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# PROTECTED SPECIES MITIGATION AND MONITORING REPORT

**Marine Geophysical 2D Seismic Survey, Cape Fear (Cruise ID No. MGL2306)**

**Cape Fear Survey, RV *Marcus G Langseth* (Callsign: WDC6698)**
**09 May 2023 – 03 June 2023**

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## Acronyms and Abbreviations

ADCP – Acoustic Doppler Current Profiler
BiOp – Biological Opinion
BOEM – Bureau of Ocean Energy Management
BSS – Beaufort Sea State
BZ – Buffer Zones
DAQ – Data acquisition
dB - decibels
DSLR – Digital Single Lens Reflex
EA – Environmental Assessment
EPU – Electronic Processing Unit
ESA – Endangered Species Act
EEZ – Economic Exclusion Zone
EZ – Exclusion Zone
GPS – Global Positioning System
HF – High Frequency
HZ – Hertz
IHA – Incidental Harassment Authorization
ITS – Incidental Take Statement
LDEO – Lamont-Doherty Earth Observatory
LF – Low Frequency
MBES – Multibeam Echosounder
MGL – RV Marcus G. Langseth
MMPA – Marine Mammal Protection Act
NMFS – National Marine Fisheries Service
NRP – Navigation Reference Point
NSF – National Science Foundation
PI – Principal Investigator
PTS – Permanent threshold shift
PSO – Protected Species Observer
RME – PAM sound card manufacturer company name (not an acronym)
RMS – Root mean square
RPS – PSO Provider company name (not an acronym)
RV – Research vessel
SBP – Sub-bottom Profiler
TOAD – Time of Arrival Distance
TTS – Temporary Threshold Shift
TVG – Transverse Gradiometer
US – United States
UTC – Coordinated Universal Time
VSA – Vessel Strike Avoidance

# 1 EXECUTIVE SUMMARY

The R/V *Marcus G. Langseth* (MGL), which is owned and operated by Columbia University's Lamont-Doherty Earth Observatory (LDEO), conducted a high-energy 2D seismic survey in the Northwest Atlantic Ocean off the coast of North Carolina from 09 May to 03 June 2023 (referred to herein as "survey"). The operational activities were conducted in support of research proposed by Principal Investigators (PIs) Drs. H. Daigle (University of Texas at Austin), A. Becel and C. Grall (L-DEO) and funded by the National Science Foundation (NSF).

The purpose of the survey was to collect low energy 2D seismic reflection data to study geological processes at the Cape Fear submarine slide complex, where submarine landslides are a common seafloor feature and have been associated with tsunamis in the past.

This report was prepared to meet the reporting requirements for the survey required under the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA). On 12 October 2022, NSF applied to the US National Marine Fisheries Service (NMFS) for an Incidental Harassment Authorization (IHA) that would allow for the potential harassment of small numbers of protected marine mammals incidental during the seismic survey. On 05 May 2023, NMFS issued the signed Biological Opinion (BiOp) and IHA for the survey.

Mitigation measures were implemented to minimize potential impacts to marine mammals and protected species. These measures included, but were not limited to, the use of NMFS approved Protected Species Observers (PSOs) for visual and acoustic monitoring, the designation of buffer zones (BZ) and exclusion zones (EZ) (where the presence of a protected species would require a mitigation action), and the implementation of ramp-up procedures, mitigation actions (including delayed operations and shutdowns), and vessel strike avoidance (VSA) maneuvers. Continuous protected species observation coverage during the survey was provided by RPS, the PSO provider contracted for the survey. PSOs monitored and reported on the presence and behavior of protected species and directed the implementation of the mitigation measures, as described in the regulatory documents issued for the survey.

A team of five PSOs, one of which was designated as the Lead, were present on board *MGL* throughout the survey to conduct visual and acoustic monitoring. Throughout the survey, PSOs conducted visual monitoring for a total of 372 hours and 40 minutes and acoustic monitoring for a total of 518 hours and 50 minutes. Visual and acoustic monitoring were conducted simultaneously for a total of 327 hours and 15 minutes. The acoustic survey source was active for a total of 497 hours and 44 minutes.

There was a total of three visual detections of protected species during the survey. Visual detections included two detections of dolphins (one sighting of bottlenose dolphins and one sighting of unidentified dolphins, and one detection of an unidentified sea turtle.

There was a total of one acoustic detection of protected species during the survey. The acoustic detection was of unidentified dolphins.

Protected species detections resulted in the implementation of one mitigation action during the survey, consisting of one shutdown for an unidentified sea turtle for a total of 16 minutes. There were no VSA maneuvers implemented for, in which would have required the vessel to reduce speed and/or alter course.

NMFS issued an IHA, authorizing 5909 Level B takes for 26 species of marine mammals, including four species that are listed as endangered. There were 31 Level A takes authorized for one species group of marine mammals. For this report, the definition of Level A and Level B are the same as found in the MMPA and the NMFS issued BiOp regarding what constitutes a take. There were 1302 Level B takes issued for four ESA-listed sea turtle species and no specific number of takes issued for ESA-listed seabird species for this survey.

During the survey program, two unidentified dolphins and one unidentified sea turtle, were observed within the predicted 160 decibel radius (where there is a potential for a behavioral response and temporary threshold shift (TTS)) while the acoustic source was active, constituting potential Level B takes. There were no protected species observed within the predicted radius at which there is a potential for auditory injury (based upon each species hearing range and how that overlaps with the frequencies produced by the sound source), constituting potential Level A takes/exposures.

# 2 INTRODUCTION

The following report details protected species monitoring and mitigation as well as seismic survey operations undertaken as part of the high-energy 2D marine geophysical survey on board the R/V *Marcus G. Langseth* (*MGL*) in the Northwest Atlantic Ocean, off the coast of North Carolina from 09 May to 03 June 2023.

This document serves to meet the reporting requirements dictated in the IHA issued to NSF by NMFS on 05 May 2023. The IHA authorized takes of specific protected species incidental to the survey. NMFS has stated that seismic source received sound levels equal to or greater than 160 dB re 1 µPa root mean square (rms) (160 dB) could potentially disturb marine mammals, temporarily disrupting behavior, such that they could be considered non-lethal 'takes' (Level B harassment). In July 2016, NMFS released new technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing, which established new thresholds for permanent threshold shift (PTS) onset, Level A harassment (auditory injury), for marine mammal species. Predicted distances to Level A harassment vary based on species specific hearing groups – low frequency cetaceans, mid frequency cetaceans, high frequency (HF) cetaceans, phocid pinnipeds, otariid pinnipeds, sea otters, and sea turtles – and how each group's hearing range overlaps with the frequencies produced by the sound source.

NMFS requires that measures such as buffer zones (BZs), exclusion zones (EZs), delayed operations, ramp-ups, and shutdowns be implemented to mitigate for potentially adverse effects of the acoustic source sounds on protected species. The BZs and EZs were established from any element on the acoustic source array as areas, where the presence of a protected species would require the implementation of a mitigation action (see Section 6). For marine mammals, the occurrence of an individual detected approaching, entering, or within their designated EZ would require the implementation of a shutdown of the seismic source. NMFS specified a 500 meter EZ for most marine mammals as it encompasses all zones within which auditory injury (Level A harassment) could occur on the basis of instantaneous exposure, provides additional protection from the potential for more severe behavioral reactions for marine mammals at relatively close range to the acoustic source, provides a consistent area for PSOs to conduct effective observational effort, and is a distance within which detection probabilities are reasonably high for most species under typical conditions.

In accordance with the IHA, the PSO team conducted an onboard environmental management briefing with the vessel personnel prior to the start of source operations. The lead PSO covered the mitigation and monitoring protocols, communication procedures, roles and responsibilities of the monitoring team and any additional operational procedures for this survey.

The IHA is attached as Appendix A.

## 2.1 Project Overview and Location

The research activities involved a 2D high-energy seismic survey. The research activities took place within the Northwest Atlantic Ocean, off the coast of North Carolina, in water depths of approximately 300 to 5200 meters (Figure 1).

The purpose of the research was to collect 2D seismic reflection data to understand the Cape Fear sub-marine landslide and provide new constraints for examining the associated tsunami hazards. The survey will provide further understanding of how slope failures operated through time and the manner in which past sub-marine landslides might affect succeeding events. Also, a regional grid of seismic data with companion multi-beam echosounder and sub-bottom profiler data were needed to place the existing and new observations within a regional stratigraphic framework.

All operations for the survey were conducted solely by *MGL*. The vessel is 72 meters (236.2 feet) in length and has a beam of 17 meters (55.8 feet) and a maximum draft of 5.9 meters (19.4 feet). The vessel's cruising speed was approximately 10 knots, during transits and varied between three and five knots during the seismic survey.

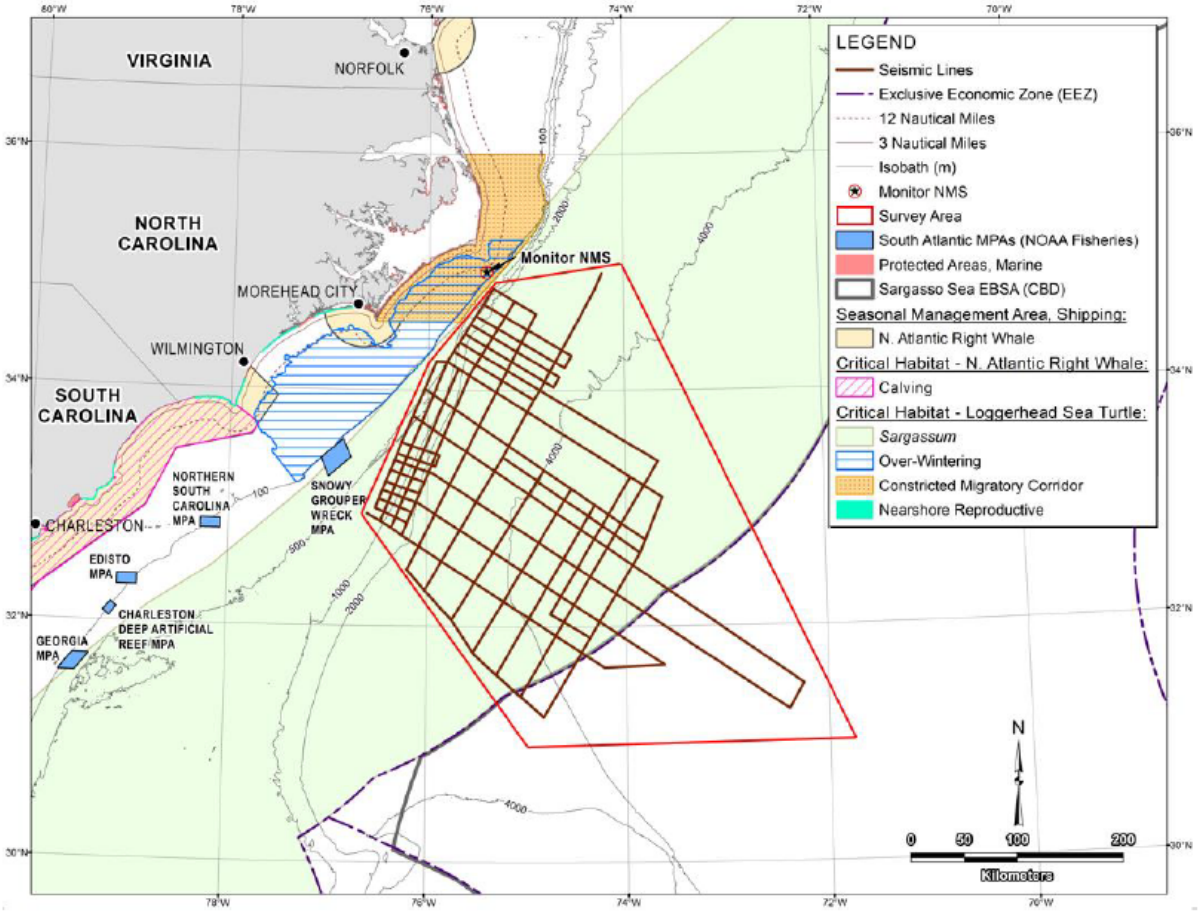


**Figure 1: Location and survey points of the 2D seismic survey.**

Seismic Operations were conducted between 11 May and 02 June 2023. There was a total of 59 survey line sequences acquired during the operational period.

### 2.1.1 Energy Source and Receiving Systems

The energy source utilized during the survey consisted of two towed acoustic source sub-arrays towed aft of the vessel, each with nine source elements, for a total of 18 source elements, a total volume of 3300 cubic inches. The source array utilized Bolt 1500LL and Bolt 1900LLX elements ranging in size from 40 to 360 cubic inches. The operating pressure was 2000 pounds per square inch and the dominant frequency components ranged from two to 188 Hertz (Hz). The shot point interval was 25 meters (10.6 seconds) dependent on vessel speed which ranged from 3 to 5.5 knots during acquisition. During acquisition, the source elements emitted a brief (approximately 0.1 second) pulse of sound. The source elements were towed at a depth of six meters. The center of the source was 304 meters from the Navigation Reference Point (NRP), which was located 29 meters from the stern of the vessel. This positioned the elements on the array 275 meters from the stern of the vessel.

The receiving system for the seismic survey consisted of one 6000-meter hydrophone streamer with 552 channels, which received the returning acoustic signals and transferred the data to the onboard processing system

Additional sound sources used in support of research efforts included a Kongsberg EM 122 multi-beam echosounder (MBES), Knudsen Chirp 3260 sub-bottom profiler (SBP), and a Teledyne RDI 75 kHz Ocean Surveyor acoustic doppler current profiler (ADCP). The hull mounted MBES operated at frequencies between 10.5 and 13 (usually 12) kilohertz. Each ping consisted of eight (in water depths

greater than 1000 meters) or four (in water depths less than 1000 meters) successive fan-shaped transmissions. The transmitting beam width was one or two degrees fore-aft and 150 degrees perpendicular to the ship's line of travel. The maximum source level was 242 dB re: 1 µPa (root mean square [rms]). The hull-mounted SBP beam was transmitted as a 27-degree cone, which was directed downward by a 3.5 kilohertz transducer. The nominal power output was 10 kilowatts; however, the actual maximum radiated power was three kilowatts or 222 dB re: 1 µPa m (rms). The ping duration was 64 seconds, and the interval was one second. The hull-mounted ADCP operated at a frequency of 75 kilohertz and a maximum source level of 224 dB re: 1 µPa m (rms) over a conically shaped 30-degree beam. The MBES and SBP operated simultaneously to provide information about near seafloor sedimentary features and to map the topography of the ocean floor. The ADCP was used to measure water current velocities.

# 3 MITIGATION AND MONITORING METHODS

The PSO monitoring program on the *MGL* was established to meet the standards set forth in the IHA and BiOp requirements. Survey mitigation measures were designed to minimize potential impacts of the MGL's seismic activities on marine mammals and other protected species of interest. The following monitoring protocols were implemented to meet these objectives.

- Visual observations were conducted to provide real-time sighting data, allowing for the implementation of mitigation procedures as necessary.
- A passive acoustic monitoring (PAM) system was operated 24 hours a day during seismic source operations to augment visual observations and provide additional marine mammal detection data.
- Effects of marine species exposed to sound levels constituting a defined take were observed and documented. The nature of the probable consequences was discussed when possible.

In addition to the mitigation objectives outlined in the project permit documents, PSOs collected and analyzed necessary data mandated by the IHA.

## 3.1 Mitigation Methodology

Mitigation actions were implemented for visual and acoustic detections of protected species, including marine mammals, as outlined in the IHA and BiOp. These actions included the establishment of buffer zones (BZs) and exclusion zones (EZs), and the implementation of delayed operations and shutdowns (where the seismic source was fully silenced) for protected species detected approaching, entering, or within their designated BZ and EZ (Table 1).

Before the acoustic source could be activated from silence, two visual PSOs and one PAM (Passive Acoustic Monitor) operator conducted a 30-minute clearance period of the BZs and EZs. In the event of a detection of protected species within their designated zones (Table 2) or as outlined in Table 1, a delay of source activation operations would be implemented. Source operations would not be cleared to begin until the protected species were observed exiting their designated zones. If the protected species were not observed exiting their designated zones (i.e., if they dove/submerged within the zone and were not re-sighted), operations would not be cleared to begin until a specific time following the final detection of the animals. For detections of small odontocetes and pinnipeds, this time was 15 minutes following last sighting. For detections of sea turtles or ESA listed sea birds, operations could resume without a ramp-up 15 minutes following the last sighting. For detections of mysticetes and other large odontocetes (including sperm whales or beaked whales), this time was 30 minutes following last sighting.

**Table 1: Specific detections of protected species and their required mitigation actions.**

| Detection of: | Mitigation Action Required |
|---|---|
| A large whale (defined as a sperm whale or any mysticete species) with a calf (defined as an animal less than two-thirds the body size of an adult and observed in close association with an adult) observed at 1500 meters from the vessel. | Delayed operation of inactive source and shutdown of active source. |
| An aggregation of six or more large whales observed at 1500 meters from the vessel. | Delayed operation of inactive source and shutdown of active source. |
| Any North Atlantic right whale observed at any distance from the vessel. | Delayed operation of inactive source and shutdown of active source. |
| Any marine mammal species not authorized for take observed approaching, entering, or within the 160-decibel radius. | Delayed operation of inactive source and shutdown of active source. |
| Any marine mammal species for which the total authorized takes has been met observed approaching, entering, or within the 160-decibel radius. | Delayed operation of inactive source and shutdown of active source. |
| Any sea turtle species detected approaching, entering, or within their designated exclusion zones, and any ESA-listed sea bird species detected diving and/or foraging within their designated exclusion zones. | Delayed operation of inactive source and shutdown of active source. |
| Any dolphin species with a shut-down exemption detected approaching, entering, or within their designated exclusion zones. | None. |

**Table 2: Separation distances, buffer and exclusion zones sizes for each species / species group expected to occur in the survey area.**

| Species/Species Groups | Separation Distance (meters) | Buffer Zones (meters) | Exclusion Zones (meters) | Delay Duration (minutes) |
|---|---|---|---|---|
| Large whale/calf, 6+ large whales | 100 | 1500 | 1500 | 30 |
| Beaked whales, dwarf, and pygmy sperm whales | 100 | 1500 | 1500 | 30 |
| North Atlantic right whales | 500 | Any distance | Any distance | 30 |
| Mysticetes and large odontocetes | 100 | 1000 | 500 | 30 |
| All other small dolphins and porpoises | 50 | 1000 | 500[1] | 15 |
| Pinnipeds | 50 | 200 | 100 | 15 |
| Sea turtles | 100 | 175 dB radius | 150 | 15 |
| ESA listed sea birds | none | none | 150 | 15 |

1 Except exempt species per the NMFS IHA

Once the acoustic source was active, the BZ from any element on the acoustic source arrays were established as areas in which the presence of a protected species would initiate an alert to the seismic operators that the animal was detected, and that the implementation of a mitigation action may soon be required. PSOs and PAM operators would keep in frequent contact with each other and the seismic team, relaying information on the location and movement of the protected species, and the implementation of any needed mitigation actions.

The EZs from any active source element were established as areas in which the detection of a protected species would require a shutdown of the seismic source, depending on the species present. For marine mammals, the detection of one approaching, entering, or within their designated zone would require a shutdown of the source. For sea turtles, the detection of one approaching within their designated zone would require a shutdown of the source. For protected sea birds, the detection of one foraging or diving within their designated zone would require a shutdown of the source.

Upon the implementation of a shutdown for a detection of protected species, a ramp-up was required to resume source activity once the protected species were confirmed to have exited their respective exclusion zones. If the protected species could not be confirmed to have exited their respective exclusion zones (i.e., if they submerged/dove within the zone and were not re-sighted), clearance for ramp-up would not be given until a specific time following the last sighting of the individuals within the zones. For detections of small odontocetes or pinnipeds, this time was 15 minutes following last sighting. For detections of mysticetes and other large odontocetes (including sperm whales or beaked whales) this time was 30 minutes following last sighting. For detections of sea turtles or ESA listed sea birds source activity could resume without a ramp-up 15 minutes following the last sighting.

The IHA also outlined additional mitigation actions for specific protected species while the acoustic source was active as outlined in Table 1.

Specific acoustic source operation procedures outlined in the IHA that were relevant to this specific survey included:

1. Ramp-ups could not be less than 20 minutes and were required to begin with the smallest volume element and continue in stages by doubling the number of active elements, with each stage approximately the same duration. The time between ramp-up completion and start of data acquisition had to be minimized.
2. Testing of individual elements or strings required a 30-minute clearance search period but no ramp-up. Testing of more than one element or string required both a 30-minute clearance search period and a ramp-up to the maximum volume being tested.
3. Brief periods (less than 30 minutes) of operational silence for reasons other than a protected species shut-down did not require a ramp-up to resume full volume source operations provided that: (1) PSOs maintained constant visual observation, and (2) no detections of protected species occurred within the applicable exclusion zone during that silent period. For any brief period of silence at night or in periods of poor visibility (e.g., BSS of four or greater), a ramp-up was required, but if constant observation was maintained, a pre-start clearance watch was not required. For any longer shutdown, both a pre-start clearance watch by a visual PSO and PAM operator and a ramp-up were required.

Table 3 describes the predicted 160 decibel radius (Level B harassment zone for marine mammals) and the predicted 175 decibel radius (Level B harassment zone for sea turtles) where the predicted distance for the source was used.

**Table 3: Predicted 160 and 175 decibel zones* implemented during the survey.**

| Source | Volume ($in^3$) | Water Depth (m) | 160 dB radius (m) – Level B harassment zone for marine mammals | 175 dB radius (m) – Level B harassment zone for sea turtles |
|---|---|---|---|---|
| 18 elements | 3300 | > 1000 | 2886 | 609 |
| 18 elements | 3300 | 100-1000 | 4329 | 909 |
| *Distances are from any single element on the array | | | | |

## 3.2 Visual Monitoring Survey Methodology

There were five experienced PSOs on board the *MGL* during the seismic survey to conduct monitoring for protected species, record and report detections, and request mitigation actions in accordance with the IHA and BiOp. The PSOs on board were NMFS approved and held certifications from a recognized Bureau of Ocean Energy Management (BOEM) PSO course. The PSOs that were onboard the *MGL* are listed in Appendix B. Visual monitoring was primarily carried out from an observation tower (Figure 2) located 18.9 meters above the surface of the water, which allowed a 360-degree viewpoint around the vessel and acoustic source.

**Figure 2: Protected Species Observer stern view of observation tower with mounted big-eye binoculars.**

The PSO tower was equipped with Fujinon 7x50 and Steiner Marine 7x50 binoculars, as well as two mounted 25x150 Big-eye binoculars for visual monitoring. A D-300-2MS Night Optics USA, Inc. monocular and two Butler Creek PVS-7-night vision devices were also available for visual monitoring during reduced/restricted lighting conditions if needed. Inside the tarpaulin tent the PSOs were provided a laptop, a telephone for communication with the PAM station, bridge, and main lab, and a monitor that displayed pertinent information about the vessel including position; speed; heading; water depth; sea temperature, wind speed and direction, and air temperature. The monitor also displayed source activity information including survey line number, total number of active elements and volume. Environmental conditions along with vessel and acoustic source activity were recorded at least once an hour, and every time there was a change in one or more of the above variables. Most visual monitoring was held from the tower; however, during severe weather or when the ships exhaust was blowing on the tower, monitoring would be conducted from the bridge (approximately 12.8 meters above sea level) or the catwalk (approximately 12.3 meters above sea level). Visual monitoring methods were implemented in accordance with the survey requirements outlined in the IHA. A minimum of two PSOs were required to be on duty and always conducting monitoring during daylight hours, from when the vessel departed port to when the vessel returned to port. Visual monitoring during the transits between ports and survey area were conducted for VSA and to gather baseline data on the presence and abundance of protected species in the areas during periods of acoustic source silence. Scheduled watches were a maximum of four hours followed by at least one hour of scheduled break time.

Visual observations were conducted around the entire area of the vessel and acoustic source, divided between the two PSOs on watch. The smaller monitoring area for each observer increased the probability of protected species being sighted. PSOs searched for blows, fins, splashes or disturbances of the sea surface, large flocks of feeding sea birds, and other sighting cues indicating the possible presence of a protected species. Upon the visual detection of a protected species, PSOs would identify the animals' range to the vessel and acoustic source. Range estimations were made using reticle binoculars, the naked eye, and by relating the animal(s) to an object at a known distance, such as the acoustic source arrays and streamer head float. PSOs would also identify to species, if possible, upon initial detection to ensure that the proper mitigation measures were implemented, should any be required.

As required by the IHA (section 5(d)(iii)), PSOs recorded the following information for each protected species detection:

I. Date, time of first and last sighting, observers on duty during the detection, location of the observers, vessel information (e.g., position, speed, heading), water depth, and acoustic source activity (e.g., volume and number of active elements).

II. Species, detection cue, group size (including number of adults, juveniles, and calves), visual description (e.g., overall size, shape of the head, position and shape of the dorsal fin, shape of the flukes, height, and direction of the blow), observed behaviors (e.g., porpoising, logging,

diving, etc.), and the initial and final pace, heading, bearing, and direction of travel in relation to both the vessel and the source (e.g., towards, away, parallel, perpendicular, etc.).

III. Initial, closest, and final distance to the vessel and the source, time when entering and exiting the exclusion zones, type of mitigation action implemented, total time of the mitigation action, description of other vessels in the area, and any avoidance maneuvers conducted.

During or immediately after each sighting event, the PSOs recorded the detection details per the requirements of the IHA in a detection datasheet. Each sighting event was linked to an entry on an effort datasheet where specific environmental conditions (e.g., Beaufort Sea state, wind force, swell height, visibility, and glare) and vessel activity were logged.

Species identifications were made whenever the distance from the observer, length of the sighting, and visual observation conditions allowed. Whenever possible during detections, photographs were taken with Canon EOS 80D cameras that had 300-millimeter lenses. Marine mammal identification manuals (*Whales, Dolphins, and Other Marine Mammal of the World; Guide to Marine Mammals of the world; Readers Digest Whales, Dolphins, and Porpoises; Seabirds of the world; Sibley Guide to Birds*) were consulted, and photos were examined to confirm identifications were consulted, and photos were examined to confirm identifications.

## 3.3 Passive Acoustic Monitoring Methodology

Passive Acoustic Monitoring (PAM) was used to augment visual monitoring efforts in the detection, identification, and locating of marine mammals. PAM is important during periods of time when visual monitoring was not effective (periods of darkness or low visibility). Acoustic monitoring was conducted continuously during all seismic operations and to the maximum extent possible during periods of acoustic source silence. When the acoustic source was activated from any period of silence, acoustic monitoring was conducted for at least 30 minutes prior to the activation of the source for the pre-clearance survey. PAM shifts were a maximum of four hours in duration followed by at least one hour of scheduled break time.

In accordance with the NMFS issued IHA and ITS, in the event of an issue with PAM equipment, acoustic source activity could continue for 30 minutes without acoustic monitoring while the PAM operator diagnosed the issue. If the diagnosis indicated that the PAM system needed maintenance, operations could continue for an additional five hours without acoustic monitoring, during daylight hours only, provided that: (1) the sea state was less than or equal to a BSS 4; (2) with the exception of delphinids, no marine mammals were acoustically detected in the applicable exclusion zones in the previous two hours; (3) active acoustic source operations without acoustic monitoring did not exceed a cumulative total of five hours within any 24 hour period; and (4) NMFS was notified via email as soon as practicable of the time and location in which operations occurred without an active PAM system.

The PAM system was located in the main science lab which allowed ample space, quick communication with the PSOs and seismic technicians, and access to the vessel's instrumentation screens. Information about the vessel (e.g., position, heading, and speed), water depth, source activity (e.g., line number, total source volume, number of active elements), and the PAM system (e.g., cable deployments/retrievals, changes to the system, background noise score, hydrophone depth) were recorded at least once an hour, and whenever any of the parameters changed.

Acoustic monitoring for marine mammals was conducted aurally, utilizing Sennheiser headphones, and visually with the PAMGuard software program. Low frequency (LF) to mid-frequency delphinid whistles, clicks, and burst pulses, as well as sperm whale clicks and baleen whale vocalizations, could be visualized in PAMGuard's spectrogram modules. Sperm whale, beaked whale, Kogia species, and delphinid clicks could also be visualized in LF and HF click detector modules. Settings adjustments to amplitude range, amplitude triggers, and spectral content filters, among others, could be made in PAMGuard's spectrogram and click detector modules to maximize the distinction between cetacean vocalizations and ambient signal. The map module within PAMGuard could be utilized to attempt localizing the position and range of vocalizing marine mammals. Sound recordings could be made using the HF and LF sound recording modules when potential marine mammal vocalizations were detected, or when the operator noted unknown or unusual sound sources.

As required by the IHA (section 5(d)(iv)), PAM operators recorded the following information during acoustic detections of protected species:

I. An acoustic encounter identification number, and whether the detection was linked with a visual sighting;
II. Date and time when first and last heard;
III. Types and nature of sounds heard (e.g., clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal);
IV. Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, and any other notable information.

### 3.3.1 Passive Acoustic Monitoring Parameters

A PAM system designed to detect most species of marine mammals was installed on board the *MGL*. The system was developed by Seiche Measurements Limited and consisted of the following main components: a 255 meter hydrophone cable (configured as a separate 230 meter steel-reinforced tow cable and detachable 25 meter hydrophone array); a 100 meter deck cable; a rack-mounted electronic processing unit (EPU) that incorporated a buffer unit, RME Fireface 800 unit and computer; two desktop monitors; a keyboard and mouse; acoustic analysis software package; and headphones for aural monitoring. A complete spare system of all components was also present on board in the event that any of the main system components became damaged or inoperable. The diagram in Figure 3 is a simplified depiction of the PAM system installed on the *MGL*, and further PAM system specifications can be found in Appendix D.

The hydrophone cable contained six hydrophone elements and a depth gauge molded into a 25-meter section of the cable. The six-element linear hydrophone array allowed the system to sample a large range of marine mammal vocalization frequencies. The hydrophone pair closest to the end by the depth gauge were used for low frequencies between 10 hertz and 24 hertz, the middle hydrophone pair was used for mid frequencies between 200 hertz and 200 kilohertz, and the forward hydrophone pair closest to the connector to the tow cable was used for high frequencies between two kilohertz and 200 kilohertz.

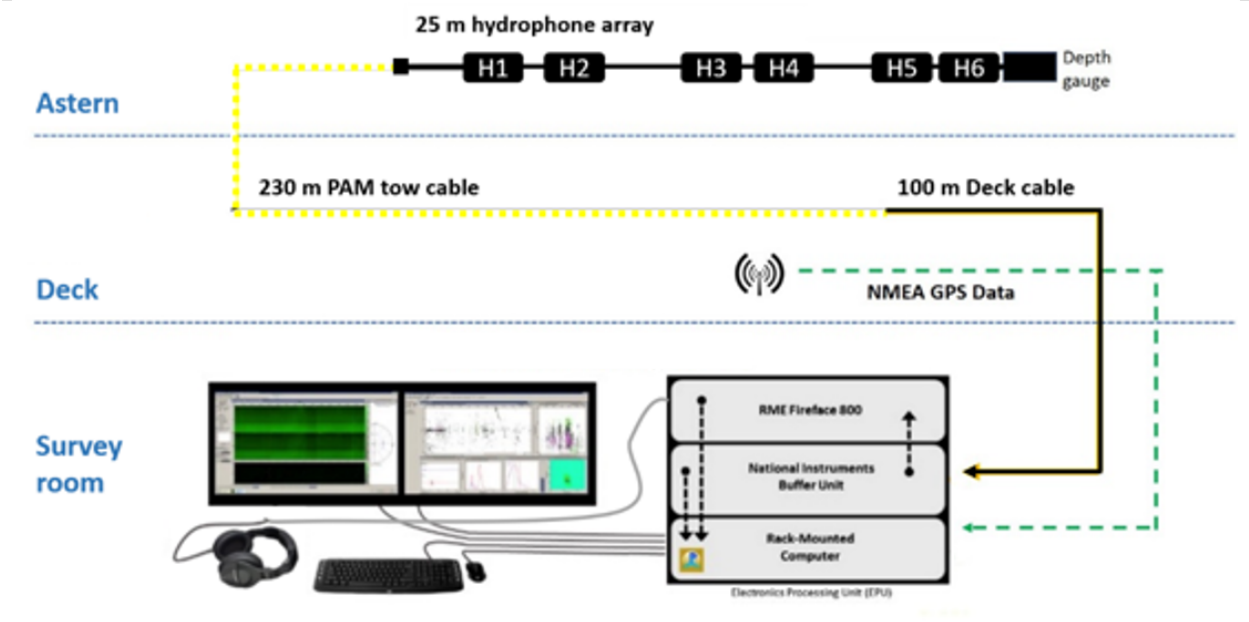


**Figure 3: Simplified pathway of data through the PAM system onboard the *MGL***

The deck cable interfaced between the hydrophone cable deployed astern of the vessel and the electronics processing unit (EPU) located in the main science lab. The rack-mounted EPU was set up with the two pre-installed, wall-mounted monitors supplied by the *Langseth*, a keyboard, a mouse, and headphones. The EPU contained a buffer unit with Universal Serial Base (USB) output, an RME Fireface

800 ADC unit with firewire output, and a rack-mounted computer. A Global Positioning System (GPS) feed of GNGGA strings was supplied from the ship's Seapath navigation system and routed to the computer, reading data every five seconds. Data from the hydrophone cable's depth transducer was routed through the buffer unit to the computer, via USB connection. PAMGuard *Beta* version 1.15.11 was the software version utilized for the survey until 22 May 2022, at which time version 1.15.17 was installed and utilized for the remainder of the survey.

Raw feed from the two high frequency hydrophone elements was digitized in the buffer unit using an analogue-digital National Instruments data acquisition (DAQ) soundcard at a sampling rate of 500 kilohertz. The output was filtered for HF content and visualized using the PAMGuard software, which used the difference between the time that a signal arrived at each of the two hydrophones to calculate and display the bearing to the source of the signal. A scrolling bearing/time module displayed the filtered data in real time, allowing for the detection and directional mapping of click trains. Additional components of the HF click detector system in PAMGuard included: an amplitude/time display that registered click intensity data in real time, as well as click waveform, click spectrum, and Wigner plot displays, providing the PAM operator immediate review of individual click characteristics in the identification process.

Raw feed from the two low frequency and two mid frequency hydrophone elements was routed from the buffer unit to the RME Fireface 800 unit, where it was digitized at a sampling rate of 48 kilohertz. The relatively low frequency (LF) output was further processed within PAMGuard by applying Engine Noise Fast Fourier Transform (FFT) filters, including click suppression and spectral noise removal filters (e.g., median filter, average subtraction, Gaussian kernel smoothing and thresholding). Filtered LF content was visualized in two spectrograms, one displaying a channel feed at frequency ranges of zero to 24 kilohertz, and another displaying a channel feed at a frequency range of zero to three kilohertz. LF click detector modules allowed for review of individual click characteristics as well as the detection and tracking of click trains.

A map module on the LF system interfaced with GPS data provided by the vessel to display the vessel location and could be used to determine range and bearing estimates based on clicks tracked in the click detector module. PAMGuard contained a function for calculating the range to vocalizing marine mammals based upon the least squares fit test. This method is most effective with animals that are relatively stationary in comparison to the moving vessel, such as sperm whales. The mathematical function estimated the range to vocalizing marine mammals by calculating the most likely crossing of a series of bearing lines generated from tracked clicks or whistles and plotted on a map display. The bearings of detected whistles and moans were calculated using a Time-of-Arrival-Distance (TOAD) method (where the signal time delay between the arrival of a signal on each hydrophone was compared), and presented on a radar display, along with amplitude information for the detected signal as a proxy for range.

Additional modules displayed on the LF monitor included a LF sound recorder and clip generator. The clip generator module within PAMGuard could be used to generate short sound clips in response to either an automatic detection or the operator manually selecting a portion of the spectrogram display. This module was useful in the event that the whistle-and-moan detector falsely triggered and identified a non-biological sound (i.e., echosounder) or if it missed detecting tonal signatures that the operator determined to be vocalizations.

### 3.3.2 Hydrophone Deployment

The hydrophone cable was deployed from a hydraulic winch on the port stern of the vessel's aft deck where the acoustic source arrays were deployed. Two deck cables, a main and a spare, were installed along the deck-head running from the winch to the main science lab. A Chinese finger attached to the tow cable approximately 125 meters ahead of the connector to the hydrophone array was secured to the port side boom via lifting rope. This reduced the tension on the cable remaining on the winch and served as a method to pull the cable further to port and away from the source arrays. This deployment method placed the trailing end of the hydrophone cable approximately 125 meters from the port stern of the vessel (Figure 4). One piece of chain of seven kilograms was attached and secured to the tow cable to increase tow depth and to decrease the chance of entanglement with the source arrays' umbilicals. The tow depth of the hydrophones varied between 12.7 and 23 meters and averaged 15.3 meters throughout the seismic survey.

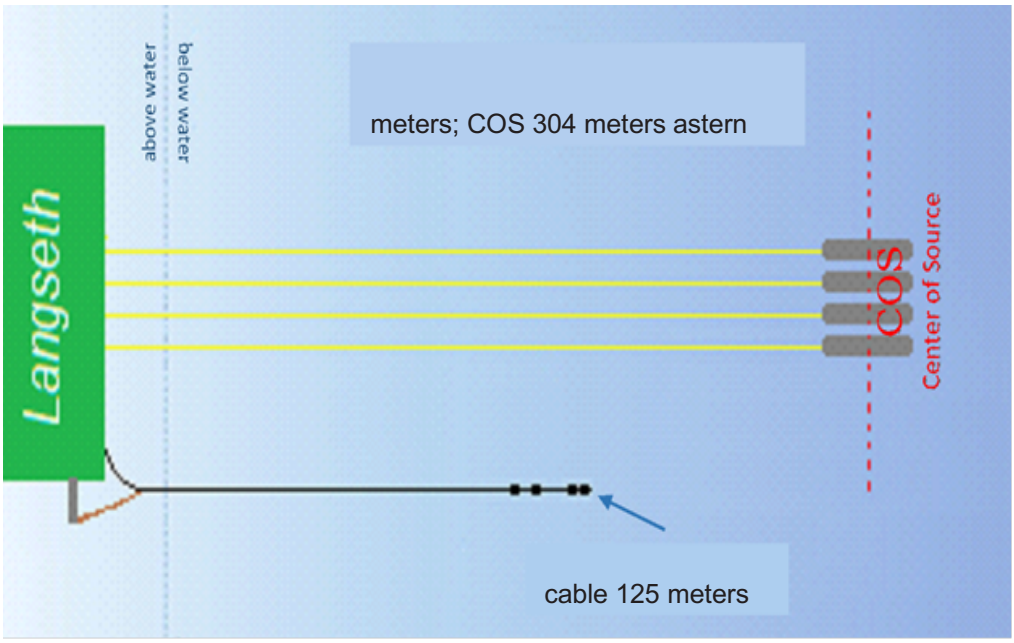


**Figure 4. Location of the PAM cable in relation to the seismic gear during the survey.**

# 4 MONITORING EFFORT SUMMARY

## 4.1 Survey Operations Summary

### 4.1.1 General Survey Parameters

The Cape Fear seismic survey began on 09 May 2023, when the *MGL* departed port in Norfolk, Virginia. Seismic data acquisition operations were conducted between 11 May and 02 June. The survey concluded on 03 June 2023, when the vessel arrived back at port in Morehead, North Carolina (Table 4).

**Table 4: Survey parameters.**

| Survey Parameter | Date | Time (UTC) | Location |
|---|---|---|---|
| Mobilization | 09 May 2023 | 17:15 | Norfolk, Virginia |
| First seismic source activity | 11 May 2023 | 09:03 | Survey area |
| Start of acquisition | 11 May 2023 | 09:59 | Survey area |
| End of acquisition | 02 June 2023 | 14:00 | Survey area |
| Transit to Morehead | 02 June 2023 | 23:37 | Survey area |
| Arrive in Morehead | 03 June 2023 | 13:00 | Morehead, North Carolina |

During the seismic survey, data was acquired continuously according to the survey plan, with source operations only suspended when there were mechanical or technical issues.

**Table 5: Suspension of source operations during the survey.**

| Date | Time Source Silenced | Date | Time Source Re-activated | Reason for Interruption to Acquisition |
|---|---|---|---|---|
| 19 May 2023 | 19:59 | 20 May 2023 | 12:26 | Stop acquisition for mechanical issues |
| 26 May 2023 | 16:10 | 27 May 2023 | 02:16 | Stop acquisition for mechanical issues |

### 4.1.2 MBES, SBP, and ADCP Operations

The multi-beam echosounder (MBES), sub-bottom profiler (SBP), and the Acoustic Doppler current profiler (ADCP) systems were active throughout the survey for a total of 1753 hours 28 minutes. The SBP was active for the first time on 09 May 2023 at 20:18 UTC. The ADCP was active for the first time on 09 May at 21:30 UTC. The MBES was active for the first time on 09 May at 21:30 UTC. All the sound sources were active during transit and throughout the survey. The ADCP, SBP, and MBES were all disabled on 03 June at 07:18 UTC. All three sound sources were disabled and re-enabled multiple times throughout the survey, mainly for technical issues.

### 4.1.3 Acoustic Source Operations

The acoustic source was active for a total of 497 hours and 44 minutes throughout the survey. This total included: two hours and 58 minutes of ramp-up, 425 hours and 44 minutes of operations on a survey line at full volume, 55 hours and 33 minutes at reduced volume on a survey line, 11 hours and 17 minutes of operations not on a survey line at full volume, two hours and six minutes at reduced volume not on a survey line and six minutes of source testing.

Table 6 summarizes the acoustic source operations over the course of the seismic survey.

The acoustic source was ramped up eight times during the survey to commence data acquisition. seven ramp-ups were cleared by visual and acoustic monitoring while one was cleared solely by acoustic monitoring for a brief technical silence at night (less than 30 minutes). Four ramp-ups occurred at night and four ramp-ups occurred during the day. The duration of all ramp-ups was between 21 and 23 minutes.

There was one occasion of source testing. It consisted of a multi-source test at the end of a survey line.

**Table 6: Total acoustic source operations during the survey.**

| | | |
|---|---|---|
| **Source Tests** | 1 | 00:06 |
| **Ramp-up** | 8 | 02:58 |
| Day-time ramp-ups | 4 | 01:29 |
| Night-time ramp-ups | 4 | 01:29 |
| **Full (3300 $in^3$)/Reduced Volume on a Survey Line** | | 425:44/55:33 |
| **Full (3300 $in^3$)/Reduced Volume not on a Survey Line** | | 11:17/02:06 |
| | | |

The geospatial data for source operations are provided as a shapefile attachment to this report.

The monitoring effort, source operations and protected species detections for this survey are provided as an excel dataset in Appendix C and the basic data summary form found in Appendix D.

### 4.1.4 Interactions with Other Vessels

In addition to visually monitoring for protected species, PSOs also observed and documented interactions with other marine vessel traffic. Such interactions included but were not limited to another vessel or another vessels' towed gear/equipment interacting with the *MGL's* towed gear/equipment, and the *MGL* having to deviate from planned survey operations (i.e., diverge from the survey line, increase/decrease speed) because of another vessel.

There were no instances where the *MGL* had such an interaction with another vessel during the survey.

## 4.2 Visual Monitoring Survey Summary

Visual monitoring was conducted by two PSOs during all daylight hours, beginning 30 minutes before sunrise and ending 30 minutes after sunset each day, initiating when the vessel left dock at the beginning of the program and terminating upon the vessels return to dock at the end of the program (Table 7). During transit, observations were undertaken by two PSOs for VSA and visual monitoring during times with no source operations was conducted to collect baseline data about protected species abundance in the survey areas.

**Table 7: Initiation and termination of visual monitoring during the survey.**

| | | |
|---|---|---|
| Initiation for the survey | 09 May 2023 | 17:15 |
| Termination for the survey | 03 June 2023 | 13:00 |

Visual monitoring on the *MGL* was conducted over a period of 26 days for a total of 372 hours and 40 minutes. Of the overall total visual monitoring effort, 84% (313 hours and 25 minutes) was undertaken while the acoustic source was active, and 16% (59 hours and 15 minutes) was undertaken while the acoustic source was silent. Visual monitoring while the acoustic source was silent was mainly conducted during the transits. Table 8 details visual monitoring with acoustic source operations on the *MGL* throughout the seismic survey.

**Table 8: Total visual monitoring effort during the survey.**

| Visual Monitoring Effort | Duration (hh:mm) | % of Overall Effort |
|---|---|---|
| Total monitoring while acoustic source active | 313:25 | 84 |
| Total monitoring while acoustic source silent | 59:15 | 16 |
| **Total monitoring effort** | 372:40 | - |

## 4.3 Acoustic Monitoring Survey Summary

Acoustic monitoring was conducted continuously throughout acoustic source operations and to the maximum extent possible while the acoustic source was silent (Table 9). Periods without source activity or acoustic monitoring occurred when the PAM hydrophone cable was secured on board the vessel during transits, during deployment and recovery of the seismic gear, and during times when operations were suspended due to rough weather and sea conditions or gear maintenance.

**Table 9: Initiation and termination of acoustic monitoring watches during survey.**

| Acoustic Monitoring | Date | Time (UTC) |
|---|---|---|
| Initiation for the survey | 11 May 2023 | 04:50 |
| Termination for the survey | 02 June 2023 | 15:25 |

Acoustic monitoring was conducted on 23 days for a total of 518 hours and 50 minutes. Of the overall total acoustic monitoring effort, 96% (497 hours and 44 minutes) was undertaken while the acoustic source was active, and 4% (21 hours and six minutes) was undertaken while the acoustic source was silent. Acoustic monitoring while the acoustic source was silent was mainly conducted during the brief periods of time between recovery/deployment of the seismic gear and recovery/deployment of the PAM cable. Table 10 details acoustic monitoring with acoustic source operations.

**Table 10: Total Passive Acoustic Monitoring (PAM) effort during the survey.**

| Acoustic Monitoring Effort | Duration (hh:mm) | % of Overall Effort |
|---|---|---|
| Total monitoring while the acoustic source was active | 497:44 | 96 |
| Total monitoring while the acoustic source was silent | 21:06 | 04 |
| **Total acoustic monitoring** | **518:50** | |

## 4.4 Simultaneous Visual and Acoustic Monitoring Summary

Simultaneous visual and acoustic monitoring was conducted to the maximum extent possible for a total of 327 hours and 15 minutes. Of the overall simultaneous monitoring effort, 96% (313 hours and 25 minutes) was conducted while the acoustic source was active (Table 11). Additional visual monitoring conducted during transit periods was not accompanied by acoustic monitoring as the increased vessel speed would causes the hydrophone cable to migrate to the water surface, out of the ideal tow position, where increased background noise would impair acoustic detection capabilities.

**Table 11: Simultaneous visual and acoustic monitoring effort during the survey.**

| Simultaneous Visual and Acoustic Monitoring | Duration (hh:mm) | % of Overall Downtime |
|---|---|---|
| Source Active | 313:25 | 96 |
| Source Silent | 13:50 | 04 |
| **Overall Total** | **327:15** | |

## 4.5 Environmental Conditions

Environmental conditions can have an impact on the probability of detecting protected species. The environmental conditions present during visual observations undertaken during the survey program were generally considered to be 'excellent.'

Visibility was classified as 'excellent' if it extended greater than 10 kilometers and 'very good' if it was between seven and 10 kilometers. 73% and 12% of monitoring effort on the *MGL* was undertaken at 'excellent' and 'very good' visibility levels, respectively (Table 12). The entire predicted harassment zone radii, BZs, and EZs were not visible on multiple occasions, mainly due to precipitation and reduced lighting before sunrise and after sunset and during night-time visual monitoring. During these times, it is possible that protected species were not detected within these zones.

**Table 12: Visibility during the survey (in kilometers).**

| Total | <0.05 | 0.05-0.1 | 0.1-0.3 | 0.3-0.5 | 0.5-1 | 1-2 | 2-5 | 5-7 | 7-10 | >10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Duration (hh:mm) | 00:00 | 00:53 | 02:13 | 04:50 | 04:24 | 11:19 | 06:29 | 25:09 | 44:58 | 272:25 |

Reduced visibility was mainly attributed to periods of heavy rain, the brief periods of reduced lighting before sunrise and after sunset, and any time visual monitoring was required for a nighttime ramp-up. Precipitation was recorded during visual monitoring on the *MGL* for a total of 53 hours 31 minutes. Most of the precipitation recorded was light rain (50%) or haze (28%) (Table 13).

**Table 13: Precipitation during the survey.**

| Total | None | Heavy Rain | Moderate Rain | Light Rain | Heavy Fog | Moderate Fog | Thin Fog | Haze | Sleet | Snow |
|---|---|---|---|---|---|---|---|---|---|---|
| Duration (hh:mm) | 319:09 | 03:56 | 03:54 | 26:37 | 00:00 | 01:08 | 03:05 | 14:51 | 00:00 | 00:00 |

The Beaufort Sea State recorded during visual monitoring ranged from level one to level seven. Most visual observations on the *MGL* were undertaken in conditions where the BSS was level three (37%) or level four (25%), which were considered 'good' conditions for the detection of protected species (Table 14).

**Table 14: Beaufort Sea State during the survey.**

| Total | B0 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 | B9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Duration (hh:mm) | 00:00 | 01:45 | 62:46 | 139:08 | 93:17 | 42:46 | 20:58 | 12:00 | 00:00 | 00:00 |

Wind speeds recorded visual monitoring ranged between one and 34 knots. Most of the visual monitoring on the *MGL* occurred during recorded wind speeds less than 10 knots (25%) and from 10 to 15 knots (27%) (Table 15).

**Table 15: Wind speed during the survey.**

| Total | <10 | 10-15 | 16-20 | 21-25 | 26-30 | >31 |
|---|---|---|---|---|---|---|
| Duration (hh:mm) | 94:09 | 102:24 | 89:31 | 52:24 | 26:42 | 7:30 |

Swell heights during visual observations were generally low, with swells of less than two meters recorded for the majority of visual observations (84%) (Table 16).

**Table 16: Swell height during the survey.**

| Total | <2m | 2-4m | >4m |
|---|---|---|---|
| Duration (hh:mm) | 313:15 | 59:25 | 0:00 |

Visual monitoring was conducted primarily when no glare (32%) was present (Table 17). During times of moderate to severe glare, it is possible that the detection of protected species was hindered.

**Table 17: Glare during the survey.**

| Total | None | Mild | Moderate | Severe |
|---|---|---|---|---|
| Duration (hh:mm) | 120:14 | 72:03 | 83:19 | 97:04 |

# 5 MONITORING AND DETECTION RESULTS

## 5.1 Visual Detections

Visual monitoring efforts during the survey program resulted in a total of three visual detections events of protected species totaling six individuals (summarized in Appendix E). This total included two detections of dolphins and one detection of a sea turtle.

Table 18 lists the total number of detections and total number of animals recorded for each protected species observed during the survey. Photographs taken of visual detections can be found in Appendix F.

Maps of the detections of the protected species are shown in Figure 5.

**Table 18: Number of visual detection records collected for each protected species during the survey.**

| Species | Total Number of Detection Records | Total Number of Animals |
|---|---|---|
| **Dolphins** | | |
| Bottlenose dolphins | 1 | 3 |
| Unidentified dolphin | 1 | 2 |
| **Sea turtles** | | |
| Unidentified sea turtle | 1 | 1 |
| **Total** | **3** | **6** |

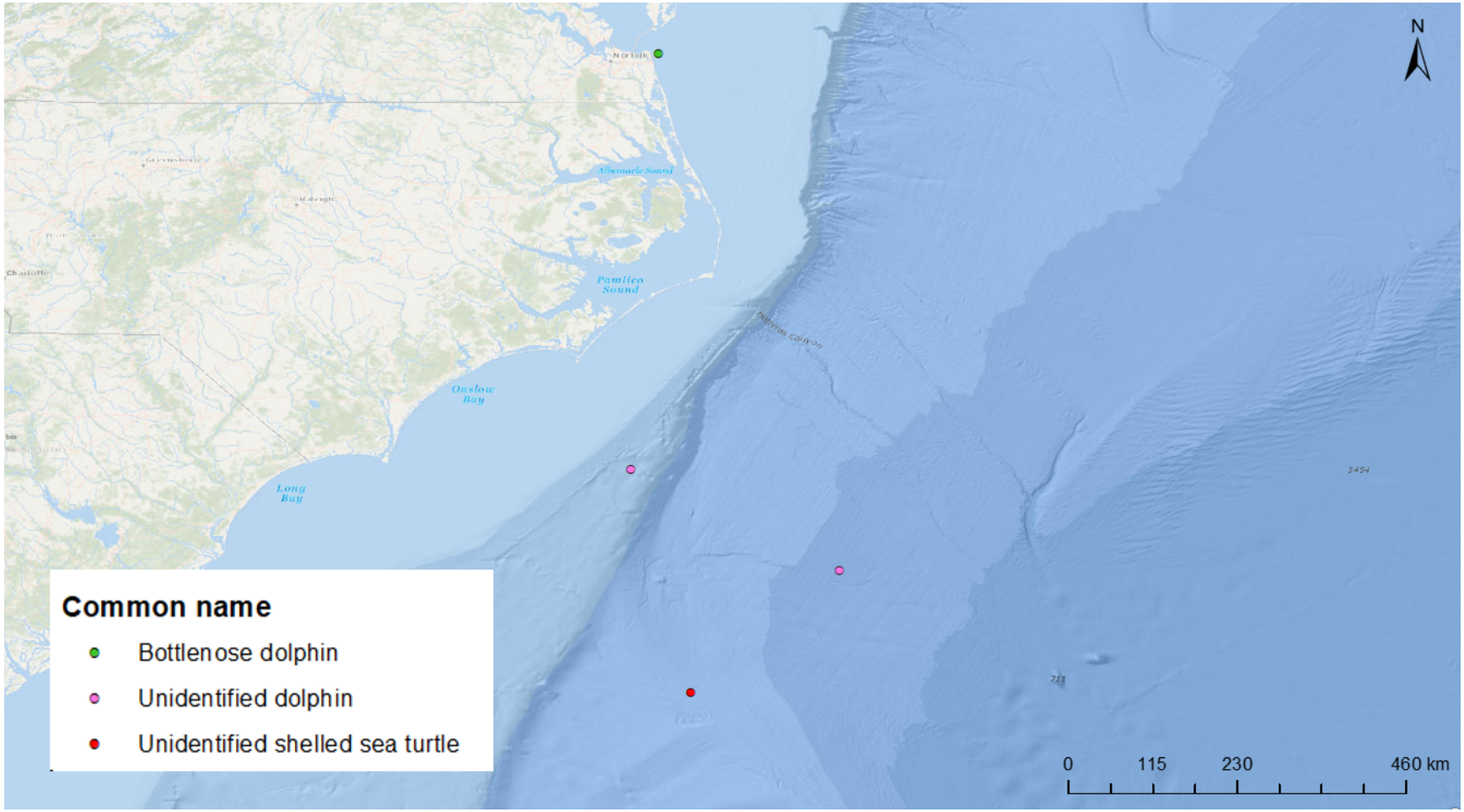


**Figure 5: All protected species detections observed by common name during the survey.**

Of the three visual detections, two detections occurred while the acoustic source was deployed and active and one detection occurred while the vessel was in transit to the survey area. The acoustic source was not deployed during this detection, therefore there is no mean closest observed approach to the source. Table 19 lists the number of each species detected during each different source activity described above as well as the species average closest approach to the source during those times. The closest distance to the source was not recorded while the source was not deployed for the remaining one detection of the three. Detections occurred in water depths ranging between 542 and 2797 meters.

**Table 19: Average closest approach of protected species to the acoustic source during the survey.**

| Species Detected | Regulated Source Active | | Regulated Source Inactive | |
|---|---|---|---|---|
| | Number of detections | Mean closest observed approach to source (meters) | Number of detections | Mean closest observed approach to source (meters) |
| Bottlenose Dolphin | - | - | 1 | - |
| Unidentified dolphin | 1 | 106 | - | - |
| Unidentified sea turtle | 1 | 160 | - | - |

In general, dolphins detected during the survey program were mainly observed porpoising and swimming below the surface while traveling at sedate or moderate paces away from or in the opposite direction as the vessel. The sea turtle detected during the survey program was mainly observed swimming below the surface and diving while traveling at a sedate pace in the opposite direction as the vessel.

### 5.1.1 Other Wildlife

Observations of other wildlife included 16 species of birds, two species of fish and one species of invertebrates. A complete list of birds and other marine wildlife 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 G. No adverse impacts to any other wildlife species as a result of research activities were observed.

## 5.2 Acoustic Detections

There was one acoustic detection of protected species during the survey program, which consisted of unidentifiable dolphins. The detection included one individual and occurred in water depths between 4412 meters. This detection occurred during hours of darkness with no ongoing visual monitoring. This detection occurred while the seismic source was active at full volume. The single acoustic detection consisted of high frequency click trains. This detection was unable to be tracked due to a short duration.

# 6 MITIGATION ACTION SUMMARY

There was one mitigation action implemented, a shutdown of the active source due to an unidentified sea turtle observed swimming below the surface and approaching its EZ at 160 meters. At the time of the detection, the source was at full volume on a survey line. The individual was initially observed swimming below the surface at a sedate pace, parallel and in the opposite direction as the vessel, 50 meters from the starboard beam and 335 meters from the active acoustic source. As the individual was observed entering the 150-meter exclusion zone, a shutdown of the active source was requested and immediately implemented. The closest distance to the active source was 160 meters, whilst the closest distance to the silent source was 150 meters. The sea turtle was not observed leaving the EZ, thus clearance was given to resume source activity 16 minutes after the mitigation shutdown. In this instance, source activities were able to resume full volume after the given clearance period without a ramp-up, per the BiOp.

## 6.1 Vessel Strike Avoidance (VSA) Maneuvers

There were no VSA measures implemented for protected species during the survey.

## 6.2 Protected Species Known to Have Been Exposed to 160 Decibels or Greater of Received Sound Levels

Numerous protected species are known to occur within the survey area, including 10 species listed as endangered or threatened under the ESA. These species included four marine mammals; blue whale, fin whale, sei whale and sperm whale, four marine reptiles; green sea turtle, Kemp's Ridley sea turtle, leatherback sea turtle and loggerhead sea turtle. NSF came to a "no effect" determination for seabirds due to their unlikely presence; however, PSOs monitored for two ESA-listed sea birds, Bermuda petrel and roseate tern, in the unlikely event they were encountered in the survey area.

NMFS granted an IHA, which included an ITS, for the marine seismic survey authorizing a total of 7211 individuals from 26 species or species groups, including nine species of whales and 17 delphinid species. four species of sea turtles. Four species of whales are listed as endangered or threatened. One species group, consisting of Kogia species, was authorized for Level A harassment takes (exposure to sound pressure levels where there is a potential for auditory injury based upon each species hearing range). All individuals were authorized for Level B harassment takes (exposure to sound pressure levels equal to or greater than 160 dB re: 1 µPa rms) where there is a potential for behavioral changes), including 419 takes for endangered/threatened species.

During acoustic source operations, two marine mammals, correlating to two unidentified dolphins, were observed within the predicted 160 decibel radius (where there is a potential for a behavioral response) while the acoustic source was active, constituting potential Level B takes. In addition, one unidentified sea turtle was observed within the predicted 160 decibel radius. There were no protected species observed within the predicted radius at which there is a potential for auditory injury (based upon each species hearing range and how that overlaps with the frequencies produced by the sound source), constituting potential Level A takes/exposures.

The number of potential takes may be an underestimation and, therefore, may be a minimum estimate of the actual number of protected species potentially exposed to received sound levels within the predicted Level A and Level B harassment zones. It is possible that the estimated numbers of animals recorded were underestimates due to some individuals not being visually sighted or having moved away before they were observed (Table 20).

**Table 20: Number of authorized and potential Level A and B harassment takes / exposures during the survey.**

| Species | IHA Authorized Level B Takes/ Exposures | Total Potential Takes/ Exposures During Seismic operations |
|---|---|---|
| Humpback whale | 2 | - |
| Fin whale | 4 | - |
| Sei whale | 8 | - |
| Minke whale | 10 | - |
| Blue whale | 1 | - |
| Sperm whale | 406 | - |
| Kogia spp. | 678 | - |
| Cuvier's beaked whale | 396 | - |
| Mesoplodont beaked whales whale | 420 | - |
| Pilot whale | 385 | - |
| Rough-toothed dolphin | 82 | - |
| Bottlenose dolphin | 1477 | - |
| Atlantic white-sided dolphin | 14 | - |
| Pantropical spotted dolphin | 114 | - |
| Atlantic spotted dolphin | 1237 | - |
| Spinner dolphin | 41 | - |
| Clymene dolphin | 79 | - |
| Striped dolphin | 45 | - |
| Fraser's dolphin | 163 | - |
| Risso's dolphin | 189 | - |
| Common dolphin | 56 | - |
| Melon-headed whale | 83 | - |
| Pygmy killer whale | 6 | - |
| False killer whale | 6 | - |
| Killer whale | 4 | - |
| Harbor porpoise | 3 | - |
| Green sea turtle | 251 | - |
| Kemp's Ridley sea turtle | 2 | - |
| Leatherback sea turtle | 2 | - |
| Loggerhead sea turtle | 1047 | - |
| Unidentified dolphin | - | 2 |
| Unidentified sea turtle | - | 1 |

Table 21 describes the behavior of all animals, including unidentified species, which were visually observed within the predicted Level B harassment zones. There were no highly distinctive behavioral reactions observed in relation to the vessel or acoustic source during the seismic survey.

**Table 21: Behavior of species visually observed to be exposed to sound pressure levels of 160 dB or greater during the survey.**

| Species | Detection No. | No. Of Animals | CPA Active Source (meters) | Source Volume ($in^3$) at CPA | Initial Behavior | Initial Direction in Relation to Vessel | Subsequent and Final Behaviors | Final Direction in Relation to Vessel |
|---|---|---|---|---|---|---|---|---|
| Unidentifiable shelled sea turtle | VD02 | 1 | 150 | 3300 | Swimming below surface | Parallel in opposite direction as vessel | Diving | Parallel in opposite direction as vessel |

| Species | Detection No. | No. Of Animals | CPA Active Source (meters) | Source Volume ($in^3$) at CPA | Initial Behavior | Initial Direction in Relation to Vessel | Subsequent and Final Behaviors | Final Direction in Relation to Vessel |
|---|---|---|---|---|---|---|---|---|
| Unidentified dolphin | VD03 | 2 | 106 | 2914 | Porpoising | parallel in opposite direction as vessel | Swimming below surface | away from vessel |

## 6.3 Implementation and Effectiveness of the Biological Opinion and IHA

To minimize the potential impacts to marine mammals during the seismic survey, LDEO and PSOs were prepared to implement mitigation measures whenever these protected species were detected approaching, entering, or within their designated exclusion zones as outlined in the IHA and BiOp. There was one mitigation action implemented for protected species consisting of a shut-down of the sound source for an unidentified sea turtle. The confirmation of the implementation of each term and condition of the project permit documents are described in this report.

If an injured or dead protected species was discovered, the incident was to be reported to the NMFS Office of Protected Resources (OPR), NMFS, and the NMFS Southeast Regional Stranding Coordinator as soon as possible. The report would include a detailed description of the incident (time, date, location, species identification, description of the animal, condition of the animal/carcass, observed behaviors if the animal was alive, and general circumstances under which the animal was discovered), including pictures when possible. There were no sightings of dead or injured protected species during the seismic survey.

To prevent the occurrence of the vessel striking a marine mammal during transits, PSOs and vessel crew members maintained a vigilant watch for marine mammals, and the vessel was prepared to slow down, stop, or alter course as appropriate to avoid striking a protected species. The vessel speed had to be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans were observed near the vessel. The vessel had to maintain the minimum separation distances as described in Table 2. If a marine mammal was sighted during transits, the vessel was to act as necessary to avoid violating the relevant separation distances (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal left the area). If marine mammals were sighted within the relevant separation distances, the vessel was required to reduce speed, shift the engines to neutral, and not engage the engines until the animals were clear of the area. If a whale entered the separation zone while the vessel was stationary, the vessel would not engage the engines until the whale has exited the zone. These requirements did not apply in any case where compliance would create an imminent and serious threat to a person or vessel, or if the vessel was restricted in maneuverability due to towed equipment. There were no instances during the survey where avoidance maneuvers were required to be implemented for protected species detections.

In the event of a ship strike of a marine mammal, the incident was to be reported to NMFS, OPR, and to the Southeast Regional Stranding Coordinator, as soon as feasible. The report would include a detailed description of the incident (date, time, location, species identification, description of the animal(s) involved, vessel speed leading up to the incident, vessel's course/heading and what operations were being conducted, status of all sound sources in use, description of avoidance measures taken if any, environmental conditions, description of the animals behavior preceding and following the strike, and estimated fate of the animal), including pictures when possible. There were no instances of the vessel striking a protected species during the survey.

PSOs likely did not detect all animals present; however, it is highly unlikely that the actual number of animals present during survey operations reached anywhere near the fully authorized levels for all species. The combination of conservative predicted mitigation zones combined with conservative take estimation by NMFS (*i.e.,* the precautionary approach), appears for most species to have resulted in an overestimation of take and of overall impact on marine species from the activity. The monitoring and mitigation measures required by the IHAs appear to have been an effective means to protect the marine species encountered during survey operations.

# **Appendix A**: Incidental Harassment Authorization

# **Appendix B**: Protected Species Observers Onboard the *MGL*

# **Appendix C**: Complete Survey Raw Datasheets (Provided in Attached File in Excel Format)

# **Appendix D**: Basic Data Summary Form

# **Appendix E**: Summary of Visual Detections of Protected Species During the Survey

# **Appendix F**: Photographs of Visual Detections During the Survey

# **Appendix G**: Photographs of Acoustic Detections During the Survey

# **Appendix H**: Birds and Other Wildlife Observed During the Survey