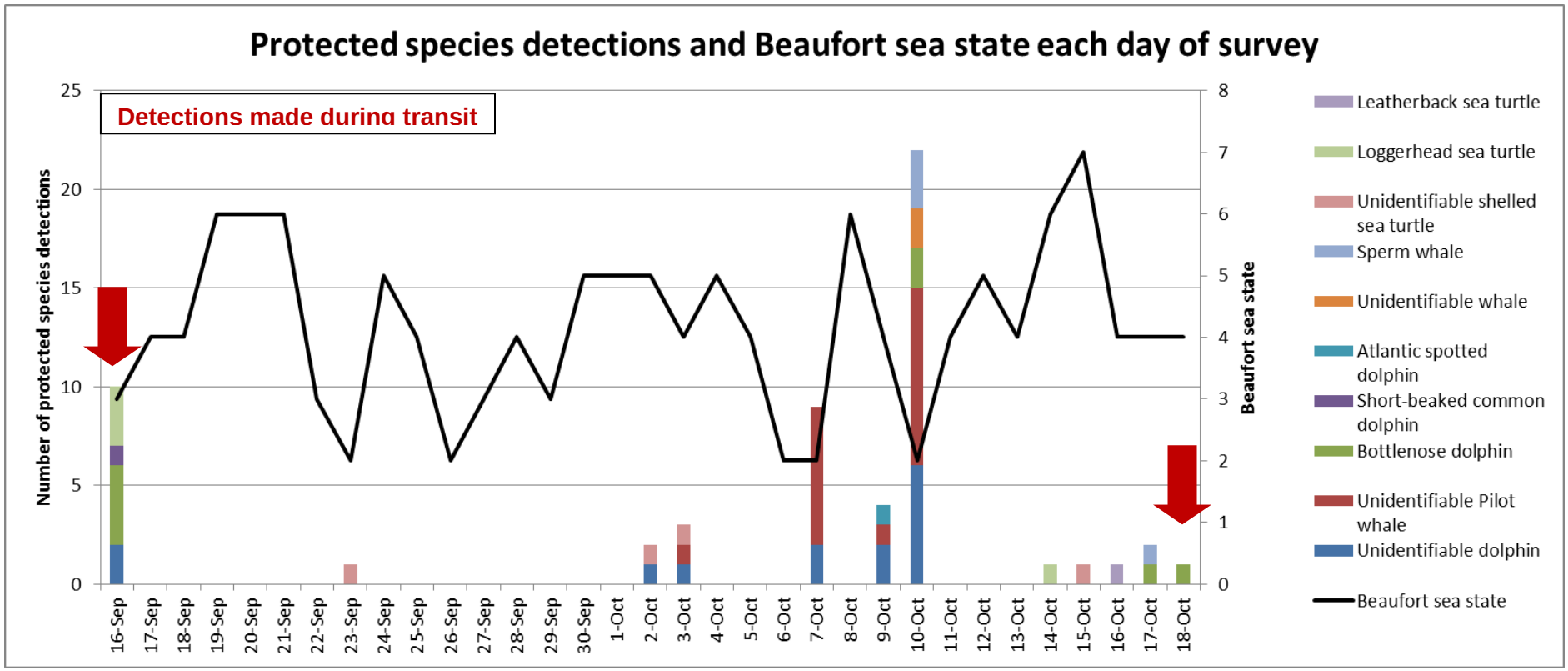

Figure 16. Number of protected species detections each day of the ENAM 2-D seismic survey

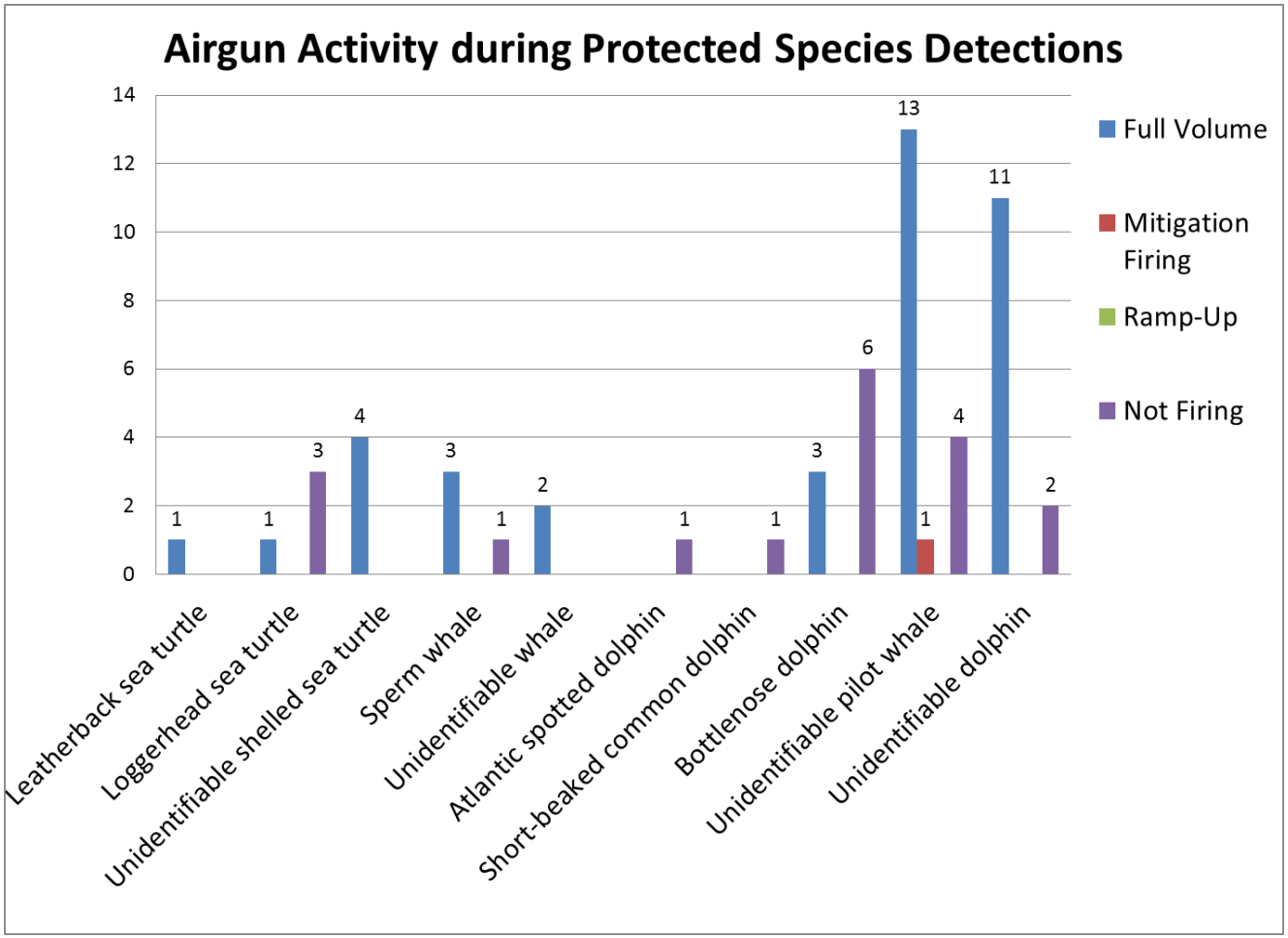

Figure 17. Acoustic source activity compared to protected species detections

The average closest approach of protected species to the source at full volume and silent was calculated (Table 7). No detections occurred while the source was in ramp-up and only one detection (unidentified pilot whales) occurred while the mitigation source was active so the average distance of protected species to the source at these volumes is not provided. The distance of closest approach to the acoustic source for detections that occurred while the acoustic source was on board was recorded as from the position the arrays would normally occupy when fully deployed.

Generally there were too few detections in each species group to compare the average closest approach to the source at varying source operation levels. When grouped into the categories of 'sea turtles', 'dolphins' and 'whales', however, it appears that dolphin pods approached the full volume source to an average distance of 1776 meters as compared to an average closest approach of 722 meters to the silent source, suggesting that some avoidance behavior may have been exhibited. Too few detections of whales were made during the program to draw any meaningful conclusions about their movements in relation to the source at different operation levels. The average closest approach of sea turtles to the source at varying operation levels appears to be not indicative of behavior alteration related to the source (such as avoidance), but rather a function of the vessel movements, which are faster than most turtles swimming speeds.

Table 7. Average closest approach of protected species to the acoustic source at full volume and silent

Species Detected	Full Volume (3,300 or 6,660 in³)		Not Operating	
	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)
Loggerhead sea turtle	1	200	3	492
Leatherback sea turtle	1	250	0	-
Unidentifiable shelled sea turtle	4	214	0	-
All sea turtle species	**6**	**218**	**3**	**492**
Short-beaked common dolphin	0	-	1	250
Bottlenose dolphin	3	777	6	343
Atlantic spotted dolphin	0	-	1	250
Unidentifiable pilot whale	13	1635	4	1770
Unidentifiable dolphin	11	2216	2	238
All dolphin species	**27**	**1776**	**14**	**722**
Sperm whale	3	2997	1	600
Unidentifiable baleen whale	1	5600	0	-
Unidentifiable whale	1	4600	0	-
All whale species	**5**	**3838**	**1**	**600**

Pilot whales were observed in the largest numbers (approximately 182 animals) and the most frequently (18 detection events) (Figure 16). This survey occurred in an area where both long-finned pilot whales and short-finned pilot whales occur and PSOs were unable to distinguish between these two species during pilot whale detection events. Bottlenose dolphins were observed nine times with a total of approximately 67 animals encountered.

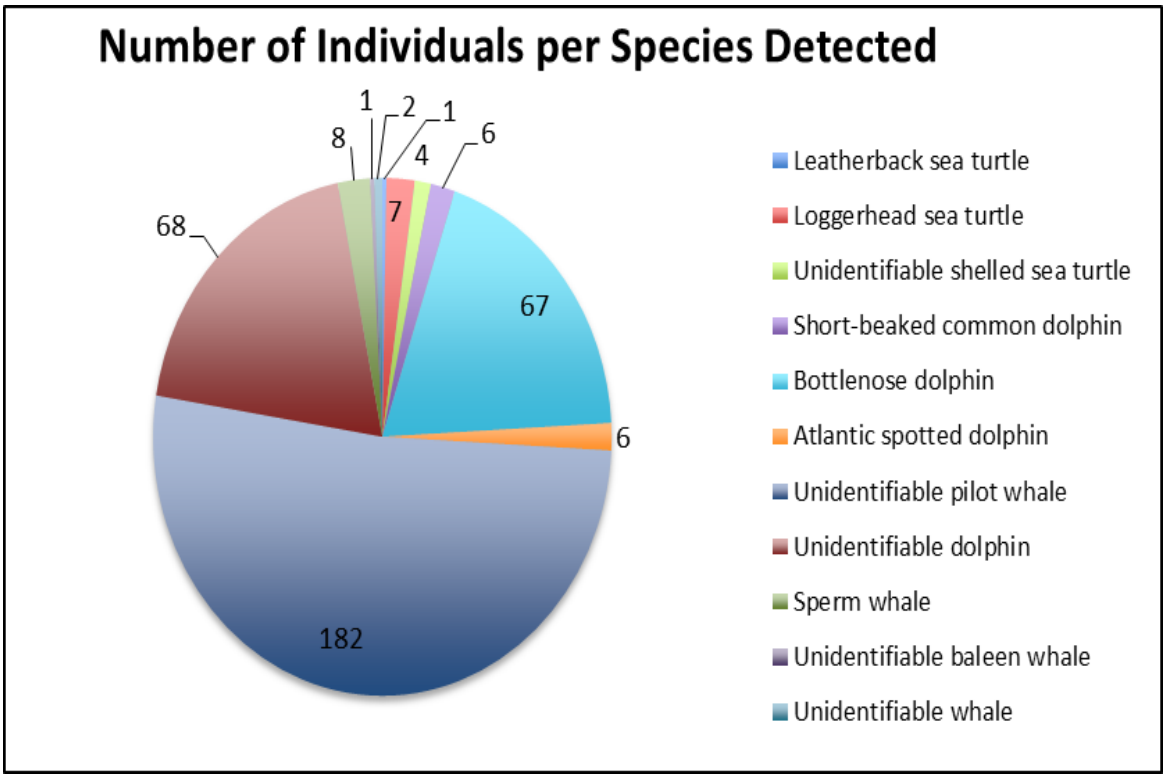

Figure 18. Number of individuals per species detected

5.1.1 Cetacean Detections

5.1.1.1 Sperm whale

There were four sightings of sperm whales (*Physeter macrocephalus*) during the survey, totalling eight individuals. One sighting required a mitigation power-down, resulting in four minutes of mitigation downtime on 10 October. Detections occurred in water depths ranging from 1,577 to 3,932 meters. The largest group of sperm whales consisted of four individuals, three adults and one juvenile, on 10 October. There were another two sightings with one individual and one sighting with two individuals. The closest approach to the active sound source was 990 meters on 10 October; the closest approach to the inactive sound source was 600 meters on 17 October.

5.1.1.2 Common bottlenose dolphin

There were nine sightings of bottlenose dolphins (*Tursiops truncatus*), totalling 67 individuals. Two of these detections resulted in mitigation power-downs, totalling 32 minutes of mitigation downtime, and one detection resulted in a mitigation shutdown, totalling 52 minutes of mitigation downtime. During six

of the bottlenose dolphin sightings, the water depth was unavailable as the Sonars were not operating during transit as a condition of the IHA; otherwise, depths during sightings ranged from 1,251 to 1,977 meters. The largest group size was a pod of 20 adults on 16 September. There was one sighting with one individual, two sightings with two individuals, one sighting with three individuals, one sighting with six individuals, one sighting with eight individuals, one sighting with 10 individuals, one sighting with 15 individuals, and one sighting with 20 individuals. The closest approach to the active sound source was 180 meters on 3 October; the closest approach to the inactive sound source involved two incidents at 150 meters on 16 September.

5.1.1.3 Atlantic spotted dolphin

There was one sighting on 9 October of Atlantic spotted dolphins (*Stenella frontalis*) during the survey, totalling six individuals. The acoustic source was not active during the detection, and no mitigation action was necessary. The water depth at the time of the sighting was 30 meters. The closest approach of the animals to the inactive sound source was 250 meters. These dolphins were also detected acoustically.

5.1.1.4 Short-beaked common dolphin

There was one sighting of short-beaked common dolphins (*Delphinus delphis*) on 16 September, totalling six individuals. The acoustic source was not active at the time of the detection, as the vessel was in transit to the survey area. Water depth at the time of the sighting was unavailable as the sonars were not operating during transit as a condition of the IHA. The closest approach to the sound source was 250 meters.

5.1.1.5 Unidentifiable pilot whale

There were 18 sightings of unidentified pilot whales during the survey, totalling 182 individuals. Six of these sightings resulted in mitigation power-downs, totalling 1 hour and 13 minutes of mitigation downtime. Water depths at the time of the detections ranged from 214 to 2,178 meters. The largest group size was 44 individuals, 42 adults and two juveniles, sighted on 7 October. There were also two sightings of two individuals, four sightings of three individuals, one sighting of four individuals, three sightings of six individuals, one sighting of seven individuals, one sighting of eight individuals, two sightings of ten individuals, one sighting of 11 individuals, and one sighting of 12 individuals. The closest approach to the active acoustic source was 400 meters on 3 October; the closest approach to the inactive sound source was 180 meters on 7 October.

5.1.1.6 Unidentifiable dolphin

There were 13 sightings of unidentified dolphins during the survey, totalling 68 individuals. Two of these sightings resulted in mitigation power-downs, totalling 30 minutes of mitigation downtime. Water depths recorded at the time of the detections ranged from 29 to 1,972 meters. The largest group size was a pod of 18 dolphins, 15 adults and three juveniles, detected on 10 October. There were also four sightings with one individual, four sightings with two individuals, one sighting with six individuals, two sightings with ten individuals, and one sighting with 12 individuals. The closest approach to the active sound source was 230 meters on 2 October; the closest approach to the inactive sound source was 175 meters on 16 September.

5.1.1.7 Unidentifiable whale

On 10 October, there was one sighting of an unidentifiable baleen whale. The animal was recorded at 5600 meters from the active acoustic source, and no mitigation action was necessary. Water depth at the time of the detection was 1,601 meters.

On 10 October, there was a single sighting of two unidentifiable whales. The animals were recorded at 4,600 meters from the sound source, so mitigation action was not necessary. Water depth at the time of the detection was 1806 meters.

5.1.2 Sea Turtle Detections

5.1.2.1 Loggerhead sea turtle

There were four sightings of loggerhead sea turtles (*Caretta caretta*) during the survey, totalling seven individuals. One of these sightings resulted in a mitigation shut-down of the acoustic source, totalling three minutes of operational downtime as a result of mitigation. During three of the detections, water depth was unavailable as the Sonars were not operating during transit as a condition of the IHA; during the fourth detection, the water depth was 621 meters. Three of the sightings consisted of two individuals that were exhibiting mating behaviors (source not active), and one of the sightings consisted of a single turtle. The closest approach to the active acoustic source was 200 meters, and the closest approach to the inactive source was 30 meters, both the same turtle observed on 14 October.

5.1.2.2 Leatherback sea turtle

On 16 October, there was one sighting of a leatherback sea turtle (*Dermochelys coriacea*). The animal was recorded at 250 meters from the active sound source, and a mitigation power-down lasting 30 minutes was required. Water depth at the time of the detection was 2,637 meters.

5.1.2.3 Unidentified shelled sea turtle

There were four sightings of unidentifiable shelled sea turtles during the survey, totaling four individuals. All four sightings consisted of a single turtle. All four detections resulted in mitigation power-downs, totaling 2 hours of mitigation downtime. Water depths recorded during the sightings ranged from 1,857 to 4,899 meters. Two of the unidentifiable sea turtles were very small, hatchling sized turtles. The closest approach to both the active and inactive sound source was 130 meters on 15 October.

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, including seabirds and fish.

5.2 ACOUSTIC DETECTIONS

5.2.1.1 Common bottlenose dolphin

On 3 October, bottlenose dolphins were briefly observed visually from 10:40 to 10:42 UTC. The dolphins were observed approaching the predicted 180 dB EZ radius for the single acoustic source element, resulting in a shut-down of the acoustic source at 10:41 UTC. At 10:45 UTC a single down-swept whistle was observed on the Pamguard Spectrogram from approximately 20 to 14 kHz (Figure 18). No vocalizations were detected aurally by the PAM operator and the dolphins were not detected again, visually or acoustically.

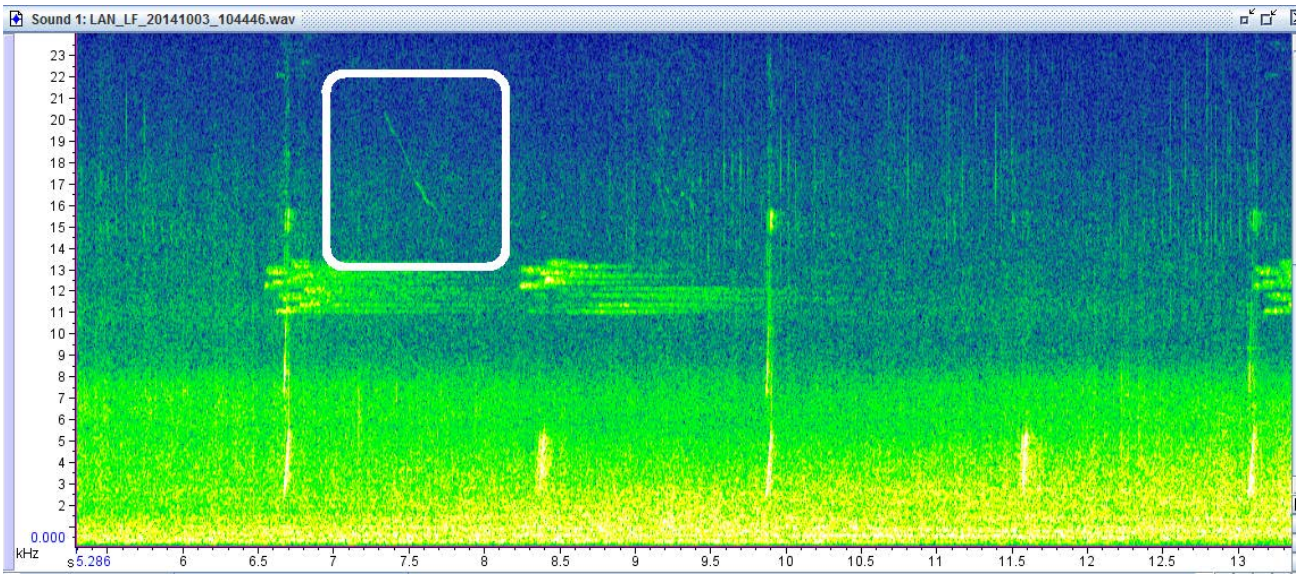

Figure 19. Down-swept whistle observed on the Spectrogram while the acoustic source was shut-down for bottlenose dolphins (Acoustic detection 1, Visual detection 14)

5.2.1.2 Atlantic spotted dolphin

On 9 October at 10:49 UTC, delphinid click trains were observed on the Pamguard HF Click Detector. Most of the clicks ranged from 35 to 90 kHz, with a peak frequency of approximately 70 kHz. The clicks were first observed at a bearing of 19° and last observed at a bearing of 136° and were received at an amplitude of up to 202 dB re 1 µPa (Figure 18). The PAM operator notified the PSOs on watch and shortly after, at 10:51 UTC, a pod of Atlantic spotted dolphins was observed near the vessel. The dolphins were last detected acoustically at 10:58 UTC. The PAM operator was able to localize the range and bearing to the high frequency clicks once during the detection event, at 10:50 UTC, to a range of approximately 19 meters from the hydrophone array. This detection occurred while the acoustic source was silent.

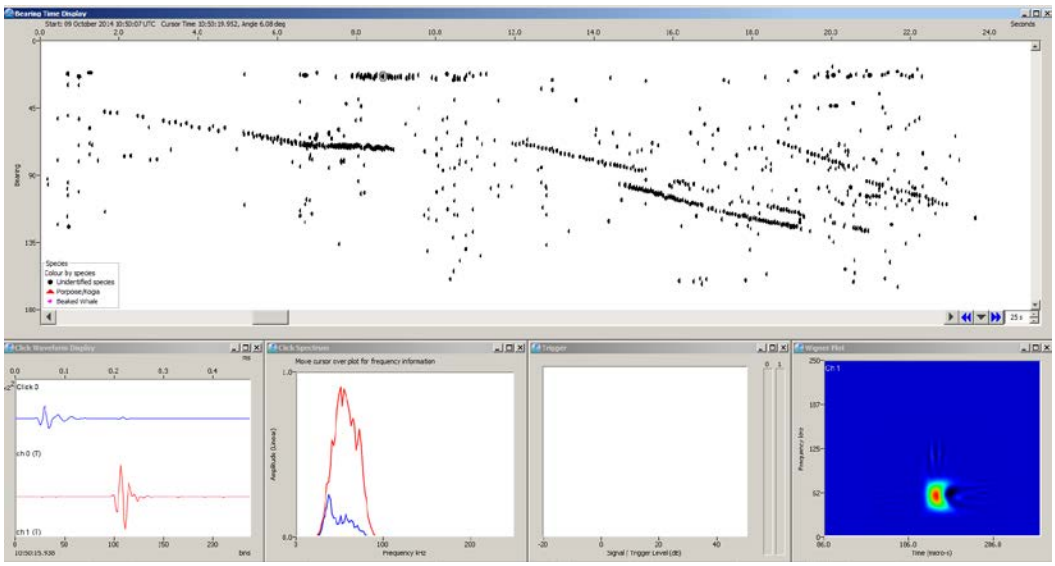

Figure 20. Delphinid click trains observed on the high frequency click detector during acoustic detection 2 of Atlantic spotted dolphins (Visual detection 26)

5.2.1.3 Unidentifiable dolphin

Two acoustic detections occurred on 16 October 2014. From 3:00 to 3:26 UTC, delphinid whistles ranging in frequency from 5 to 20 kHz with amplitudes of 75 to 90 dB re 1 µPa were detected visually on the Spectrogram and aurally (Figure 19). Click trains were also observed on the HF Click Detector Bearing Time display between a bearing of 18 to 150 degrees. There were three simultaneous click trains indicating the presence of a minimum of three animals. Clicks were localized, producing a range and bearing estimate, twice during the detection event: the first time to a range of 395 meters to the hydrophone elements and the second time at a range of 251 meters to the hydrophone elements. Lower frequency clicks were also observed on the Spectrogram and aurally detected during this event. The acoustic source was silent throughout the entire detection.

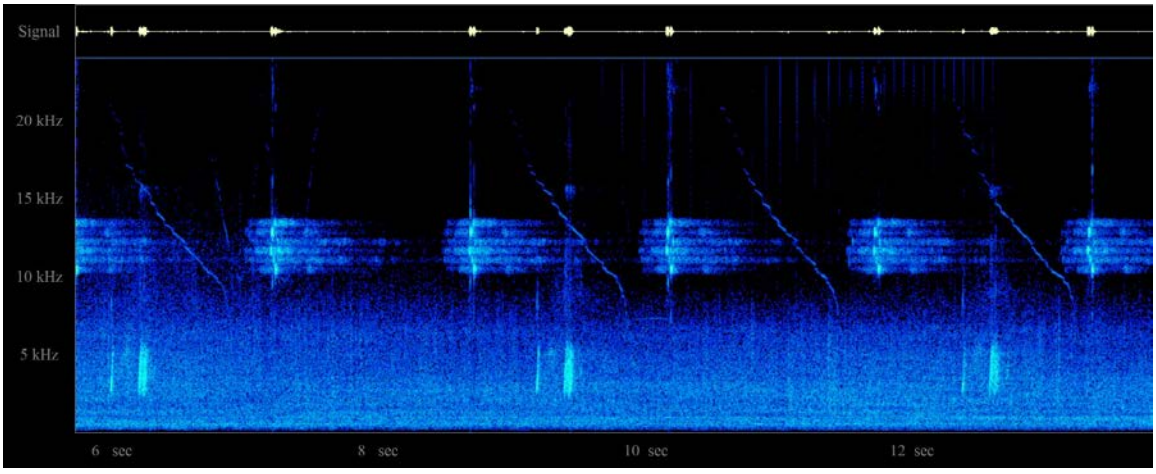

Figure 21. Whistles and clicks displayed on Spectrogram 16 during post-detection analysis of recordings made during Acoustic Detection #3

Dolphin whistles were observed again on PAMGuard Spectrogram and detected aurally from 5:08 to 5:10 UTC. Overlapping whistles indicated the presence of two animals. The whistles ranged in frequency from 8 to17 Hz with amplitude of 90 dB re 1 µPa (Figure 20). During this detection, the acoustic source was silent.

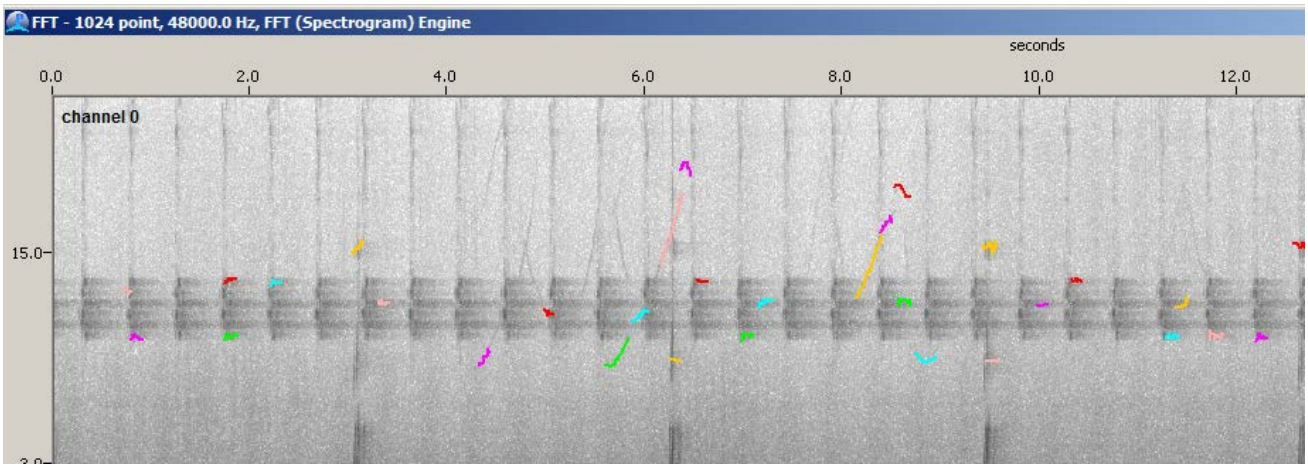

Figure 22. Whistles observed on Pamguard Spectrogram during acoustic detection 4, highlighted by the Whistle and Moan Detector

6 MITIGATION ACTION SUMMARY

Operational mitigation measures were defined in the PEIS, NSF Final EA and FONSI for the project and the NMFS issued IHA and ITS, including: ramp-ups, power-downs, and shut-downs of the acoustic source, and vessel speed and course alterations. In addition, LDEO's outreach plan also extended to coordinating with local dive operators, other academic researchers, and notification to local ship traffic and fishing vessels.

There were 18 mitigation actions implemented during the ENAM 2-D seismic survey due to protected species being observed within, entering, or approaching the predicted 180 dB EZ radius. Mitigation actions consisted of power-downs, and shutdowns of the acoustic source. There were no ramp-up delays due to the presence of protected species inside the exclusion zone. The total duration of downtime caused by mitigation actions (including ramp-up, if required) was 5 hours 44 minutes during the survey. The number and duration of mitigation actions is summarized in Table 8.

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

Mitigation Action	Cetaceans		Sea Turtles		Totals	
	Number	Duration	Number	Duration	Number	Duration
Delayed Ramp-up	0	0:00	0	0:00	0	0:00
Power-down	11	2:19	5	2:30	16	4:49
Shutdown	1	0:52	1	0:03	2	0:55
Total	**12**	**3:11**	**6**	**2:33**	**18**	**5:44**

Unidentifiable pilot whale detections resulted in the implementation of the greatest number of mitigation actions with six power-downs of the acoustic source (21% of the total project mitigation downtime). Unidentifiable sea turtle detections and resulting mitigation actions were responsible for the greatest percentage of mitigation downtime at 35% (Table 9). As a species group (whales, dolphins or turtles), delphinids were responsible for close to half of the total mitigation downtime for the survey program (Figure 21).

Table 9. Mitigation actions and downtime duration by species

Species	Number of Power-downs	Number of Shut-downs	Duration of Downtime (h:mm)	Percentage of Mitigation Downtime
Loggerhead sea turtle	0	1	0:03	**1%**
Leatherback sea turtle	1	0	0:30	**9%**
Unidentifiable shelled sea turtle	4	0	2:00	**35%**
Bottlenose dolphin	2	1	1:24	**24%**
Unidentifiable pilot whales	6	0	1:13	**21%**
Unidentifiable dolphin	2	0	0:30	**9%**
Sperm whale	1	0	0:04	**1%**

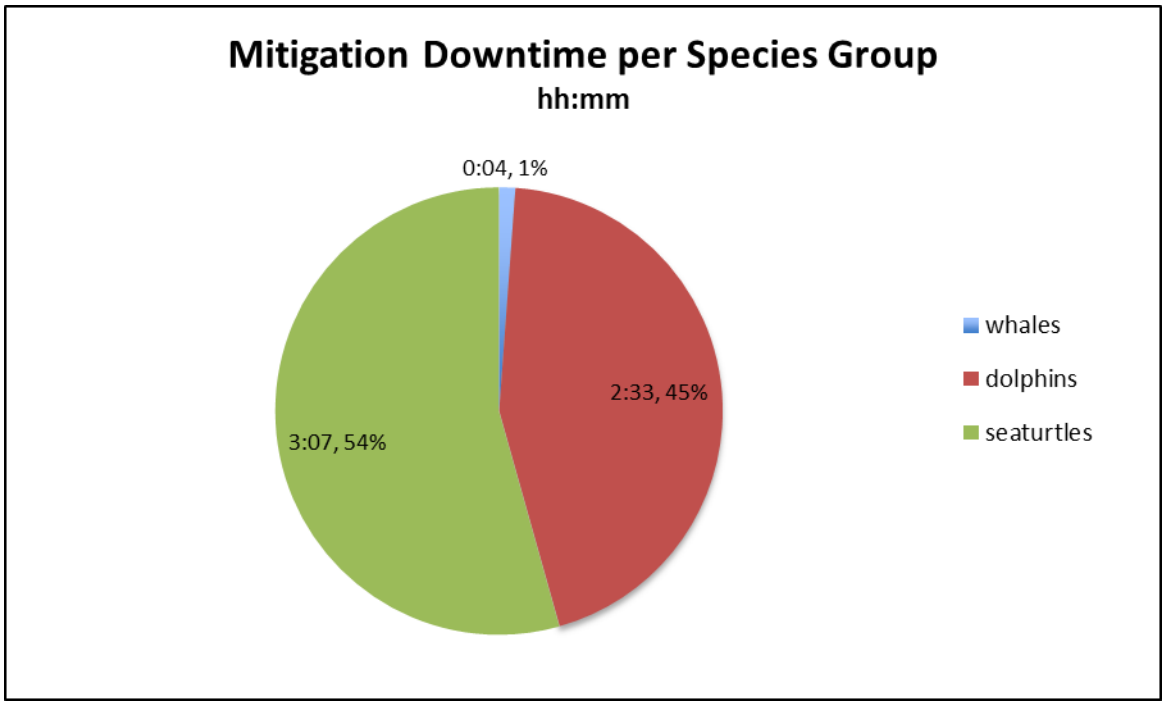

Figure 23. Duration of mitigation downtime by protected species group

Each mitigation action implemented during the survey is summarized in Table 10 and described in detail below:

The acoustic source was powered-down when an unidentifiable shelled sea turtle was observed within the predicted 180 dB EZ radius on 23 September at 17:48 UTC. The sea turtle was observed very briefly approximately 25 meters from the starboard bow. The turtle was observed to be swimming quickly away from the vessel and remained submerged throughout the detection. The acoustic source was powered-down at 17:48 UTC when the sea turtle was approximately 245 meters from the acoustic source. The sea turtle was not seen again. After 30 minutes with no protected species being observed the acoustic source resumed full volume.

On 2 October at 12:38 UTC two unidentifiable delphinids were briefly observed near the starboard side of the vessel in a severe glare. The animals were observed swimming slowly parallel to and in the opposite direction as the vessel and were last observed at 12:39 UTC. The acoustic source was powered-down at 12:39 UTC; after 15 minutes with no protected species observed the acoustic source resumed full volume at 12:54 UTC.

On 2 October a hatchling-sized sea turtle was observed very briefly off the starboard bow of the vessel at 17:14 UTC, swimming at a moderate pace away from the vessel. The acoustic source was powered-down immediately at 17:14 UTC and after 30 minutes with no protected species observed the acoustic source resumed full volume at 17:44 UTC.

On 3 October two bottlenose dolphins were observed at 10:40 UTC near the starboard bow swimming at a moderate pace towards the vessel. The dolphins then turned towards the stern of the vessel and appeared to be traveling directly towards the acoustic source. The acoustic source was shut-down at

10:41 UTC and the dolphins were last observed approximately 160 meters from the acoustic source at 10:42 UTC. The dolphins were briefly detected acoustically on PAM at 10:45 UTC. After 15 minutes from the last visual sighting of the dolphins a ramp-up was conducted before resuming full volume operations, resulting in a total of 52 minutes of mitigation downtime.

At 13:17 UTC on 3 October several pilot whales were observed 400 meters off the port bow of the vessel. The acoustic source was powered-down immediately at 13:17 UTC and the animals were observed to swim briefly towards the vessel, at a moderate pace, before continuing parallel to and in the opposite direction as the vessel. At 13:24 UTC the pilot whales were observed approximately 1,350 meters off the port stern, outside of the predicted 180 dB EZ radius, and the full volume was resumed at 13:25 UTC.

On 3 October a hatchling-sized sea turtle was observed very briefly off the port bow of the vessel at 15:17 UTC, swimming at a moderate pace away from the vessel. The acoustic source was powered-down immediately at 15:17 UTC and after 30 minutes with no protected species observed the acoustic source resumed full volume at 15:47 UTC.

On 7 October at 18:23 UTC six unidentifiable pilot whales were observed surfacing within the predicted 180 dB EZ radius traveling slowly away from the vessel. A power-down of the acoustic source was requested immediately. The animals were next observed at 18:29 UTC swimming slowly parallel to and in the opposite direction as the vessel outside of the predicted 180 dB EZ radius. The acoustic source resumed full volume at 18:30 UTC and the pilot whales were last observed at 19:34 UTC continuing on the same heading.

Just afterwards at 18:35 UTC another group of five pilot whales was observed surfacing within the predicted 180 dB EZ radius and a power-down of the acoustic source was requested immediately. This pod of whales dove and were not observed again, however, additional small groups were observed farther out, spread out over several kilometers. While the acoustic source was powered-down the vessel moved into water less than 100 meters deep, expanding the predicted 180/177 dB EZ radius. The power-down was continued due to the other groups of pilot whales then being within the predicted 177 dB EZ radius. A total of approximately 42 pilot whales were observed. The animals were observed leaving the predicted, 177 dB EZ radius at 19:01 UTC and after scanning to make sure no other protected species had entered the EZ radius, the acoustic source resumed full volume at 19:03 UTC. While all 42 pilot whales were observed to be within the predicted 160 dB zone, only five animals were observed to be within the predicted 180 dB zone.

On 9 October at 18:36 UTC, one unidentifiable dolphin was briefly observed breaching within the predicted 180 dB EZ. The acoustic source was powered-down and the dolphin was not observed again. After waiting 15 minutes, with no sight of the dolphin, the acoustic source resumed full volume at 18:51 UTC.

At 21:40 UTC on 9 October three pilot whales were observed surfacing within the predicted 180 dB EZ radius and the acoustic source was powered-down. The animals were traveling parallel to the vessel in the opposite direction and continued traveling at a moderate pace until they were observed outside of the predicted 180 dB EZ radius at 21:48 UTC and full volume was resumed.

On 10 October at 11:50 UTC an active pod of 10 bottlenose dolphins was observed just outside the predicted 180 dB EZ radius. The acoustic source was powered-down at 11:50 UTC as it seemed likely the dolphins would enter the EZ radius. The dolphins travelled within 700 meters of the powered-down source and were observed outside the predicted 180 dB EZ radius at 12:02 UTC and the acoustic source resumed full volume. The dolphins were observed to be leaping and milling with no general direction of travel throughout detection.

At 12:24 UTC on 10 October seven pilot whales surfaced in a severe glare, just inside the predicted 180 dB EZ radius. The acoustic source was powered down at 12:24 UTC and pilot whales continued to travel slowly parallel to and in the opposite direction of the vessel. The animals were observed outside of the predicted 180 dB EZ radius at 12:28 UTC and the acoustic source resumed full volume at 12:29 UTC. The pilot whales then rested at the surface for several minutes before continuing to swim.

Later on 10 October at 18:17 UTC four sperm whales were observed 1800 meters directly ahead of the vessel, crossing in front of the vessel. The whales dove shortly after and next surfaced just outside the predicted 180 dB EZ radius. The acoustic source was powered down at 18:29 UTC in case the whales travelled closer, however they began to travel away from the vessel, never entering the predicted EZ radius, and the acoustic source resumed full volume at 18:33 UTC. Whales were observed until 18:46 UTC making shallow dives and resurfacing, occasionally an animal would fluke.

At 19:07 UTC on 10 October a pod of approximately 15 bottlenose dolphins was observed 3 kilometers directly ahead of the vessel. As the vessel approached the pod moved off to the port side and appeared likely to enter the predicted 180 dB EZ radius. The acoustic source was powered down at 19:33 UTC, and shortly after, four of the dolphins swam to the vessel while the remainder of the pod travelled away from the vessel. The dolphins were last seen near the bow of the vessel, so after 15 minutes of no sight of them, the acoustic source resumed full volume at 19:53 UTC.

The last mitigation of this week occurred on 10 October at 20:46 UTC when 11 pilot whales were first observed 1500 meters from the vessel traveling away from the vessel. The pilot whales were next observed within the predicted 180 dB EZ radius at 20:49 UTC. The acoustic source was powered down immediately. The animals were last observed within the predicted EZ radius and after 15 minutes with no sightings, the acoustic source resumed full volume at 21:06 UTC.

On 14 October a loggerhead sea turtle was observed while the source was active on full volume. A power down was initially requested but the turtle came closer to the acoustic source and a shut down was implemented at 15:29 UTC. The turtle was last observed breathing at the surface off the stern of the vessel travelling on the same heading, swimming parallel and in the opposite direction as the vessel.

On 15 October an unidentified shelled juvenile sea turtle was observed while the source was active on full volume and the source was powered down. The turtle was last observed within the predicted 180 dB EZ radius and after 30 minutes the acoustic source resumed at full volume.

On 16 October a leatherback sea turtle was observed while the source was active on full volume. The source was powered down. The turtle was last observed within the predicted 180 dB EZ radius and after 30 minutes the acoustic source resumed at full volume.

Table 10. Summary of each mitigation action implemented during the ENAM 2-D seismic survey

Date	Visual Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Source / Volume	Mitigation Action	Duration of Mitigation (h:mm)
23-Sep	11	Unidentifiable shelled sea turtle	1	Full volume (6600 in³)	245 m / Full Volume	Power-down	0:30
2-Oct	12	Unidentifiable delphinid	2	Full volume (6560 in³)	230 m / Full Volume	Power-down	0:15
2-Oct	13	Unidentifiable shelled sea turtle	1	Full volume (6560 in³)	240 m / Full Volume	Power-down	0:30
3-Oct	14	Bottlenose dolphins	2	Full volume (6600 in³)	180 m / Full Volume	Shutdown	0:52
3-Oct	15	Unidentifiable pilot whales	3	Full volume (6600 in³)	400 m / Mitigation source	Power-down	0:08
3-Oct	16	Unidentifiable shelled sea turtle	1	Full volume (6600 in³)	240 m / Full Volume	Power-down	0:30
7-Oct	22	Unidentifiable pilot whales	6	Full volume (6600 in³)	1250 m / Full Volume	Power-down	0:07
7-Oct	23	Unidentifiable pilot whales	42	Full volume (6600 in³)	700 m / Full Volume	Power-down	0:28
9-Oct	27	Unidentifiable dolphin	1	Full volume (3300 in³)	800 m / Full Volume	Power-down	0:15
9-Oct	29	Unidentifiable pilot whales	3	Full volume (3300 in³)	600 m / Full Volume	Power-down	0:08
10-Oct	31	Bottlenose dolphins	10	Full volume (6600 in³)	700 m / Mitigation source	Power-down	0:12
10-Oct	32	Unidentifiable pilot whales	7	Full volume (6600 in³)	800 m / Mitigation source	Power-down	0:05
10-Oct	48	Sperm whale	4	Full volume (6600 in³)	990 m / Full Volume	Power-down	0:04
10-Oct	50	Bottlenose dolphins	15	Full volume (6600 in³)	250 m / Mitigation source	Power-down	0:20
10-Oct	51	Unidentifiable pilot whales	11	Full volume (6600 in³)	400 m / Mitigation source	Power-down	0:17
14-Oct	52	Loggerhead sea turtle	1	Full volume (3300 in³)	30 m / Silent	Shutdown	0:03
15-Oct	53	Unidentifiable shelled sea turtle	1	Full volume (6600 in³)	130 m / Full volume	Power-down	0:30
16-Oct	54	Leatherback sea turtle	1	Full volume (3300 in³)	250 m / Full volume	Power-down	0:30

6.1. OUTREACH MITIGATION ACTIONS SUMMARY

In advance of the proposed cruise, LDEO contacted local scuba diving website aggregators and operators, an academic research group from University of North Carolina who had made public comments on LDEO project, and discussed the project with the local USCG office to inform them and get

their input on how to best reach fishing vessels and other ships transiting in the local area. USCG provided LDEO with a form to issue a Notice to Mariners for local ship traffic and fishing boats. During the survey, all of these groups were provided daily updates on the operational cruise plans. All groups cooperated effectively to avoid space-use conflicts. The diving groups provided the R/V *Langseth* information on the busiest local areas to expect divers during the week and on weekends.

LDEO accommodated the marine science research group from University of North Carolina that had planned diving activities near the end of Line 2 (Figure 2) by shifting the track line survey schedule and avoiding their dive windows. No other diving groups indicated any conflicts ahead of, or during, the survey; LDEO actively continued outreach efforts with scuba diving groups during the survey.

The R/V *Langseth* encountered a minor level of fishing activities near the shelf end of Line 1 (Figure 2). There was successful cooperation between local fishing boats and R/V *Langseth* in this area to avoid space-use conflict. In one instance, the R/V *Langseth* deviated course so a fishing boat could leave its long line equipment in its current location. No other issues with local fishing activities were observed or reported.

6.2. MARINE MAMMALS AND SEA TURTLES OBSERVED WITHIN THE PREDICTED 160/166 DB ZONE DURING ACTIVE SEISMIC OPERATIONS

NMFS granted an IHA and ITS to L-DEO 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 33 marine mammal species (seven mysticetes, 25 odontocete species, and one pinniped species) and 166 dB re: 1 µPa (rms)) for five sea turtle species. Direct visual observations recorded by PSOs of three 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 potentially exposed to received sound levels within the predicted 180 dB and 160 dB zones. Level B harassment may be expected to occur in sea turtles at the 166dB zone and two species of sea turtles were observed to be exposed to received sound levels equal to or greater than 166 dB.

During the ENAM 2-D seismic bottlenose dolphins, unidentifiable pilot whales, unidentifiable dolphins, sperm whales, unidentifiable baleen whales, unidentifiable whales, a leatherback sea turtle, a loggerhead sea turtle, and unidentifiable shelled sea turtles were observed within the predicted 160/166 dB radius, where Level B harassment is expected to occur, while the acoustic source was active (Table 11). For sperm whales, bottlenose dolphins (groups combined), and unidentifiable pilot whales (long and short finned combined), the potential takes represent only approximately 7, 1, and 10 percent of the total takes issued for each of these species/species groups respectively. The unidentifiable dolphin, unidentifiable baleen whale, and unidentifiable whale potential takes represent less than one half of a percent of the total takes authorized for marine mammals for the survey. All potential marine mammal takes combined represent less than 2 percent of the total takes authorized for marine mammals for the survey.

The observed number of potential takes may be an underestimate and, therefore, may be a minimum number of animals actually exposed. It is possible that the estimated numbers of animals recorded during each sighting event were underestimates, some animals not being seen or having moved away before they were observed. This is most likely to have occurred during detection events consisting of many animals, where it would be difficult to count all of those present, and during this survey program only three detection events occurred where 20 or more animals were observed. The Beaufort sea state has a large impact on the ability to visibly detect many smaller or unobtrusive marine species such as beaked whales and sea turtles and there were several days of the program where high Beaufort sea states (greater than level 5) may have resulted in some missed protected species detections. However, the majority of the detections (31 of the 37 total detections) observed during this program occurred on two days of the program, 7 and 10 October, while the vessel was operating in or adjacent to the continental shelf. In other regions of the survey area, even while Beaufort sea state conditions were favorable, no detections were observed so it is possible that detections were not missed in these areas but rather that no animals were present in these regions to be detected.

Recent analysis of R/V *Langseth* source received levels collected via hydrophone streamers in shallow waters demonstrated that the predicted mitigation zones, both the 180 and 160, were substantially smaller than those predicted (Crone 2013 and 2014). Therefore, animals observed within the predicted mitigation zones in shallow water for this survey may similarly not have experienced received levels at those predicted levels. Furthermore, as described in the PEIS, Lloyd's mirror and surface release effects ameliorate the effects for animals at or near the sea surface.

Besides night time hours, there were several occasions during daytime visual watches that the entire 160/166 dB radius was not visible due to fog and rain and animals may have been missed. Additionally, the entire 160/166 dB radius was not visible while the vessel was surveying in waters shallower than 100 meters where the predicted 160/166 dB radius ranged from 15.3 to 22.6 kilometers.

Table 12 describes the behavior of all animals, including unidentified species, which were exposed to 160/166 dB for the duration they were observed. There were no highly distinct behavioural reactions observed in relation to the vessel or acoustic source during the seismic survey.

Table 11. Level B Harassment Takes authorized by NMFS IHA and ITS for the ENAM 2-D seismic survey and number of known individuals observed within the 160/166 dB and 180 dB zones through visual observations

Species	IHA Authorized Takes	Number of animals observed within the predicted 180 dB zone	Number of animals observed within the predicted 160 dB zone
Mysticetes			
North Atlantic right whale	5	0	0
Blue whale	3	0	0
Bryde's whale	21	0	0
Fin whale	19	0	0
Humpback whale	44	0	0
Minke whale	2	0	0
Sei whale	98	0	0
Unidentifiable baleen whale	-	0	1
Odontocetes			
Sperm whale	104	0	7
Pygmy sperm whale	39	0	0
Dwarf sperm whale	39	0	0
Cuvier's beaked whale	19	0	0
Gervais' beaked whale	19	0	0
Blainville's beaked whale	19	0	0
True's beaked whale	19	0	0
Rough-toothed dolphin	18	0	0
Bottlenose dolphin (offshore)	3,829	12	27
Bottlenose dolphin (SMC)	778		
Bottlenose dolphin (NNCE)	7		
Bottlenose dolphin (NNCE)	23		
Pantropical spotted dolphin	830	0	0
Atlantic spotted dolphin	5,239	0	0
Spinner dolphin	74	0	0
Striped dolphin	112	0	0
Clymene dolphin	398	0	0
Short-beaked common dolphin	1,519	0	0
Atlantic white-sided dolphin	0	0	0
Fraser's dolphin	114	0	0
Risso's dolphin	100	0	0
Melon headed whale	114	0	0
Pygmy killer whale	57	0	0
False killer whale	18	0	0
Killer whale	7	0	0
Long-finned pilot whale	903	33	147
Short-finned pilot whale	903		
Harbor porpoise	0	0	0
Unidentifiable dolphin	-	3	64
Pinnipeds			
Harbor seal	5	0	0
Cetaceans			
Unidentifiable whale	-	0	2

Species	IHA Authorized Takes	Number of animals observed within the predicted 180 dB zone	Number of animals observed within the predicted 166 dB zone
Sea Turtles			
Leatherback sea turtle	-	1	1
Loggerhead sea turtle	-	1	1
Unidentifiable shelled sea turtle	-	4	4

Table 12. Behavior of species observed within the predicted 160 dB zone (cetaceans) / 166 dB zone (sea turtles)

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
Leatherback sea turtle	54	1	Breathing	Away from vessel	Slow travel	Away from vessel
Loggerhead sea turtle	52	1	Slow travel	Parallel, opposite direction	Breathing	Parallel, opposite direction
Unidentifiable shelled sea turtle	11	1	Fast travel	Away from vessel	Diving	Away from vessel
	13	1	Normal travel	Away from vessel	Normal travel	Away from vessel
	16	1	Normal travel	Away from vessel	Normal travel	Away from vessel
	53	1	Slow travel	Parallel, opposite direction	Breathing	Parallel, opposite direction
Sperm whale	40	1	Blowing	Away from vessel	Slow travel	Perpendicular, behind vessel
	48	4	Blowing	Perpendicular, ahead of vessel	Fluking then moderate travel	Parallel, opposite direction
	49	2	Blowing	Away from vessel	Moderate travel	Away from vessel
Unidentifiable baleen whale	37	1	Blowing	Unknown	Blowing	Unknown
Unidentifiable whale	41	2	Blowing	Away from vessel	Slow travel	Away from vessel
Bottlenose dolphins	14	2	Slow travel	Towards vessel	Slow travel	Towards source arrays
	31	10	Breaching	Towards vessel	Milling then moderate travel	Away from vessel
	50	15	Moderate travel	Away from vessel	Porpoising	Towards vessel

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 pilot whale	15	3	Blowing	Parallel, opposite direction	Normal travel	Towards vessel then parallel, opposite direction
	21	44	Slow travel	Parallel, opposite direction	Milling then slow travel	Perpendicular, behind vessel
	22	6	Slow travel	Away from vessel	Milling then slow travel	Parallel, opposite direction
	23	42	Milling	Parallel, opposite direction	Moderate travel	Parallel, opposite direction
	29	3	Moderate travel	Parallel, opposite direction	Moderate travel	Parallel, opposite direction
	30	6	Moderate travel	Away from vessel	Moderate travel	Away from vessel
	32	7	Moderate travel	Parallel, opposite direction	Moderate travel	Away from vessel
	33	4	Moderate travel	Perpendicular, behind vessel	Moderate travel	Perpendicular, behind vessel
	35	3	Breaching	Parallel, opposite direction	Moderate travel	Parallel, opposite direction
	36	2	Moderate travel	Away from vessel	Moderate travel	Away from vessel
	38	6	Moderate travel	Parallel, opposite direction	Moderate travel	Parallel, opposite direction
	39	8	Moderate travel	Parallel, opposite direction	Moderate travel	Parallel, opposite direction
	44	2	Slow travel	Parallel, same direction	Slow travel	Parallel, same direction
	51	11	Moderate travel	Away from vessel	Moderate travel	Parallel, opposite direction
Unidentifiable dolphin	12	2	Surfacing	Parallel, opposite direction	Slow travel	Parallel, opposite direction
	24	1	Breaching	Away from vessel	Moderate travel	Away from vessel
	25	2	Breaching	Away from vessel	Moderate travel	Away from vessel
	27	1	Breaching	Unknown	n/a	n/a
	28	6	Breaching	Parallel, opposite direction	Fast travel	Parallel, opposite direction
	34	1	Slow travel	Parallel, opposite direction	Slow travel	Parallel, opposite direction
	42	10	Porpoising	Away from vessel	Fast travel	Away from vessel

Unidentifiable dolphin	43	12	Slow travel	Parallel, same direction	Slow travel	Away from vessel
	45	1	Breaching	Unknown	n/a	n/a
	46	10	Moderate travel	Parallel, same direction	Moderate travel	Away from vessel
	47	18	Moderate travel	Towards vessel	Tail slapping	Parallel, same direction

6.3. IMPLEMENTATION AND EFFECTIVENESS OF THE BIOLOGICAL OPINIONS'S ITS AND IHA

In order to minimize potential impacts to marine mammals and sea turtles during the ENAM 2-D seismic survey, mitigation measures were implemented whenever these protected species were seen approaching, entering, or within the predicted EZ radii designated in the IHA and ITS. Eighteen mitigation actions were implemented during this survey for large and small odontocetes and sea turtles. Mitigation power-downs and mitigation shutdowns of the acoustic source were implemented and no soft-start delays were required 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. There were several conflicting items between ITS and the IHA, which were clarified with NSF via email before the start of the survey: information concerning the survey area, the duration of delay required before beginning ramp-up if a protected species is observed inside the exclusion zone during the search period and the duration of delay required prior to resuming source operations following the detection of mysticetes or large odontocetes inside the exclusion zone

Additional mitigation measures specific to the ENAM 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 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 ENAM 2-D seismic survey.

Per the conditions of the IHA and ITS, concentrations of six or more individuals of humpback (*Megaptera novaengliea*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and/or sperm whales (*Physeter macrocephalus*) visually sighted that did not appear to be traveling (e.g., feeding, socializing, etc.) were to be avoided when possible and the array powered-down. No groups of six or more of these whales were observed during the survey; therefore, this mitigation measure was not employed.

PAM was conducted throughout the survey program and the majority of acoustic monitoring was undertaken while the source was active. High levels of background noise on the hydrophone cable are experienced when the vessel travels at higher speeds (greater than 6 knots), which made it impractical to conduct monitoring for baseline acoustic data collection while the vessel was in transit to and from the survey site. There were several acoustic detections during the cruise.

The predicted 160 and 180dB zones for the survey were viewed to be conservative (i.e. based upon conservative parameters). Of the 15,498 marine mammal takes issued for the survey, only 296

individuals were observed to be within the predicted 160dB zone and potentially taken, representing less than 2% of authorized takes. Although observation conditions were fairly good during the survey, it is unlikely that PSOs detected all animals during survey operations, especially given there were nighttime operations. The combination of conservative predicted mitigation zones with conservative take estimation by NMFS (i.e. precautionary approach), however, appears to have resulted in an overestimation of take and of overall impact on marine species from the proposed activity. The monitoring and mitigation measures required by the IHA and ITS appear to have been an effective means to protect the few marine species observed during this survey.

7 LITERATURE CITED

Crone, T. J., M. Tolstoy, and H. Carton (2014), Estimating shallow water sound power levels and mitigation radii for the R/V Marcus G. Langseth using an 8 km long MCS streamer, Geochem. Geophys. Geosyst., 15, doi:10.1002/2014GC005420.

NOAA, 2014. Endangered Species Act Section 7 Consultation Biological Opinion for a seismic survey by L-DEO along North Carolina's Outer Banks and Issuance of an IHA pursuant of the MMPA.

APPENDIX A. INCIDENTAL HARASSMENT AUTHORIZATION FOR THE ENAM 2-D MARINE GEOPHYSICAL SURVEY

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

SEP 1 2 2014

Sean Higgins
Marine Environmental & Safety Coordinator
Department of Marine Operations
Lamont-Doherty Earth Observatory
P.O. Box 1000
Palisades, New York 10964-8000

Dear Mr. Higgins:

Enclosed is an Incidental Harassment Authorization (Authorization) issued to the Lamont-Doherty Earth Observatory, 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 seismic survey in the Atlantic Ocean during September through October, 2014.

You are required to comply with the conditions contained in the Authorization. Lamont-Doherty must report the taking of any marine mammal, in a manner prohibited under this Authorization, to the Office of Protected Resources, National Marine Fisheries Service (NMFS), at 301-427-8401.

In addition, Lamont-Doherty must submit a report to the NMFS' Office of Protected Resources within 90 days after completing the survey. The Authorization 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 Authorization or its requirements, please contact Jeannine Cody, Office of Protected Resources, NMFS, at 301-427-8401.

Sincerely,

Donna S. Wieting

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

We hereby authorize the Lamont- Doherty Earth Observatory (Lamont- Doherty), Columbia University, P.O. Box 1000, 61 Route 9W, Palisades, New York 10964–8000, under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107, to incidentally harass small numbers of marine mammals incidental to a marine geophysical survey conducted by the R/V *Marcus G. Langseth* (*Langseth*) marine geophysical survey in the Atlantic Ocean offshore Cape Hatteras, NC September through October, 2014.

1. Effective Dates

This Authorization is valid from September 15, 2014 through October 31, 2014.

2. Specified Geographic Region

This Authorization is valid only for specified activities associated with the *Langseth's* seismic operations as specified in Lamont-Doherty's Incidental Harassment Authorization (Authorization) application and environmental analysis in the following specified geographic area:

a. In the Atlantic Ocean bounded by the following coordinates: in the Atlantic Ocean, approximately 17 to 422 kilometers (km) (10 to 262 miles (mi)) off the coast off Cape Hatteras, NC between approximately 32–37° N and approximately 71.5–77° W, as specified in Lamont-Doherty's application and the National Science Foundation's Environmental Assessment.

3. Species Authorized and Level of Take

a. This Authorization limits the incidental taking of marine mammals, by Level B harassment only, to the species listed in Table 1 in the area described in Condition 2(a):

   i. During the seismic activities, if the Holder of this Authorization encounters any marine mammal species that are not listed in Condition 3 for authorized taking and are likely to be exposed to sound pressure levels greater than or equal to 160 decibels (dB) re: 1 µPa, then the Holder must alter speed or course or shut-down the airguns to avoid take.

b. This Authorization prohibits the taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 3 or the taking of any kind of any other species of marine mammal. Thus, it may result in the modification, suspension, or revocation of this Authorization.

c. This Authorization limits the methods authorized for taking by Level B harassment to the following acoustic sources without an amendment to this Authorization:

   i. An airgun array with a total capacity of 6,600 cubic inches (in^3) (or smaller).

   ii. Lamont-Doherty will not operate the multi-beam echosounder, the sub-bottom profiler, or the acoustic Doppler current profiler during transit.

4. Reporting Prohibited Take

The Holder of this Authorization must report the taking of any marine mammal in a manner prohibited under this Authorization immediately to the Office of Protected Resources, National Marine Fisheries Service, at 301–427–8401 and/ or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

5. Cooperation

We require the Holder of this Authorization to cooperate with the Office of Protected Resources, National Marine Fisheries Service, and any other Federal, state or local agency monitoring the impacts of the activity on marine mammals.

6. Mitigation and Monitoring Requirements

We require the Holder of this Authorization to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable adverse impact on affected marine mammal species or stocks:

Visual Observers

a. Use two, National Marine Fisheries Service-qualified, vessel-based Protected Species Visual Observers (visual observers) to watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from civil twilight- dawn to civil twilight-dusk) and before and during start-ups of airguns day or night.

   i. At least one visual observer will be on watch during meal times and restroom breaks.

   ii. Observer shifts will last no longer than four hours at a time.

   iii. Visual observers will also conduct monitoring while the *Langseth* crew deploy and recover the airgun array and streamers from the water.

   iv. When feasible, visual observers will conduct observations during daytime periods when the seismic system is not operating for comparison of sighting rates and behavioral reactions during, between, and after airgun operations.

   v. The *Langseth's* vessel crew will also assist in detecting marine mammals, when practicable. Visual observers will have access to reticle binoculars (7×50 Fujinon), and big-eye binoculars (25×150), optical range finders, and night vision devices.

Exclusion Zones

b. **Shallow Water (<=100 m)**: Establish a 180-dB and 190-dB exclusion zone (with 3-dB buffer) before starting the airgun subarray (6,600 in^3 or smaller); and a 180-dB and 190-dB exclusion zone (with buffer) for the single airgun (40 in^3). Observers will use the predicted radius distance for the 180-dB and 190-dB exclusion zones (with buffer) for mitigation shown in Table 2 (attached).

   Intermediate and Deep Water (>100 m): Establish a 180-dB and 190-dB exclusion zone before starting the airgun subarray (6,600 in^3 or smaller); and a 180-dB and 190-dB exclusion zone for the single airgun (40 in^3). Observers will use the predicted radius distance for the 180-dB and 190-dB exclusion zones for mitigation shown in Table 2 (attached).

Visual Monitoring at the Start of Airgun Operations

c. Monitor the entire extent of the relevant exclusion zones for at least 30 minutes (day or night) prior to the ramp-up of airgun operations, including after a shutdown.

d. Delay airgun operations if the visual observer sees a cetacean within the 180-dB exclusion zone (with buffer as defined in Table 2) in shallow water or within the 180-dB exclusion zone in intermediate or deep water (as defined in Table 2) until the marine mammal(s) has left the area.

   Delay airgun operations if the visual observer sees a pinniped within the 190-dB exclusion zone (with buffer as defined in Table 2) in shallow water or within 190-dB exclusion zone in intermediate or deep water (as defined in Table 2) until the marine mammal(s) has left the area.

   i. If the visual observer sees a marine mammal that surfaces, then dives below the surface, the observer shall wait 30 minutes. If the observer sees no marine mammals during that time, he/she should assume that the animal has moved beyond the relevant exclusion zone (as defined in Table 2).

   ii. If, for any reason the visual observer cannot see the full relevant exclusion zone (as defined in Table 2) for the entire 30 minutes (*i.e.*, rough seas, fog, darkness), or if marine mammals are near, approaching, or within zone, the *Langseth* may not resume airgun operations.

   iii. If one airgun is already running at a source level of at least 180 dB re: 1 μPa, the *Langseth* may start the second gun–and subsequent airguns–without observing relevant exclusion zones for 30 minutes, provided that the observers have not seen any marine mammals near the relevant exclusion zones (in accordance with Condition 6(b)).

Passive Acoustic Monitoring

e. 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 visual observer and/or bioacoustician will monitor the PAM at all times in shifts no longer than 6 hours. A 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.

f. Do and record the following when an observer detects an animal by the PAM:

   i. Notify the visual observer immediately of a vocalizing marine mammal so a power-down or shut-down can be initiated, if required;

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

Ramp-Up Procedures

g. Implement a ‘‘ramp-up’’ procedure when starting the airguns at the beginning of seismic operations or any time after the entire array has been shutdown for 8 minutes or longer, which means start the smallest gun first and add airguns in a sequence such that the source level of the array will increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-up, the observers will monitor the exclusion zones, and if the observers sight marine mammals, the *Langseth* will implement a course/speed alteration, power-down, or shutdown as though the full array were operational.

Recording Visual Detections

h. Visual observers must record the following information when they detect a marine mammal:

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

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

   iii. The data listed under 6(f)(ii) 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.

Speed or Course Alteration

i. Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant 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 relevant exclusion zone, Lamont-Doherty will implement further mitigation measures, such as a power-down or shutdown.

Power-Down Procedures

j. Power down the airguns if a visual observer detects a marine mammal within, approaching, or entering the relevant exclusion zone (as defined in Table 2). A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun. This would reduce the relevant exclusion zone to the degree that the animal(s) is/are outside of that zone. 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. Following a power-down, if the marine mammal approaches the smaller exclusion zone (as defined in Table 2), then the *Langseth* must completely shut down the airguns.

Resuming Airgun Operations after a Power-Down

k. Airgun activity will not resume until the observer has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or the observer has not seen the animal within the relevant exclusion zone for 15 minutes for species with shorter

dive durations (*i.e.*, small odontocetes); or 30 minutes has passed for mysticetes and large odontocetes (including pygmy sperm, dwarf sperm, and killer whales); and 60 minutes has passed for sperm and beaked whales which can have longer dive durations.

l. Following a power-down and subsequent animal departure, the *Langseth* may resume airgun operations at full power. Initiation requires that the observers can effectively monitor the full exclusion zones described in Condition 6(b). If the observer sees a marine mammal within or about to enter the relevant zones then the *Langseth* will implement a course/speed alteration, power-down, or shutdown.

Shutdown Procedures

m. Shutdown the airgun(s) if a visual observer detects a marine mammal within, approaching, or entering the relevant exclusion zone (as defined in Table 2). A shutdown means that the *Langseth* turns off all operating airguns.

n. If an observer visually detects a North Atlantic right whale (*Eubalaena glacialis*), the *Langseth* will shut-down the airgun array regardless of the distance of the animal(s) to the sound source. The array will not resume firing until 30 minutes after the last documented North Atlantic right whale visual sighting.

Resuming Airgun Operations after a Shutdown

o. Following a shutdown, if the observer has visually confirmed that the animal has departed the relevant exclusion zone within a period of less than or equal to 8 minutes after the shutdown, then the *Langseth* may resume airgun operations at full power.

p. Else, if the observer has not seen the animal depart the relevant exclusion zone (as defined in Table 2), the *Langseth* shall not resume airgun activity until 15 minutes has passed for species with shorter dive times (*i.e.*, small odontocetes and pinnipeds); 30 minutes has passed for mysticetes and large odontocetes (including pygmy sperm, dwarf sperm, and killer whales); and 60 minutes has passed for sperm and beaked whales which can have longer dive durations. The *Langseth* will follow the ramp-up procedures described in Conditions 6(g).

Survey Operations

q. The *Langseth* may continue marine geophysical surveys into night and low-light hours if the Holder of the Authorization initiates these segment(s) of the survey when the observers can view and effectively monitor the full relevant exclusion zones (as defined in Table 2).

r. This Authorization does not permit the Holder of this Authorization to initiate airgun array operations from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the visual observers cannot view and effectively monitor the full relevant exclusion zones (as defined in Table 2).

s. To the maximum extent practicable, the Holder of this Authorization should schedule seismic operations (*i.e.*, shooting the airguns) during daylight hours.

t. To the maximum extent practicable, the *Langseth* will conduct the seismic survey (especially when near land) from the coast (inshore) and proceed towards the sea (offshore) in order to avoid trapping marine mammals in shallow water.

Mitigation Airgun

u. The *Langseth* may operate a small-volume airgun (*i.e*., mitigation airgun) during turns and maintenance at approximately one shot per minute. The *Langseth* would not operate the small-volume airgun for longer than three hours in duration during turns. During turns or brief transits between seismic tracklines, one airgun would continue to operate.

Special Procedures for Large Whale Concentrations

v. The *Langseth* will power-down the array and avoid concentrations of humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), and/or sperm whales (*Physeter macrocephalus*) if possible (*i.e*., exposing concentrations of animals to 160 dB re: 1 μPa). 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.). The *Langseth* will follow the procedures described in Conditions 6(k) for resuming operations after a power down.

7. Reporting Requirements

This Authorization requires the Holder of this Authorization to:

a. Submit a draft report on all activities and monitoring results to the Office of Protected Resources, National Marine Fisheries Service, within 90 days of the completion of the *Langseth's* cruise. This report must contain and summarize the following information:

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

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

   iii. An estimate of the number (by species) of marine mammals with known exposures to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re: 1 μPa and/or 180 dB or 190-dB re: 1 μPa for cetaceans and pinnipeds, respectively and a discussion of any specific behaviors those individuals exhibited.

   iv. An estimate of the number (by species) of marine mammals with estimated exposures (based on modeling results) to the seismic activity at received levels greater than or equal to 160 dB re: 1 μPa and/or 180 dB or 190-dB re: 1 μPa with a discussion of the nature of the probable consequences of that exposure on the individuals.

   v. A description of the implementation and effectiveness of the: (A) Terms and Conditions of the Biological Opinion's Incidental Take Statement; and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report will 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, National Marine Fisheries Service, within 30 days after receiving comments from us on the draft report. If we decide that the draft report needs no comments, we will consider the draft report 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 not permitted by the Authorization, such as an injury, serious injury, or mortality (*e.g.*, ship-strike, gear interaction, and/or entanglement), Lamont-Doherty shall immediately cease the specified activities and immediately report the take to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

Lamont-Doherty must also contact the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the 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:

- Time, date, and location (latitude/longitude) of the incident;
- Name and type of vessel involved;
- Vessel's speed during and leading up to the incident;
- Description of the incident;
- Status of all sound sources used 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 all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

Lamont-Doherty shall not resume its activities until we are able to review the circumstances of the prohibited take. We shall work with Lamont-Doherty to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. Lamont-Doherty may not resume their activities until notified by us via letter, email, or telephone.

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

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead visual observer 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 we describe in the next section), Lamont-Doherty will immediately report the incident to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

Lamont-Doherty must also contact the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the 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 same information identified in Condition 8. Activities may continue while we review the circumstances of the incident. We would work with Lamont-Doherty to determine whether modifications in the activities are appropriate.

10. Reporting an Injured or Dead Marine Mammal Unrelated to the Activities

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead visual observer determines that the injury or death is not associated with or related to the authorized activities (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Lamont-Doherty would report the incident to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and ITP.Cody@noaa.gov.

Lamont-Doherty must also contact the NMFS Greater Atlantic Region Marine Mammal Stranding Network at 866-755-6622 (Mendy.Garron@noaa.gov), and the NMFS Southeast Region Marine Mammal Stranding Network at 877-433-8299 (Blair.Mase@noaa.gov and Erin.Fougeres@noaa.gov).

Lamont-Doherty would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS.

11. Endangered Species Act Biological Opinion and Incidental Take Statement

Lamont-Doherty must comply with the Terms and Conditions of the Incidental Take Statement corresponding to the Endangered Species Act Biological Opinion issued to the National Science Foundation and NMFS' Office of Protected Resources, Permits and Conservation Division.

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

Donna S. Wieting

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

SEP 12 2014

Date

Table 1 – Authorized Level B harassment take numbers for each marine mammal species during Lamont-Doherty's marine seismic survey in the Atlantic Ocean September 15, 2014 to October 31, 2014.

Mysticetes	Authorized Level B Take
North Atlantic right whale	5
Blue whale	3
Bryde's whale	21
Fin whale	19
Humpback whale	44
Minke whale	2
Sei whale	98
Odontocetes	**Authorized Level B Take**
Sperm whale	104
Dwarf sperm whale	39
Pygmy sperm whale	39
Cuvier's beaked whale	19
Gervais' beaked whale	19
Blainville's beaked whale	19
True's beaked whale	19
Rough-toothed dolphin	18
Bottlenose dolphin (offshore)	3,829
Bottlenose dolphin (SMC)	778
Bottlenose dolphin (NNCE)	7
Bottlenose dolphin (NNCE)	23
Pantropical spotted dolphin	830
Atlantic spotted dolphin	5,239
Spinner dolphin	74
Striped dolphin	112
Clymene dolphin	398
Short-beaked common dolphin	1,519
Atlantic white-sided-dolphin	0
Fraser's dolphin	114
Risso's dolphin	100
Melon-headed whale	114
Pygmy killer whale	57
False killer whale	18
Killer whale	7
Long-finned pilot whale	903
Short-finned pilot whale	903
Harbor porpoise	0
Harbor Seal	5

Table 2 –Exclusion Zones

Source and Volume (in^3)	Tow Depth (m)	Water Depth (m)	Predicted RMS Distances[1] (m)				
			190 dB with Buffer	190 dB	180 dB with Buffer	180 dB	160 dB
Single Bolt airgun (40 in^3)	6 or 9	< 100 100-1,000 > 1,000	37[3] - -	27[3] - -	121[3] 100 100	86[3] 100 100	938[3] 582[2] 388[1]
18-Airgun array (3,300 in^3)	6	< 100 100-1,000 > 1,000	436[4] - -	294[4] - -	1,628[4] - -	1,097[4] 675[2] 450[1]	15,280[4] 5,640[2] 3,760[1]
36-Airgun array (6,600 in^3)	9	< 100 100-1,000 > 1,000	877[3] - -	645[3] - -	2,838[3] - -	2,060[3] 1,391[2] 927[1]	22,600[3] 8,670[2] 5,780[1]

[1]

[1] Based on Lamont-Doherty modeling results.
[2] Predicted distances based on model results with a 1.5 correction factor between deep and intermediate water depths.
[3] Predicted distances based on empirically-derived measurements in the Gulf of Mexico with scaling factor applied to account for differences in tow depth.
[4] Predicted distances based on empirically-derived measurements in the Gulf of Mexico.

APPENDIX B. BASIC DATA SUMMARY FORM

BASIC DATA FORM				
LDEO Project Number		MGL1408		
Seismic Contractor		Lamont-Doherty Earth Observatory of Columbia University		
Area Surveyed During Reporting Period		17-422 km off Cape Hatteras, North Carolina		
		32-37° N 71.5-77° W		
Survey Type		2-D surface seismic		
Vessel and/or Rig Name		R/V *Marcus G. Langseth*		
Permit Number		IHA granted by NMFS on 12 September 2014		
Location / Distance of Acoustic Source Deployment		213 meters aft of PSO tower		
Water Depth	**Min**	15 meters		
	Max	5,418 meters		
Dates of project		16 September	THROUGH	18 October 2014
Total time acoustic source operating – all power levels:		644 hours 28 minutes		
Time acoustic source operating at full power on survey lines:		559 hours 45 minutes		
Time acoustic source operating at full power on line changes:		68 hours 57 minutes		
Amount of time mitigation source (40 in³) operations:		10 hours 58 minutes		
Amount of time in ramp-up:		4 hours 48 minutes		
Number daytime ramp-ups:		6		
Number of night time ramp-ups:		1		
Number of ramp-ups from mitigation source:		2		
Amount of time conducted in acoustic source testing:		None		
Duration of visual observations:		403 hours 01 minute		
Duration of observations while acoustic source active:		339 hours 52 minutes		
Duration of observation during acoustic source silence:		63 hours 09 minutes		
Duration of acoustic monitoring:		684 hours 59 minutes		
Duration of acoustic monitoring while acoustic source active:		636 hours 13 minutes		
Duration of acoustic monitoring acoustic source silence:		48 hours 46 minutes		
Duration of simultaneous acoustic and visual monitoring:		353 hours 32 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:		48		
Number of Marine Mammals Acoustically Detected:		4		
Number of acoustic detections confirmed by visual sighting:		1		
Number of visual sighting confirmed by acoustic detection:		1		
Number of Sea Turtles detected:		9		
List Mitigation Actions (e.g. Power-downs, shut-downs, ramp-up delays)		16 power-downs, 2 shut-downs		
Duration of operational downtime due to mitigation:		5 hours 44 minutes		

APPENDIX C. 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 D. PAM HYDROPHONE DEPLOYMENT ON THE R/V *MARCUS G. LANGSETH*

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

Overview

A 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.

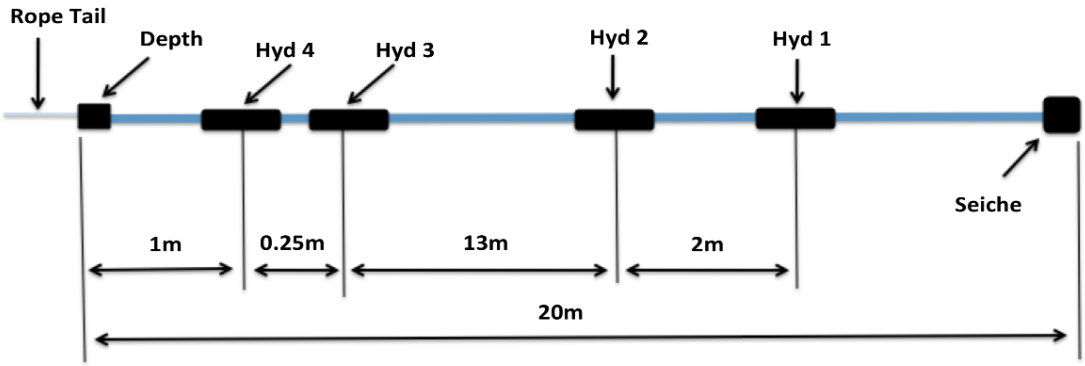

Figure 1. Diagram of the hydrophone array cable indicating the position and separation of the individual hydrophone elements

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

There is a total of 75m of tow cable along with the 20m hydrophone cable deployed 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 102 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.

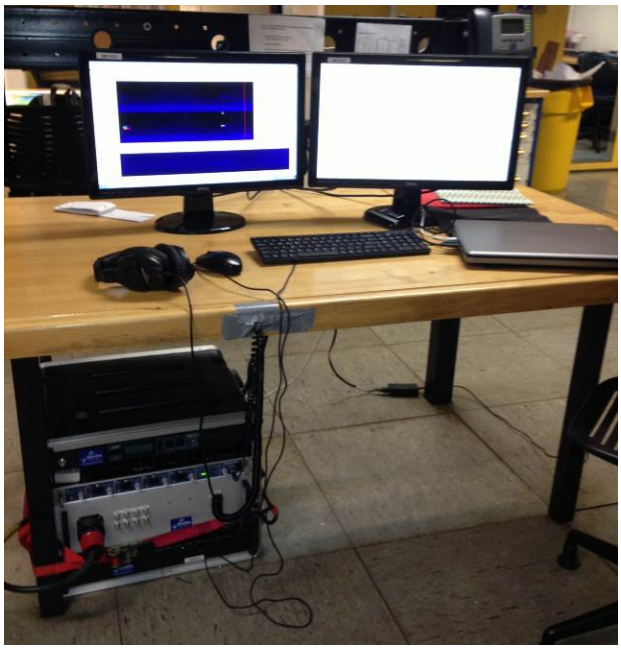

Figure 5. Passive acoustic monitoring station located in the instrument room

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 75m 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.

HSE

Normal working deck 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 E. SURVEY LINES ACQUIRED

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced (UTC)	Date Acquisition Completed	Time Acquisition Completed (UTC)
MGL1408OBS001 Seq01	18-Sep-14	05:35	20-Sep-14	14:57
MGL1408MCS002 Seq02	20-Sep-14	17:30	23-Sep-14	00:36
MGL1408OBS003 Seq03	23-Sep-14	15:20	25-Sep-14	10:10
MGL1408MCS003 Seq04	25-Sep-14	13:08	27-Sep-14	11:21
MGL1408MCS031 Seq05	27-Sep-14	12:42	27-Sep-14	17:42
MGL1408MCS032 Seq06	27-Sep-14	18:25	28-Sep-14	11:19
MGL1408MCS033 Seq07	28-Sep-14	11:24	28-Sep-14	17:34
MGL1408MCS034 Seq08	28-Sep-14	17:38	29-Sep-14	14:02
MGL1408MCS035 Seq09	29-Sep-14	15:39	29-Sep-14	20:03
MGL1408OBS04A Seq10	29-Sep-14	22:16	30-Sep-14	19:58
MGL1408MCS041 Seq11	30-Sep-14	20:55	01-Oct-14	04:36
MGL1408MCS042 Seq12	01-Oct-14	05:01	01-Oct-14	21:39
MGL1408OBS04B Seq13	02-Oct-14	01:26	02-Oct-14	20:58
MGL1408OBS01A Seq14	03-Oct-14	06:03	04-Oct-14	09:27
MGL1408OBS01B Seq15	04-Oct-14	12:14	05-Oct-14	03:45
MGL1408MCS001 Seq16	05-Oct-14	06:43	06-Oct-14	12:13
MGL1408MCS01A Seq17	06-Oct-14	17:11	07-Oct-14	04:55
MGL1408MCS01B Seq18	07-Oct-14	18:07	07-Oct-14	22:02
MGL1408MCS052 Seq19	08-Oct-14	00:40	08-Oct-14	08:58
MGL1408MCS053 Seq20	08-Oct-14	12:18	08-Oct-14	14:59
MGL1408MCS057 Seq21	08-Oct-14	18:50	09-Oct-14	00:54
MGL1408MCS058 Seq22	09-Oct-14	18:54	10-Oct-14	04:20
MGL1408MCS04B Seq23	10-Oct-14	10:54	12-Oct-14	10:14
MGL1408MCS062 Seq24	12-Oct-14	15:28	13-Oct-14	11:01
MGL1408MCS063 Seq25	13-Oct-14	13:44	13-Oct-14	21:40
MGL1408MCS063A Seq26	13-Oct-14	21:46	14-Oct-14	04:29
MGL1408MCS064 Seq27	14-Oct-14	07:18	14-Oct-14	15:29
MGL1408MCS04A Seq28	14-Oct-14	22:17	15-Oct-14	12:01
MGL1408MCSA4A Seq29	15-Oct-14	12:03	15-Oct-14	22:07
MGL1408MCS071 Seq30	16-Oct-14	14:49	17-Oct-14	08:00

APPENDIX F. PASSIVE ACOUSTIC MONITORING DOWNTIME

Date	Monitoring Suspended	Date	Monitoring Resumed	Duration acoustic monitoring suspended	Comments
9/19/14	13:10	9/19/14	15:03	1:53	Replacing damaged cable
9/20/14	5:24	9/20/14	5:52	0:28	Tow cable depth adjustment
9/20/14	6:39	9/20/14	7:30	0:51	Tow cable depth adjustment
9/20/14	7:34	9/20/14	8:02	0:28	Tow cable depth adjustment
9/26/14	12:28	9/26/14	13:23	0:55	Sargassum removal
9/29/14	12:31	9/29/14	13:08	0:37	Sargassum removal
10/5/14	20:12	10/5/14	20:53	0:41	Replacing damaged cable
10/7/14	4:55	10/7/14	17:29	12:34	Seismic gear maintenance
Total PAM Downtime				**18:27**	

APPENDIX G. SUMMARY OF VISUAL DETECTIONS OF PROTECTED SPECIES DURING THE ENAM 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

Behavioral 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 behavior; **MT**: mating behavior; **BV**: blow visible (whale); **SV**: only splashes visible (dolphins); **DV**: dorsal fin visible; **OB**: other behavior

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behavior		CPA Source / Source Activity	Mitigation Action	Comments
1	16-Sep	14:38	Bottlenose dolphin	2	36.99297°N 076.19417°W	Silent	PV/SD	SA FT	150 m / Silent	None	Vessel in transit, all seismic gear on board.
2	16-Sep	15:34	Bottlenose dolphin	8	36.94318°N 076.00285°W	Silent	PV/OD	NS	300 m / Silent	None	Vessel in transit, all seismic gear on board.
3	16-Sep	15:48	Bottlenose dolphin	20	36.93035°N 075.96223°W	Silent	PV/OD	NS	1000 m / Silent	None	Vessel in transit, all seismic gear on board.
4	16-Sep	18:27	Loggerhead sea turtle	2	36.56333°N 075.57950°W	Silent	SA	MT	400 m / Silent	None	Vessel in transit, all seismic gear on board.
5	16-Sep	18:49	Loggerhead sea turtle	2	36.50533°N 075.53517°W	Silent	SA	MT	1100 m / Silent	None	Vessel in transit, all seismic gear on board.
6	16-Sep	19:54	Loggerhead sea turtle	2	36.32500°N 075.39867°W	Silent	SA	MT	75 m / Silent	None	Vessel in transit, all seismic gear on board.
7	16-Sep	20:25	Unidentifiable dolphin	2	36.23342°N 075.33848°W	Silent	TV	PO FT	300 m / Silent	None	Vessel in transit, all seismic gear on board.
8	16-Sep	21:47	Bottlenose dolphin	1	36.00872°N 075.17590°W	Silent	PV/SD	SA FT	150 m / Silent	None	Vessel in transit, all seismic gear on board.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behavior		CPA Source / Source Activity	Mitigation Action	Comments
9	16-Sep	21:59	Unidentifiable dolphin	2	35.98287°N 075.15300°W	Silent	PV/OD	FT	175 m / Silent	None	Vessel in transit, all seismic gear on board.
10	16-Sep	23:13	Short-beaked common dolphin	6	35.77562°N 075.00492°W	Silent	PV/SD	PO FT	250 m / Silent	None	Vessel in transit, all seismic gear on board.
11	23-Sep	17:48	Unidentifiable shelled sea turtle	1	32.95505°N 073.69977°W	Full volume	AV	FT	245 m / Full volume	Power-down	Turtle last observed within 180 dB safety radius.
12	2-Oct	12:38	Unidentifiable delphinid	2	35.55950°N 074.61827°W	Full volume (6,560 in^3)	PV/OD	ST BV	230 m / Full Volume	Power-down	Animals last observed within 180 dB safety radius.
13	2-Oct	17:14	Unidentifiable shelled sea turtle	1	35.96737°N 074.54492°W	Full volume (6,560 in^3)	AV	NS	240 m / Full Volume	Power-down	Turtle last observed within 180 dB safety radius.
14	3-Oct	10:40	Bottlenose dolphins	2	35.73902°N 074.71730°W	Full volume (6,600 in^3)	TV	ST	160 m / Silent	Shut-down	Animals last observed approaching 180 dB safety radius for single source element. Correlates with acoustic detection 1.
15	3-Oct	13:17	Unidentifiable pilot whales	3	35.70143°N 074.43022°W	Full volume (6,600 in^3)	PV/OD	NS	400 m / Mitigation gun	Power-down	Animals observed leaving 180 dB safety radius.
16	3-Oct	15:17	Unidentifiable shelled sea turtle	1	35.64313°N 074.31072°W	Full volume (6,600 in^3)	AV	NS	240 m / Full Volume	Power-down	Turtle last observed within 180 dB safety radius.
17	7-Oct	11:34	Unidentifiable pilot whale	10	35.82233°N 074.61753°W	Silent	PV/SD	ST	1200 m / Silent	None	
18	7-Oct	12:12	Unidentifiable pilot whale	10	35.80478°N 074.63567°W	Silent	PV/SD	ST MI	1600 m / Silent	None	
19	7-Oct	12:54	Unidentifiable pilot whale	3	35.79172°N 074.64952°W	Silent	MI	MI	4100 m / Silent	None	

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behavior		CPA Source / Source Activity	Mitigation Action	Comments
20	7-Oct	15:26	Unidentifiable pilot whale	12	35.74832°N 074.68435°W	Silent	PE/AH	ST MI	180 m / Silent	None	
21	7-Oct	17:08	Unidentifiable pilot whale	44	35.76698°N 074.77618°W	Mitigation firing	PV/OD	ST MI	2500 m / Mitigation	None	Animals exposed to received sound levels of 160 dB.
22	7-Oct	18:23	Unidentifiable pilot whale	6	35.79700°N 074.85017°W	Full volume	AV	ST MI	1250 m / Full volume	Power-down	Four animals exposed to received sound levels of 180 dB.
23	7-Oct	18:35	Unidentifiable pilot whale	42	35.80317°N 074.86633°W	Full volume	PV/OD	ST MI	700 m / Full volume	Power-down	Five animals exposed to received sound levels of 180 dB.
24	7-Oct	20:32	Unidentifiable dolphin	1	35.86760°N 075.03912°W	Full volume	AV	SA NS	3250 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
25	7-Oct	21:38	Unidentifiable dolphin	2	35.90350°N 075.13633°W	Full volume	AV	SA NS	3000 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
26	9-Oct	10:51	Atlantic spotted dolphin	6	36.18492°N 075.05718°W	Silent	TV	PO	250 m / Silent	None	Correlates with acoustic detection 2.
27	9-Oct	18:36	Unidentifiable dolphin	1	36.32020°N 075.01503°W	Full volume	UN	SA	800 m / Full volume	Power-down	Animal exposed to received sound levels of 180 dB.
28	9-Oct	21:21	Unidentifiable dolphin	6	36.32430°N 074.75408°W	Full volume	PV/OD	SA FT	800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
29	9-Oct	21:40	Unidentifiable pilot whale	3	36.32483°N 074.72133°W	Full volume	PV/OD	NS	600 m / Full volume	Power-down	Animal exposed to received sound levels of 180 dB.
30	10-Oct	11:03	Unidentifiable pilot whale	6	36.40552°N 074.46543°W	Full volume	AV	NS	1500 m / Full volume	None	Animals exposed to received sound levels of 160 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behavior		CPA Source / Source Activity	Mitigation Action	Comments
31	10-Oct	11:50	Bottlenose dolphin	10	36.34502°N 074.47648°W	Full volume	TV	PO NS	700 m / Mitigation firing	Power-down	Animals exposed to received sound levels of 160 dB.
32	10-Oct	12:24	Unidentifiable pilot whale	7	36.30178°N 074.48438°W	Full volume	PV/OD	ST	800 m / Mitigation firing	Power-down	Animals exposed to received sound levels of 180 dB.
33	10-Oct	12:56	Unidentifiable pilot whale	4	36.26247°N 074.49162°W	Full volume	PE/BH	NS	3700 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
34	10-Oct	13:04	Unidentifiable dolphin	1	36.25520°N 074.49295°W	Full volume	PV/OD	ST	1700 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
35	10-Oct	13:07	Unidentifiable pilot whale	3	36.25135°N 074.49367°W	Full volume	PV/OD	SA NS	3900 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
36	10-Oct	13:12	Unidentifiable pilot whale	2	36.24555°N 074.49472°W	Full volume	AV	NS	1800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
37	10-Oct	13:22	Unidentifiable baleen whale	1	36.23602°N 074.49645°W	Full volume	UN	BV	5600 m / Full volume	None	Animal exposed to received sound levels of 160 dB.
38	10-Oct	13:29	Unidentifiable pilot whale	6	36.23073°N 074.49742°W	Full volume	PV/OD	NS	1000 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
39	10-Oct	13:46	Unidentifiable pilot whale	8	36.21463°N 074.50037°W	Full volume	PV/OD	NS	3900 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
40	10-Oct	14:12	Sperm whale	1	36.18950°N 074.50497°W	Full volume	AV	BV DV ST	3800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
41	10-Oct	15:06	Unidentifiable whale	2	36.13672°N 074.51455°W	Full volume	AV	BV ST	4600 m / Full volume	None	Animals exposed to received sound levels of 160 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behavior		CPA Source / Source Activity	Mitigation Action	Comments
42	10-Oct	15:31	Unidentifiable dolphin	10	36.12118°N 074.51740°W	Full volume	AV	PO FT	3200 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
43	10-Oct	15:51	Unidentifiable dolphin	12	36.10517°N 074.52030°W	Full volume	PV/SD	ST	1000 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
44	10-Oct	16:45	Unidentifiable pilot whale	2	36.05917°N 074.52867°W	Full volume	PV/SD	ST	1000 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
45	10-Oct	17:18	Unidentifiable dolphin	1	36.02895°N 074.53418°W	Full volume	UN	SA	4600 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
46	10-Oct	17:19	Unidentifiable dolphin	10	36.02895°N 074.53418°W	Full volume	PV/SD	NS	3000 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
47	10-Oct	17:45	Unidentifiable dolphin	18	36.01168°N 074.53733°W	Full volume	TV	SA NS	2800 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
48	10-Oct	18:17	Sperm whale	4	35.98400°N 074.54233°W	Full volume	PE/AH	BV DV DF	990 m / Full volume	Power-down	Animals exposed to received sound levels of 160 dB.
49	10-Oct	19:05	Sperm whale	2	35.94350°N 074.54967°W	Full volume	AV	BV DV	4200 m / Full volume	None	Animals exposed to received sound levels of 160 dB.
50	10-Oct	19:07	Bottlenose dolphin	15	35.94200°N 074.54983°W	Full volume	AV	PO NS	250 m / Mitigation firing	Power-down	Animals exposed to received sound levels of 160 dB.
51	10-Oct	20:46	Unidentifiable pilot whale	11	35.86417°N 074.56400°W	Full volume	AV	NS	600 m / Mitigation firing	Power-down	Animals exposed to received sound levels of 180 dB.
52	14-Oct	15:29	Loggerhead sea turtle	1	33.13958°N 076.61152°W	Full volume	PV/OD	SS	30 m / Silent	Shut-down	Turtle exposed to received sound levels of 180 dB.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Movement/ Behavior		CPA Source / Source Activity	Mitigation Action	Comments
53	15- Oct	15:51	Unidentified shelled sea turtle	1	34.86295°N 074.90322°W	Full volume	PV/OD	ST	130 m / Full volume	Power-down	Turtle exposed to received sound levels of 180 dB.
54	16-Oct	17:43	Leatherback sea turtle	1	35.00658°N 074.94757°W	Full volume	AV	ST	250 m / Full volume	Power-down	Turtle exposed to received sound levels of 180 dB.
55	17-Oct	14:10	Sperm whale	1	34.47158°N 073.63157°W	Silent	AV	BV	600 m / Silent	None	Vessel in transit, all seismic gear on board.
56	17-Oct	21:46	Bottlenose dolphins	6	35.58795°N 074.62810°W	Silent	TV	NS	200 m / Silent	None	Vessel in transit, all seismic gear on board.
57	18-Oct	12:07	Bottlenose dolphins	3	34.00092°N 076.20473°W	Silent	TV	NS	260 m / Silent	None	Vessel in transit, all seismic gear on board.

Summary of acoustic detections of protected species during the ENAM 2-D seismic survey

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	Acoustic Detection Details	CPA Source / Source Activity	Mitigation Action	Comments
1	3-Oct	10:45	Bottlenose dolphin	2	35.73902°N 074.71730°W	Silent	A single down-swept whistle was observed from 20-14 kHz.	160 m / Silent	Shut-down	Correlates with visual detection 14.
2	9-Oct	10:49	Atlantic spotted dolphin	6	36.18492°N 075.05718°W	Silent	Multiple click trains observed on HF click detector. Most clicks ranged from 35-90 kHz, with a peak frequency of ~ 70 kHz. Beginning at a bearing of 19° and ending at a bearing of 136°. Received at an amplitude of up to 202 dB re 1 µPa. Localized once at 19:50 UTC at a distance of ~19 meters.	19 m / Silent	None	Correlates with visual detection 26.
3	16-Oct	3:00	Unidentifiable delphinid	3	35.63757°N 074.77548°W	Silent	Whistles were seen and heard audibly and ranged in frequency from 5-20 Hz with amplitude of 75-90 dB. High frequency clicks were seen in a range of 18-150 degrees. There were three simultaneous click trains at once indicating the presence of possibly three delphinids. Clicks were localized twice; first at a range of 395m and secondly at 251m. Low frequency clicks were also seen on PAMGuard Spectrogram and heard audibly.	251 m / Silent	None	No visual correlation.
4	16-Oct	5:08	Unidentifiable delphinid	2	35.57937°N 074.87493°W	Silent	Whistles were seen on PAMGuard Spectrogam and heard audibly. Since the two separate whistles overlapped, it would indicate the presence of two delphinids. The whistles ranged in frequency from 8-17 Hz with amplitude of 90 dB.	Unknown / Silent	None	No visual correlation.

APPENDIX H. SPECIES OF BIRDS AND OTHER WILDLIFE OBSERVED DURING THE ENAM 2-D SEISMIC SURVEY

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
American kestrel	Falconidae	*Falco*	*sparverius*	1	1
American redstart	Parulidae	*Setophaga*	*ruticilla*	42	5
Audobon's shearwater	Procellariidae	*Puffinus*	*lherminieri*	3	3
Belted kingfisher	Alcedinidae	*Ceryle*	*alcyon*	3	2
Black-and-white warbler	Parulidae	*Mniotilta*	*varia*	1	1
Black-throated blue warbler	Parulidae	*Dendroica*	*caerulescens*	1	1
Black-throated green warbler	Parulidae	*Dendroica*	*virens*	1	1
Blue-winged teal	Anatidae	*Anas*	*discors*	18	2
Bobolink	Icteridae	*Dolichonyx*	*oryzivorus*	4	2
Brown booby	Sulidae	*Sula*	*leucogaster*	2	2
Brown pelican	Pelecanidae	*Pelecanus*	*occidentalis*	10	2
Brown thrasher	Mimidae	*Taxostoma*	*rufum*	1	1
Canada goose	Anatidae	*Branta*	*canadensis*	36	1
Chestnut-sided warbler	Parulidae	*Dendroica*	*pensylvanica*	1	1
Common loon	Gaviidae	*Gavia*	*immer*	6	1
Common nighthawk	Caprimulgidae	*Chordeiles*	*minor*	2	2
Cory's shearwater	Procellariidae	*Calonectris*	*diomedea*	95	13
Double-crested cormorant	Phalacrocoracidae	*Phalacrocorax*	*auritus*	27	3
Eastern phoebe	Tyrannidae	*Sayornis*	*phoebe*	1	1
Gray catbird	Mimidae	*Dumetella*	*carolinensis*	5	7
Great blue heron	Ardeidae	*Ardea*	*herodias*	7	6
Great egret	Ardeidae	*Ardea*	*alba*	1	1
Greater shearwater	Procellariidae	*Puffinus*	*gravis*	16	6
Green heron	Ardeidae	*Butorides*	*virescens*	1	1

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
Herring gull	Laridae	*Larus*	*argentatus*	47+	7
House wren	Troglodytidae	*Troglodytes*	*aedon*	1	1
Masked booby	Sulidae	*Sula*	*dactylatra*	1	1
Merlin	Falconidae	*Falco*	*columbarius*	2	2
Mourning dove	Columbidae	*Zenaida*	*macroura*	6	5
Northern flicker	Picidae	*Colaptes*	*auratus*	2	2
Northern parula	Parulidae	*Parula*	*americana*	1	1
Osprey	Accipitridae	*Pandion*	*haliaetus*	7	5
Ovenbird	Parulidae	*Seiurus*	*aurocapilla*	1	1
Peregrine falcon	Falconidae	*Falco*	*peregrinus*	16	14
Pine warbler	Parulidae	*Dendroica*	*pinus*	1	1
Pomarine jaeger	Laridae	*Stercorarius*	*pomarinus*	2	2
Prairie warbler	Parulidae	*Dendroica*	*discolor*	1	1
Rose-breasted grosbeak	Cardinalidae	*Pheucticus*	*ludovicianus*	1	1
Royal tern	Laridae	*Thalasseus*	*maximus*	1	1
Semipalmated plover	Charadriidae	*Charadrius*	*semipalmatus*	1	5
Western kingbird	Tyrannidae	*Tyrannus*	*verticalis*	1	1
White-tailed tropicbird	Phaethontidae	*Phaethon*	*lepturus*	3	3
Wilson's plover	Charadriidae	*Charadrius*	*wilsonia*	3	3
Yellow-bellied sapsucker	Picidae	*Sphyrapicus*	*varius*	1	1
UID gull	Laridae	-	-	1	1
UID shearwater	Procellariidae	-	-	6	2
UID tern	Laridae	-	-	1	1
UID vireo	Vireonidae	-	-	1006+	5
UID warbler	-	-	-	8	5
UID bat	-	-	-	1	1

Common Name	Family	Genus	Species	Approximate Number of Individuals Observed	Approximate Number of Days Species Was Observed
Blacktip shark	Carcharhinidae	*Carcharhinus*	*limbatus*	1	1
Flying fish	Exocoetidae	-	-	2254+	28
Moon jellyfish	Ulmaridae	*Aurelia*	*aurita*	202	10
Ocean sunfish	Molidae	*Mola*	*mola*	3	2
Oceanic triggerfish	Balistidae	*Canthidermis*	-	9	5
Porcupinefish	Diodontidae	-	-	2	2
Pufferfish	Tetraodontidae	-	-	12	4
Scalloped hammerhead shark	Sphyrnidae	*Sphyrna*	*lewini*	1	1
Mahi-mahi	Coryphaenidae	*Coryphaena*	*hippurus*	26	4
Manta ray	Myliobatidae	*Manta*	-	1	1
UID grouper	Serranidae	-	-	4	2
UID shark	-	-	-	1	1