



Protected Species Mitigation and Monitoring Report

Marine Geophysical (Seismic) Survey
Northwest Atlantic Ocean – United States

08 August- 28 August 2018
R/V Hugh R. Sharp

Prepared for:
USGS
for submission to:
National Marine Fisheries Service, Office of Protected Resources
1315 East-West Hwy, Silver Spring, MD 20910-3282

Project No.	200126	RPS
Authors	Bianca Mares, Lilia Oyosa, Lluvia Durantes	1160 Dairy Ashford Rd, Suite 500
		Houston, Tx 77079
Reviewer(s)	Megan McManus	Tel : (281) 448-6188 Fax : (281) 448-6189
Submittal Date	2018	E-mail : Megan.mcmanus@rpsgroup.com
		Web : www.rpsgroup.com

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY	4
2. INTRODUCTION	6
2.1. PROJECT OVERVIEW AND LOCATION	6
2.1.1. Energy Source and Receiving Systems	8
3. MITIGATION AND MONITORING METHODS	9
3.1. MITIGATION METHODOLOGY	9
3.2. VISUAL MONITORING SURVEY METHODOLOGY	10
4. MONITORING EFFORT SUMMARY	13
4.1. SURVEY OPERATIONS SUMMARY	13
4.1.1. General survey parameters	13
4.1.2. Airgun operations	13
4.2. VISUAL MONITORING SURVEY SUMMARY	14
4.3. ENVIRONMENTAL CONDITIONS	15
5. MONITORING AND DETECTION RESULTS	17
5.1. VISUAL DETECTIONS	17
5.1.1. Other Wildlife	19
6. MITIGATION ACTION SUMMARY	20
6.1. MARINE MAMMALS KNOWN TO HAVE BEEN EXPOSED TO 160 DB / 175 DB OF RECEIVED SOUND LEVELS	21
6.2. IMPLEMENTATION AND EFFECTIVENESS OF THE BIOLOGICAL OPINION'S ITS AND IHA	24
7. LITERATURE CITED	26

LIST OF FIGURES

Figure 1: Location of survey area.....	7
Figure 2: Protected Species Observer observation tower under awning on top of bridge with mounted big eye binoculars, as seen from the bow of the vessel.....	11
Figure 3: Number of Protected Species Detections each day of the MATRIX Seismic Survey Program and Corresponding Weather Data for each day.	18

LIST OF TABLES

Table 1: Predicted 160 Decibel Zones Implemented during the MATRIX Seismic Survey Program.	10
Table 2: Survey parameters of programs	13
Table 3. Total Acoustic Source Operations during the MATRIX Seismic Survey Program.	14
Table 4: Initiation and termination of visual monitoring watches during the MATRIX Seismic Survey programs	14
Table 5. Total Visual Monitoring Effort during the MATRIX Seismic Survey Program	14
Table 6: Total visual monitoring effort from observation locations during the MATRIX seismic survey program	14
Table 7. Visibility during the MATRIX Seismic Survey Program.	15
Table 8. Precipitation during the MATRIX Seismic Survey Program.	16
Table 9. Beaufort Sea State during the MATRIX Seismic Survey Program.	16
Table 10. Beaufort Wind Force during the MATRIX Seismic Survey Program.	16
Table 11. Swell Height during the MATRIX Seismic Survey Program.	16
Table 12. Summary of Glare during the MATRIX Seismic Survey Program.	16
Table 13. Number of Visual Detection Records Collected for the MATRIX Seismic Survey Program.	17
Table 14. Average Closest Approach of Protected Species to the Acoustic Source during the MATRIX Seismic Survey Program.	19
Table 15. Number and Duration of Mitigation Actions Implemented during the MATRIX Seismic Survey Program.	20
Table 16: Mitigation Actions and Downtime Duration by Species during the MATRIX Seismic Survey Program.	20
Table 17. Summary of each Mitigation Action Implemented during the MATRIX Seismic Survey Program.	20
Table 18. Number of Authorized and Potential Level A and B Harassment Takes During the MATRIX Seismic Survey Program.	21
Table 19: Behavior of Species Visually Observed to be Exposed to Sound Pressure Levels of 160 dB during the MATRIX Seismic Survey Program.	23

APPENDICES:

Appendix	Description
Appendix A	Incidental Harassment Authorization for the MATRIX geophysical survey.
Appendix B	Basic Data Summary Form
Appendix C	Survey Lines Acquired
Appendix D	Summary of Visual Detections of Protected Species
Appendix E	Photographs of Positively Identified Protected Species
Appendix F	Birds and Other Wildlife Observed

1. EXECUTIVE SUMMARY

The United States Geological Survey (USGS) conducted a marine geophysical (seismic) survey onboard the federal fleet vessel *R/V Hugh R. Sharp* in the Northwest Atlantic Ocean off the coast of the United States. The U.S Geological Survey's seismic program is named the Mid-Atlantic Resource Imaging Experiment (MATRIX). The principal investigators were Dr. Carolyn Ruppel and Dr. Nathan Miller, research geophysicists at the U.S. Geological Survey's Woods Hole Coastal and Marine Science Center.

The MATRIX program consists of one 2D seismic survey off the east coast of the United States. The survey was comprised of two legs, with the first leg of MATRIX conducted from 08 August 2018 to 17 August 2018 and the second leg conducted from 19 August 2018 to 28 August 2018. As stated by the USGS, the purpose of the MATRIX seismic program was to collect data to constrain lateral and vertical distribution of gas hydrates and associated shallow free natural gas in marine sediments and their association to seafloor gas seeps, large scale slope failures and erosional processes, and other geological features.

This report serves to comply with the reporting obligations for the survey pursuant to the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA). On 19 March 2018, USGS submitted an application to the National Marine Fisheries Service (NMFS) for an Incidental Harassment Authorization (IHA) that would allow for the potential harassment of small numbers of marine mammals incidental to the seismic surveys. On 06 August 2018, NMFS issued an IHA, Incidental Take Statement (ITS), and Biological Opinion (BO) for the project. Mitigation measures were implemented to minimize potential impacts to marine mammals and endangered or threatened sea turtles during the survey program. These measures included, but were not limited to, the use of NMFS approved Protected Species Observers (PSOs) for visual monitoring, the establishment of a 100 meter buffer zone from the established exclusion zone (where the source operators would be alerted to the presence of the animal(s)), a 100 meter exclusion zone from any source element (where the source would be shut down), a power-down condition for specific delphinid species within the 100 meter exclusion zone, and the implementation of ramp-up procedures.

Continuous protected species observation coverage during the survey was provided by RPS, the environmental consulting company contracted by USGS for the project. Pursuant to the contract, PSOs monitored and reported on the presence and behavior of protected species and directed the implementation of the mitigation measures as described in the EA and the IHA issued by NMFS. Three PSOs, of which one was designated as the Lead PSO, were present on board the *R/V Hugh R. Sharp* throughout the MATRIX survey program. Over the course of the entire survey program, PSOs conducted visual observations for a total of 264 hours and 10 minutes.

There were a total of 33 protected species detections during the MATRIX program. Visual detections included: 11 detections of whales, 19 detections of dolphins and three detections of sea turtles. Visual detections of positively identified whales included eight detections of sperm whales (*Physeter macrocephalus*) and two detections of fin whales (*Balaenoptera physalus*). Visual detections of positively identified dolphins included five detections of Atlantic spotted dolphins (*Stenella frontalis*), six detections of bottlenose dolphins (*Tursiops truncatus*), two detections of short-beaked common dolphins (*Delphinus delphis*), one detection of striped dolphin (*Stenella coeruleoalba*), one detection of short-finned pilot whales (*Globicephala macrorhynchus*), and one detection of pygmy killer whales (*Feresa attenuata*). In addition to dolphins that were positively identified to species, there were also

three detections of unidentified dolphins. Visual detections of positively identified sea turtles included one detection of a loggerhead sea turtle (*Caretta caretta*).

Protected species detections resulted in the implementation of 10 mitigation actions throughout the survey program. These mitigation actions included eight power-downs and two shutdowns. Overall, there were two hours and 33 minutes of downtime attributed to mitigation actions implemented for detections of protected species, of which one hour and 49 minutes were considered production loss.

An IHA was issued by NMFS authorizing Level B takes for marine mammals observed in the Northwest Atlantic Ocean territorial waters for the MATRIX program. A total of 207 individual marine mammal potential Level B takes occurred during the survey, consisting of six positively identified marine mammal species and one unidentified dolphin. Takes for these species included one fin whale (*Balaenoptera physalus*), seven sperm whales (*Physeter macrocephalus*), 80 striped dolphins (*Stenella coeruleoalba*), 64 common bottlenose dolphins (*Tursiops truncatus*), 47 Atlantic spotted dolphins (*Stenella frontalis*), 6 pygmy killer whales (*Feresa attenuata*) and two unidentifiable dolphins. No Level A Takes were authorized.

A summary sheet of observation, detection, and operational totals for the survey program can be found in Appendix B.

2. INTRODUCTION

The following report details protected species monitoring and mitigation as well as seismic survey operations undertaken as part of the marine geophysical survey on board the *R/V Hugh R. Sharp* in the Northwest Atlantic Ocean off the coast of the United States from 08 August 2018 to 28 August 2018. Although not required, also included in this report are visual protected species monitoring details for the transit from the port to the permit site.

This document serves to meet the reporting requirements dictated in the IHA issued to USGS by NMFS on 06 August 2018. The IHA authorized “takes” of Level B harassment of specific marine mammals, incidental to the marine seismic survey. NMFS has stated that seismic source received sound levels equal to or greater than 160 dB re 1 μ Pa (root mean square (rms)) could potentially disturb marine mammals and temporarily disrupt behavior, such that they could be considered non-lethal ‘takes’ (Level B harassment). Level A harassment are sound sources that have the potential to injure, but not seriously injure or kill, a marine mammal. The IHA did not authorize Level A harassment for any marine mammals. For sea turtles, per the Biological Opinion based from modeling previously conducted by Lamont-Doherty Earth Observatory of Columbia University (L-DEO), received sound levels equal to or greater than 175 dB re 1 μ Pa represents the current best understanding of the threshold at which they exhibit behavioral responses. Received sound levels equal to or greater than 195 dB re 1 μ Pa represent the current best understanding of the threshold at which sea turtles experience PTS, corresponding to Level A take.

NMFS requires that provisions such as exclusion zones (EZ), delayed operations, ramp-ups, power-downs and shutdowns be implemented to mitigate for potentially adverse effects of the acoustic source sounds on protected species. An exclusion zone of 100 meters for a full active source were established from any single element on the array. With a few exceptions, the occurrence of a marine mammal detected approaching, entering, or within the EZ would trigger the implementation of a mitigation action, including a power-down of the acoustic source for the 100 meter EZ or a shutdown of the acoustic source for the 100 meter EZ, depending on species. The 100 meter buffer zone, established around the 100 meter EZ, was intended to be precautionary as it encompassed the zone for most species within which auditory injury (Level A harassment) could occur on the basis of instantaneous exposure. It also provided 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. For sea turtles, the predicted 175 dB threshold distances to which sound source levels will be received from the full array comprised of four 105 cubic inch (in³) elements in shallow water (depths of 100 to 1,000 meters) and deep waters (waters greater than 1000 meters in depth) was used as the EZ for sea turtles. The occurrence of a sea turtle detected approaching, entering, or within this EZ would trigger the implementation of a shutdown of the acoustic source.

2.1. PROJECT OVERVIEW AND LOCATION

The survey program named MATRIX, for “Mid-Atlantic Resource Imaging Experiment,” was conducted by the USGS with principal investigators Dr. Carolyn Ruppel and Dr. Nathan Miller. The survey was conducted in part for the continuation of the USGS’s Gas Hydrates Project, which has been instrumental in advancing the understanding of natural gas hydrate systems nationally and internationally for more than three decades.

The MATRIX program's principal purpose was to collect data to constrain lateral and vertical distribution of gas hydrates and associated shall free natural gas in marine sediments and their association to the sea floor gas seeps, large-scale slope failures and erosional processes, as well as other geological features. This survey will update previous data collected between 35 to 45 years ago in order to provide a high-quality characterization of the U.S. Atlantic Ocean continental margin.

The MATRIX survey was conducted in the northwest Atlantic Ocean entirely within the U.S. Exclusive Economic Zone (EEZ), 65.8 kilometers south of Hudson Canyon to approximately Cape Hatteras. The permit area had a closest approach to the U.S. coastline of 70 kilometers offshore North Carolina and 130 kilometers offshore New Jersey in water depths ranging from 100 meters to 3,700 meters.

Seismic survey acquisition consisted of 19 tracklines both down the continental slope and parallel to the continental shelf break through three large areas (purple) previously identified by BOEM as prospective for gas hydrate occurrences. The 19 tracklines are depicted in yellow in Figure 1, for a total of 2,049 kilometers including linking, transit, and interseismic tracklines. The orange crosses indicate locations of 63 sonobuoy deployments throughout the survey area.

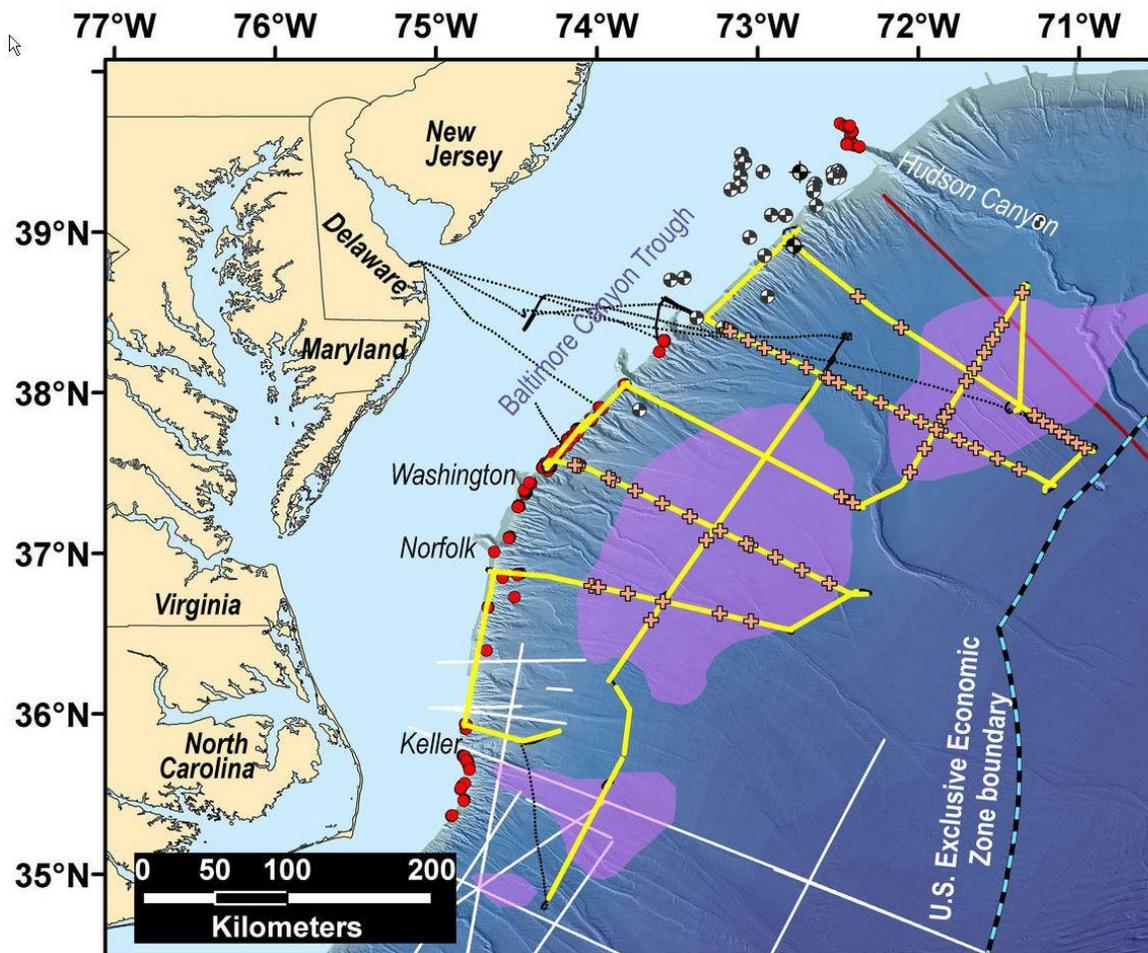


Figure 1: Location of survey area

2.1.1. Energy Source and Receiving Systems

Two source array configurations were arranged for use during the MATRIX survey, both chosen to be the lowest practical energy output to meet the scientific objectives. The first airgun array configuration was referred to as base configuration or GI configuration. Base configuration consisted of two deployed gun strings, each with two Sercel GI airguns, operated with a combined total discharge volume of 420 in³. Each single airgun had a discharge volume of 105 in³ while operating in base configuration. The second airgun array configuration was referred to as GG configuration. GG configuration was made up of the same two deployed gun strings as base configuration, but operated at a total discharge volume of 840 in³. Each single airgun had a discharge volume of 210 in³ when operating in GG configuration. Base or GI configuration was originally meant to be utilized at water depths less than 1,000 meters, but was instead used throughout the entire survey area. GG configuration was intended to be used at water depths greater than 1,000 meters, but was not utilized during the survey. During compressor refueling and at upper slope depths less than approximately 250 meters, operations often used only two airguns with a total air volume of 210 in³.

In base and GG configurations, the four GI airguns were towed behind the *R/G Hugh R. Sharp* at a water depth of three meters. Two airguns were towed on each side of the stern with 8.6 meters separation between the pairs of airguns, with two meters of separation between the airguns on each tow line. All the airguns were fired simultaneously at a shot point interval of approximately 12 seconds, or 25 meters. The receiving system consisted of a 1.2 kilometer, 112 to 160-channel towed hydrophone streamer. As the vessel transited along the proposed tracklines with the airgun array active, the towed hydrophone streamer received the returning acoustic signals and transferred the data to the onboard processing system. In addition, 63 dispensable sonobuoys were deployed along tracklines at water depths greater than 1,000 meters. The sonobuoys consisted of hydrophones suspended below the water's surface and transmitted data through radio frequencies to receivers on the research vessel to provide velocity control and wide-angle reflections along high-priority tracklines.

In addition to the airgun array, the *R/V Hugh R. Sharp* operated a split-beam fisheries echosounder continuously. The echosounder (EK80) consisted of a 38-kilohertz split-beam transducer mounted on the ship's retractable keel, approximately three meters below the hull. It pinged once a second or once every two seconds with a duration of 0.256 to 1.024 milliseconds, and the return signal detected on the EK80 broadband transceiver.

3. MITIGATION AND MONITORING METHODS

The PSO monitoring program on the *R/V Hugh R. Sharp* was established to meet the standards set forth in the NMFS issued IHA and BO. Survey mitigation measures were designed to minimize potential impacts of the *Sharp's* seismic activities on sea turtles, 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.
- Effects of marine mammals and sea turtles exposed to sound levels constituting a take were observed and documented. The nature of the probable consequences was discussed when possible.

3.1. MITIGATION METHODOLOGY

Mitigation actions were implemented for visual and acoustic detections of protected species, including marine mammals and sea turtles as outlined in the IHA. These actions included the establishment of a 100 meter EZ, a 100 meter buffer zone around the 100 meter EZ, and the implementation of delayed operations, power-downs for specific delphinid species (during which the source volume was reduced to a single active 105 cubic inch element), and shutdowns (during which the source was fully silenced) for protected species detected approaching, entering, or within the designated EZ.

Before the acoustic source could be activated after a period of silence, two PSOs conducted a 30 minute survey of the EZ. If a marine mammal or sea turtle was detected approaching, entering, or within the 100 meter EZ, source operations would be delayed until the animals were observed exiting the 100 meter exclusion zone. If the animal(s) were not detected leaving the designated zones (i.e. if they dove 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, pinnipeds, sea turtles, this time was 15 minutes following the last sighting. For detections of mysticetes or large odontocetes, this time was 30 minutes following the last sighting.

A 100 meter buffer zone around the 100 meter EZ was established as an area in which the presence of a protected species would initiate an alert to the seismic operators that the animal was sighted, and that the implementation of a mitigation action might soon be required. PSOs would keep in frequent contact with the seismic operator on the location and movement of the animal(s). This process ensured that everyone remained fully informed of ongoing detections of protected species and the pertinent information for mitigation implementation.

A 100 meter exclusion zone (EZ) from any element on the acoustic source array was established as the area in which the presence of a marine mammal observed approaching, entering, or within the zone would initiate a shutdown of the acoustic source for both full power source and during soft start. A shut down of the source array would be required upon observations beyond the 100 meter EZ if any of the following occur; the detection of large whales with calves, aggregations of large whales that didn't appear to be traveling, marine mammal species not authorized for take that is approaching or entering the Level B zone, an authorized marine mammal species that has reached its total allotted Level B take that is approaching or entering the Level B zone.

Once the acoustic source had been powered down or shut down for a protected species detection, the acoustic source would not resume normal operations until the animal(s) were confirmed exiting the 100 meter EZ, or until a specific time had passed following the last detection. As with delayed operations, this time was 15 minutes for small odontocetes, pinnipeds, and sea turtles, and 30 minutes for mysticetes or large odontocetes. A ramp-up of the acoustic source was required after shutdowns for protected species in order for full volume operations to resume.

Both the IHA and the BO outlined several exceptions for mitigation actions, as well as several extra mitigation actions required for detections of specific marine mammals. For dolphins of the genera *Tursiops*, *Steno*, *Stenella*, *Lagenorhynchus* and *Delphinus*, if upon initial detection of the mammal in the EZ the PSOs could positively identify the species, a power-down of the source to a single 105 in³ element would be implemented. If the delphinids were observed to be voluntarily entering the exclusion zone, a mitigation action would not be required. However, if there was any uncertainty to the species identification, a mitigation action would be implemented per normal procedures.

Table 1 describes the predicted 160 decibel radius (Level B harassment zone for marine mammals) and the predicted 175 decibel radius (sea turtles) for protected species takes. Calculations for protected species takes were formulated assuming that the survey would be conducted in base (GI) configuration in water depths less than 1,000 meters and GG configuration for water depths greater than 1,000 meters. However, base (GI) configuration, with its smaller overall air volume, ended up being utilized for nearly the entirety of the MATRIX program. Mitigations for protected species takes continued to be based on water depth even though the smaller sound source was nearly always in use.

Table 1: Predicted 160 Decibel Zones Implemented during the MATRIX Seismic Survey Program.

Source and Volume	Tow Depth (m)	Water Depth (m)	160 dB radius – Level B harassment zone for marine mammals	175 dB radius – Behavioral harassment zone for sea turtles
Base Configuration – Four 105 in ³ GI-guns	3	>1000	1091	194
	3	100 to 1,000	1637	291
GG Configuration – Four 210 in ³ GI-guns	3	>1000	1244	220
	3	100 to 1,000	1866	330

3.2. VISUAL MONITORING SURVEY METHODOLOGY

There were three trained and experienced PSOs on board the *R/V Hugh R. Sharp* for each survey during the program to conduct the monitoring for protected species, record and report detections, and request mitigation actions in accordance with the BO and IHA. The PSOs on board were NMFS approved and held certifications from a recognized Bureau of Ocean Energy Management (BOEM) course. Visual monitoring was primarily carried out from an observation tower (Figure 2) located 11 meters above the surface of the water, which allowed a 360 degree viewpoint around the vessel and acoustic source.



Figure 2: Protected Species Observer observation tower under awning on top of bridge with mounted big eye binoculars, as seen from the bow of the vessel

The PSO tower was equipped with Fujinon 7x50 binoculars, as well as one mounted 25x150 Big-eye binoculars, and a D-300-2MS Night Optics USA, Inc. monocular (for visual clearance and monitoring of night time ramp-ups). In addition, a Butler Creek PVS-7 night vision monocular was secured in the bridge and could be requested for use by the PSOs when needed. Inside the tarpaulin tent located in the middle of the platform was a laptop for data collection, and a telephone for communication with the main lab. Environmental conditions along with vessel and acoustic source activity were recorded at least once every three hours, or every time there was a change of one or more of the variables. Most observations were held from the tower; however, during severe weather or when the ships exhaust was blowing on the tower, observations would be conducted from the bridge (approximately 8 meters above sea level) or the catwalk (approximately eight meters above sea level) around the bridge.

Visual monitoring methods were implemented in accordance with the survey requirements outlined in the IHA. One PSO visually monitored for protected species at all times during daylight hours throughout each survey, from the moment the vessel departed the dock at the beginning of the survey until the vessel returned to dock at the end of the survey, regardless of acoustic source activity. Visual monitoring during periods of acoustic source silence were conducted to gather baseline data on the presence and abundance of protected species in the areas. When the acoustic source was activated from silence, PSOs maintained a two-person watch for at least 30 minutes prior to the activation of the source. During ramp-ups, the two-person watch was maintained until the acoustic source reached full operating volume.

Monitoring was conducted each day from 30 minutes before sunrise until 30 minutes after sunset as required by the IHA and ITS. For the first leg of the project observation, times ranged between 09:30 to 00:30 Coordinated Universal Time (UTC) (05:30 to 8:30 local time). For the second leg of the project, observation times ranged between 9:40 to 00:00 UTC (05:40 to 8:00 local time). A visual monitoring schedule was established by the PSOs where each person completed visual watches of three hours in

length throughout the day. Scheduled watches were no more than four hours in duration and were each followed by at least one hour of scheduled break time.

Visual observations were conducted around the entire area of the vessel and acoustic source, and during two person watches each PSO focused on a specific half of the area. The smaller monitoring area for each observer increased the probability of protected species being sighted prior to source ramp up. PSOs searched for blows, fins, splashes or disturbances of the sea surface, 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 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 tail buoy. PSOs would also identify the animals' species, if possible upon initial detection, to ensure that the proper mitigation measures were implemented, should any be required.

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, acoustic source activity (e.g. volume and number of active elements), and environmental conditions (e.g. Beaufort sea state, wind force, swell height, visibility and glare).
- II. Species, detection cue, group size (including number of adults and juveniles), 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 and final distance to the vessel and the source, time and distance of the closest distance to the source, time when entering and exiting the exclusion zones, type of mitigation action implemented, total time of the mitigation action and any production loss, description of other vessels in the area, any avoidance maneuvers conducted, and if the detection occurred within or outside of territorial waters.

During or immediately after each sighting event, the PSOs recorded the detection details per the requirements of the IHA in a provided detection datasheet. Each sighting event was linked to an entry on an effort datasheet where specific environmental conditions and vessel activity were logged.

Species identifications were made whenever the distance of the animal(s), length of the sighting, and visual observation conditions allowed. Whenever possible during detections, photographs were taken with their own personal cameras. Marine mammal identification manuals were consulted, and photos were examined during observation breaks to confirm identifications.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

4.1.1. General survey parameters

The Northwest Mid-Atlantic Resource Imaging Experiment (MATRIX) seismic survey program was conducted in two legs (Table 2). The dates and times of acquisition for each survey line on the two programs can be found in Appendix C.

Table 2: Survey parameters of programs

Survey	Mobilization Location / Date	First Airgun Source Activity (UTC)	Start of Acquisition	End of Acquisition	Demobilization Location / Date
Leg 1	Lewes, DE / 08 Aug 2018	Testing / 18:55 / 09 AUG 2018	18:55 UTC 09 AUG 2018	16:00 UTC 17 AUG 2018	Lewes, DE / 17 AUG 2018
Leg 2	Lewes, DE / 19 AUG 2018	Ramp-up / 22:18 / 19 AUG 2018	22:18 UTC 19 AUG 2018	10:15 UTC 28 AUG 2018	Lewes, DE / 28 AUG 2018

4.1.2. Airgun operations

The acoustic source was active for a total of 302 hours 11 minutes during the survey programs. This total includes ramp-up of the acoustic source, full and reduced volume operations on a survey line, full and reduced volume operations not on a survey line, operation of a single 105 in³ source element, and testing of the acoustic source elements. The acoustic source was ramped-up 15 times totaling five hours over the course of the survey programs to commence full volume operations from silence or resume full volume operations from a mitigation shutdown down. Table 3 summarizes the acoustic source operations over the course of the MATRIX project.

Operations with only a single 105 in³ source element were conducted for protected species mitigation power-downs as well as several times during the survey due to technical difficulties with the gear. Overall single 105 in³ source element operations totaled one hour 30 minutes, of which 44 minutes were from protected species power-downs. There was only one test during the MATRIX survey, occurring on 08 August 2018, lasting for 53 minutes.

Per the IHA, for non-biological shutdowns of 30 minutes or less, such as trouble-shooting mechanical or technical issues, ramp-up was not required to resume full volume operations provided that (1) the PSOs maintained constant visual observation during the silence, and (2) no visual detections of protected species occurred within the buffer or exclusion zones.

Table 3. Total Acoustic Source Operations during the MATRIX Seismic Survey Program.

Acoustic Source Operations	Number	Duration (hh:mm)
	Total	Total
Source Tests	1	00:53
Ramp-up	15	05:00
Day time ramp-ups from source silence	11	03:40
Day time ramp-ups from mitigation source	0	00:00
Night time ramp-ups from source silence	4	01:20
Night time ramp-ups from mitigation source	0	00:00
Full 420 in³/Reduced Volume Operations		296:18
Single Source Element (105 in³)		01:30
Total Time Acoustic Source Was Active		302:11

4.2. VISUAL MONITORING SURVEY SUMMARY

Visual monitoring during the MATRIX seismic survey program was conducted during all daylight hours throughout each survey of the program, beginning 30 minutes before sunrise and ending 30 minutes after sunset each day, starting when the vessel left the dock and terminating upon return to port upon completion of the survey (Table 4). This included times when the vessel was in transit and deploying and retrieving equipment. Visual monitoring during times with no source operations was conducted to collect baseline data about protected species abundance in the survey areas.

Table 4: Initiation and termination of visual monitoring watches during the MATRIX Seismic Survey programs

Survey program	Visual Monitoring Began	Visual Monitoring Ended
Leg 1	18:00 UTC, 08 AUG 2018	23:45 UTC, 17 AUG 2018
Leg 2	12:30 UTC, 19 AUG 2018	19:00 UTC, 28 AUG 2018

Throughout the entire MATRIX seismic survey program, visual monitoring was conducted over a period of 21 days for a total of 264 hours 10 minutes. Visual monitoring while the acoustic source was silent was mainly conducted during the transits to and from the survey sites, and during equipment deployment, recovery and maintenance. One PSO conducted visual monitoring during all daylight hours except when a ramp up was requested. During ramp up and the 30 minutes prior, two PSOs conducted visual monitoring.

Table 5 details visual monitoring with acoustic source operations throughout the MATRIX seismic survey programs. Table 6 details the total visual monitoring effort from different observation locations onboard the vessel.

Table 5. Total Visual Monitoring Effort during the MATRIX Seismic Survey Program

Visual Monitoring Effort	Duration (hh:mm)
Total monitoring while acoustic source active	166:57
Total monitoring while acoustic source silent	97:13
Total monitoring effort	264:10

Table 6: Total visual monitoring effort from observation locations during the MATRIX seismic survey program

Survey Program	Observation Locations During Visual Effort (hh:mm)					
	Tower	Bridge	Catwalk	Tower/ Bridge	Tower/ Catwalk	Bridge/ Catwalk
MATRIX	92:34	41:09	43:33	6:45	9:49	71:20

4.3. 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 good to moderate for the MATRIX seismic survey.

Visibility during the MATRIX survey for the sighting of protected species was overall favorable. Observers could monitor a range of greater than five kilometers for 214 hours 21 minutes, or 81% of the overall visual monitoring effort. Reduced visibility was mainly attributed to brief periods of reduced lighting before sunrise and after sunset, totaling 49 hours 49 minutes, or 19% of the overall visual monitoring effort (Table 7). Throughout the survey program, precipitation was recorded on three of the 21 days at sea with light to heavy rain (Table 8).

The Beaufort Sea State recorded during visual monitoring ranged from level one to level six over the course of the survey program. A total of 61 hours 26 minutes (23.3%) were undertaken in conditions where the Beaufort Sea State was level two or less, which were considered excellent conditions for the detection of protected species. Beaufort Sea States of three to four were recorded for a total of 167 hours 06 minutes, 63.3% of all visual monitoring observations and were considered moderate conditions for the detection of protected species. Beaufort Sea States of five to six were recorded for a total of 35 hours 38 minutes, 13.5% of all visual monitoring observations (Table 9).

The Beaufort Wind Force recorded during visual monitoring ranged from one (one to three knots) to seven (28 to 33 knots) over the course of the survey program. The majority of visual monitoring occurred during a recorded wind force of three and four (7 to 16 knots) for 89 hours 01 minute and 98 hours 08 minutes respectively, 70.8% of all visual monitoring observations. Beaufort Wind Force of one and two (1 to 6 knots) occurred for four hours 45 minutes and 38 hours respectively. Beaufort Wind Force of five (17 to 21 knots) occurred for 27 hours 34 minutes. The highest wind speeds, between 22-33 knots (level 6 and 7), were recorded for five hours 40 minutes and one hour two minutes respectively, 2.5% of all visual monitoring observations (Table 10).

Swell heights during visual observations were generally low, with swells of less than two meters recorded for 241 hours 18 minutes, 91.3% of the total visual effort during the survey program. Swell heights of two to four meter swells occurred during three of the 21 days at sea, 22 hours and 32 minutes, 8.7% of the total visual effort during the survey program (Table 11.)

The majority of visual monitoring effort during the survey program was conducted while severe glare was present, for a total of 148 hours six minutes, or 56.3%. Little to moderate glare occurred for a combined total of 37 hours 17 minutes, or 14.1% of the overall monitoring effort. No glare occurred for 78 hours 17 minutes, or 29.6% of the total monitoring effort, and included hours of monitoring during darkness (Table 12).

Table 7. Visibility during the MATRIX Seismic Survey Program.

Visibility	Duration (hh:mm)	% of Overall Visibility
Excellent (Greater than five kilometers)	214:21	81.0%
Moderate (two to five kilometers)	00:00	0%
Poor (less than two kilometers)	49:49	19.0%
Total Visual Monitoring Effort	246:10	-

Table 8. Precipitation during the MATRIX Seismic Survey Program.

Precipitation	Duration (hh:mm)	% of Overall Visibility
None	252:08	95.4%
Light Rain	05:50	2.2%
Heavy Rain	06:12	2.3%

Table 9. Beaufort Sea State during the MATRIX Seismic Survey Program.

Beaufort Sea State	Duration (hh:mm)	% of Overall Visibility
B0 to B2	61:26	23.3%
B3 to B4	167:06	63.3%
B5 to B6	35:38	13.5%

Table 10. Beaufort Wind Force during the MATRIX Seismic Survey Program.

Beaufort Wind Force	Duration (hh:mm)	% of Overall Wind Force
B1	04:45	1.8%
B2	38:00	14.4%
B3	89:01	33.7%
B4	98:08	37.1%
B5	27:34	10.4%
B6	05:40	2.1%
B7	01:02	0.4%

Table 11. Swell Height during the MATRIX Seismic Survey Program.

Beaufort Sea State	Duration (hh:mm)	% of Overall Visibility
Less than 2 meters	241:18	91.3%
2 to 4 meters	22:52	8.7%
Greater than 4 meters	00:00	0.0%

Table 12. Summary of Glare during the MATRIX Seismic Survey Program.

Glare	Duration (hh:mm)	% of Overall Visibility
None	78:17	29.6%
Little	11:00	4.2%
Moderate	26:17	9.9%
Severe	148:36	56.3%

5. MONITORING AND DETECTION RESULTS

5.1. VISUAL DETECTIONS

Visual monitoring efforts during the MATRIX seismic survey program resulted in a total of 33 detections of protected species (summarized in Appendix D). Visual detections consisted of eight sperm whale detections, three fin whale detections, six bottlenose dolphin detections, five Atlantic spotted dolphin detections, two short-beaked common dolphin detections, one short-finned pilot whale detection, one striped dolphin detection, one pygmy killer whale detection, two leatherback sea turtle detections, three unidentified dolphin detections, and one unidentified sea turtle detection. Eleven detections of whales, 19 detections of dolphins, and three detection of sea turtles occurred during the survey. Table 13 lists the total number of detections and total number of animals recorded for each protected species observed during the survey program. Figure 3 depicts weather conditions during the protected species detections. Photographs taken of visual detections can be found in Appendix E.

Table 13. Number of Visual Detection Records Collected for the MATRIX Seismic Survey Program.

Species	MATRIX	
	Total Number Detection Records	Total Number Animals Recorded
Whales		
Fin Whale	3	6
Sperm Whale	8	20
Dolphins		
Bottlenose Dolphins	6	76
Short-finned Pilot Whales	1	7
Short-beaked Common Dolphins	2	20
Atlantic Spotted Dolphin	5	63
Striped Dolphin	1	80
Pygmy Killer Whale	1	6
Unidentified Dolphins	3	14
Sea Turtles		
Leatherback Sea Turtle	2	2
UID Sea Turtle	1	1
TOTAL	37	217

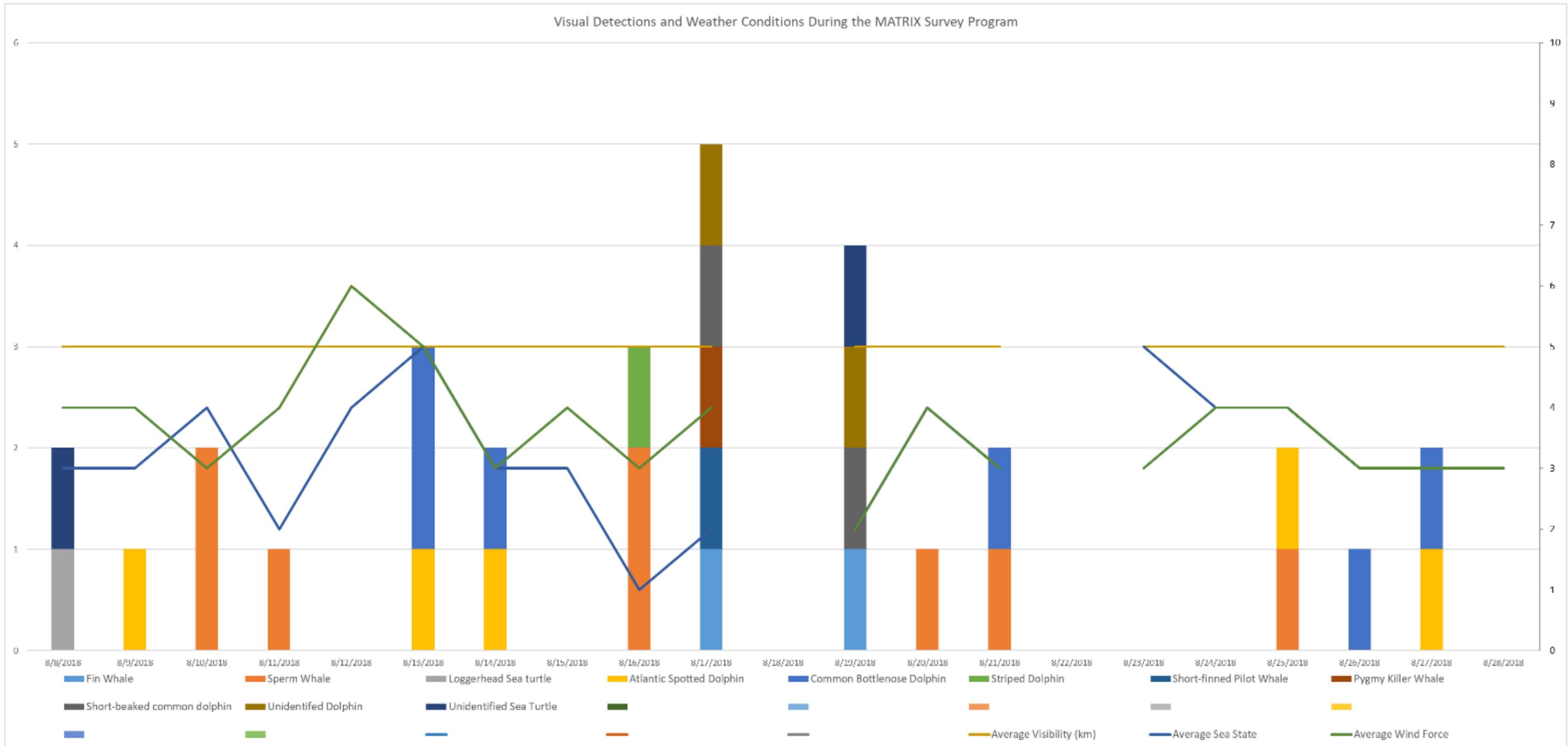


Figure 3: Number of Protected Species Detections each day of the MATRIX Seismic Survey Program and Corresponding Weather Data for each day.

Of the 33 visual detections of protected species during the MATRIX seismic survey program, 20 detections occurred while the acoustic source was at full or reduced volume on a survey line and 12 detections occurred while the acoustic source was silent (Table 14). All of the detections that occurred during source silence occurred while the source was on board the vessel.

Table 14. Average Closest Approach of Protected Species to the Acoustic Source during the MATRIX Seismic Survey Program.

Species Detected	Full or Reduced Volume on a Survey Line		Silent Source	
	Number of detections	Average closest approach to source (meters)	Number of detections	Average closest approach to source (meters)
Fin Whale	1	200	2	N/A
Sperm Whale	6	2342	2	N/A
All Whale Species	7	1271	4	N/A
Short-finned Pilot Whales	1	2000	-	-
Short-beaked Common Dolphins	-	-	2	N/A
Atlantic Spotted Dolphin	4	25	1	N/A
Common Bottlenose Dolphin	5	72	1	N/A
Striped Dolphin	1	90	-	-
Pygmy Killer Whale	1	150	-	-
Unidentified Dolphins	1	1100	2	N/A
All Dolphin Species	13	573	6	N/A
Loggerhead Sea turtle	-	-	1	N/A
UID Sea Turtle	-	-	2	N/A
All Sea Turtle Species	-	-	3	N/A
All Species	20	747	13	N/A

5.1.1. Other Wildlife

Observations of other wildlife during the MATRIX survey program included 13 species of birds, eight species of fish, and three species of marine invertebrates. None of the other wildlife species observed were listed as endangered species. 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 F. No impacts to any other wildlife species as a result of research activities were observed during the survey program.

6. MITIGATION ACTION SUMMARY

There were 10 mitigation actions implemented during the MATRIX seismic survey program due to protected species being observed approaching, entering, or within the 100-meter exclusion zone. Overall, mitigation actions implemented during the survey program totaled two hours 33 minutes (Table 15). Nine of the mitigation actions were implemented during acquisition of a survey line, and one mitigation action was implemented on a line change.

Table 15. Number and Duration of Mitigation Actions Implemented during the MATRIX Seismic Survey Program.

Mitigation Action	Whales		Dolphins		Sea Turtles	
	Number	Duration (hh:mm)	Number	Duration (hh:mm)	Number	Duration (hh:mm)
Power-down	0	00:00	8	00:44	0	00:00
Shutdown	1	00:55	1	00:54	0	00:00

Four species were involved in the ten mitigation actions during this survey: common bottlenose dolphins accounted for 10.5%, Atlantic spotted dolphins for 50.3%, striped dolphins for 3.3%, and sperm whales accounted for 35.9% of the mitigation downtime (Table 16).

These ten mitigations consisted of eight power-downs and two shutdowns of the acoustic source. Of the eight power-downs, four were attributed to common bottlenose dolphins, three were attributed to Atlantic spotted dolphins, and one was attributed to striped dolphins. Of the two shut downs, one occurred as a result of Atlantic spotted dolphins that could not initially be identified, and one occurred as a result of a mother calf pair during a sperm whale detection. A summary of each mitigation action can be found in Table 17.

Table 16: Mitigation Actions and Downtime Duration by Species during the MATRIX Seismic Survey Program.

Species	Number of Delayed Operations	Number of Power-downs	Number of Shutdowns	Duration of Mitigation action (hh:mm)	Percentage of Mitigation Downtime
Common Bottlenose Dolphin	0	4	0	00:16	10.5%
Atlantic Spotted Dolphin	0	3	1	01:17	50.3%
Striped Dolphin	0	1	0	00:05	3.3%
Sperm Whale	0	0	1	00:55	35.9%

Table 17. Summary of each Mitigation Action Implemented during the MATRIX Seismic Survey Program.

Date	Visual Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Active Source (m)	Mitigation Action	Total Duration of Mitigation Event	Total Duration of Production Loss
2018-08-13	7	Common Bottlenose Dolphin	6	Full volume on a survey line	200	Power Down	00:03	00:00
2018-08-13	8	Atlantic Spotted Dolphin	15	Full volume on a survey line	60	Shut Down	00:03	00:54
2018-08-14	10	Common Bottlenose Dolphin	5	Full volume on a survey line	25	Power Down	00:02	00:00

Date	Visual Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Active Source (m)	Mitigation Action	Total Duration of Mitigation Event	Total Duration of Production Loss
2018-08-14	11	Atlantic Spotted Dolphin	6	Full volume on a survey line	60	Power Down	00:15	00:00
2018-08-16	12	Striped Dolphin	80	Full volume on a survey line	90	Power Down	00:05	00:00
2018-08-16	13	Sperm Whale	6	Full volume on a survey line	800	Shut Down	00:03	00:55
2018-08-25	27	Atlantic Spotted Dolphin	20	Full volume not on a survey line	30	Power Down	00:03	00:00
2018-08-26	29	Common Bottlenose Dolphin	8	Full volume on a survey line	70	Power Down	00:06	00:00
2018-08-27	31	Common Bottlenose Dolphin	25	Full volume on a survey line	25	Power Down	00:05	00:00
2018-08-27	32	Atlantic Spotted Dolphin	6	Full volume on a survey line	5	Power Down	00:05	00:00

6.1. MARINE MAMMALS KNOWN TO HAVE BEEN EXPOSED TO 160 DB / 175 DB OF RECEIVED SOUND LEVELS

NMFS granted an IHA for the marine seismic survey allowing Level B harassment takes (exposure to sound pressure levels equal to or greater than 160 dB re: 1 μ Pa (rms) where there is a potential for behavioral changes) for 23 marine mammal species. For sea turtles, behavioral harassment was expected to occur in the 175 dB zone. The BO allowed for Level B harassment takes of three sea turtle species during the MATRIX Seismic Survey Program.

Table 18. Number of Authorized and Potential Level A and B Harassment Takes During the MATRIX Seismic Survey Program.

Species	IHA Authorized Level A Takes	Potential Level A Takes / PTS During the Program	IHA Authorized Level B Takes	Potential Level B Takes During the Program	Total IHA Authorized Takes	Total Potential Takes During the Program
Humpback Whale	0	0	3	0	3	0
Sei Whale	0	0	3	0	3	0
Fin Whale	0	0	5	1	5	1
Sperm Whale	0	0	161	7	161	7
Kogia spp.	0	0	9	0	9	0
Beaked Whales	0	0	128	0	128	0
Common Bottlenose Dolphin	0	0	757	64	757	64
Short-beaked Common Dolphin	0	0	1620	0	1620	0
Rough Toothed Dolphin	0	0	10	0	10	0
Northern Bottlenose Whale	0	0	4	0	4	0
Risso's Dolphin	0	0	237	0	237	0
False Killer Whale	0	0	28	0	28	0
Killer Whale	0	0	7	0	7	0

Species	IHA Authorized Level A Takes	Potential Level A Takes / PTS During the Program	IHA Authorized Level B Takes	Potential Level B Takes During the Program	Total IHA Authorized Takes	Total Potential Takes During the Program
Pilot Whale	0	0	288	0	288	0
Clymene Dolphin	0	0	122	0	122	0
Atlantic Spotted Dolphin	0	0	1598	47	1598	47
Pantropical Spotted Dolphin	0	0	50	0	50	0
Spinner Dolphin	0	0	91	0	91	0
Striped Dolphin	0	0	1459	80	1459	80
Fraser's Dolphin	0	0	204	0	204	0
Atlantic White Sided Dolphin	0	0	48	0	48	0
Melon-headed Whale	0	0	50	0	50	0
Pygmy Killer Whale	0	0	6	6	6	6
Sea turtles						
Leatherback Sea Turtle	-	0	28	0	-	0
Hawksbill Sea Turtle	-	0	-	0	-	0
Loggerhead Sea Turtle	-	0	174	0	-	0
Kemp's Ridley Sea Turtle	-	0	9	0	-	0
Green Sea Turtle	-	0	-	0	-	0
Unidentified species						
Unidentified Whale	-	0	-	0	-	0
Unidentified Dolphin	-	0	-	2	-	2
Unidentified Pinniped	-	0	-	0	-	0
Unidentified Sea Turtle	-	0	-	0	-	0

During the MATRIX survey, six identified species (fin whales, sperm whales, common bottlenose dolphin, Atlantic spotted dolphin, striped dolphin and pygmy killer whale), along with one dolphin detection that was not identifiable to species level, were observed within the Level B harassment zone.

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 animals not being seen or having moved away before they were observed. This is most likely to have occurred with sea turtles that were not close enough to the surface to be sighted from the vessel, and large pods of dolphins where exact number of individuals is difficult to determine. 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. During the MATRIX survey program, 13.5% of visual monitoring efforts were conducted with Beaufort Sea states greater than level 4, which may have resulted in some missed protected species detections.

Table 19 describes the behavior of all animals, including unidentified species, which were visually observed within the predicted Level B harassment zones during the survey program. While there were no highly distinctive behavioral reactions observed in relation to the vessel or acoustic source during the seismic survey, the majority of the protected species detected were last observed moving away from the vessel.

Table 19: Behavior of Species Visually Observed to be Exposed to Sound Pressure Levels of 160 dB during the MATRIX Seismic Survey Program.

Species	Detection No.	No. of Animals	Highest Observed Sound Pressure Level (dB)	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
Fin Whale	33	1	160	Blowing	Away from the vessel	Blowing, Diving	Away from the Vessel
Sperm Whale	4	3	160	Blowing	Away from the vessel	Blowing, Swimming	Away from the Vessel
	5	1	160	Blowing	Away from the Vessel	Blowing	Away from the Vessel
	13	6	160	Blowing	Crossing Ahead of the Vessel	Blowing, Fast Travel, Swimming, Diving	Parallel in Opposite Direction
	14	3	160	Blowing	Away from the Vessel	Blowing, Diving	Away from the Vessel
Sperm Whale	24	1	160	Body	Crossing ahead of the Vessel	Diving, Blowing	Away from the Vessel
	28	1	160	Blowing	Away from the Vessel	Blowing	Away from the Vessel
Common Bottlenose Dolphin	7	6	160	Jumping	Crossing ahead of the Vessel	Swimming, Porpoising, Fast Travel, Bow-riding	Away from the Vessel
	9	20	160	Swimming	Towards Vessel	Swimming, Porpoising, Feeding, Bow-riding	Away from the Vessel
	10	5	160	Swimming	Towards Vessel	Swimming, Milling, Bow-riding	Parallel to the Vessel in the Opposite Direction
	29	8	160	Jumping	Towards Vessel	Swimming, Diving, Fast Travel, Bow-riding	Away from the Vessel
	31	25	160	Swimming	Towards Vessel	Milling, Bow-riding	Away from the Vessel
Atlantic Spotted Dolphin	8	15	160	Porpoising	Towards Vessel	Swimming, Porpoising, Fast Travel, Bow-riding	Parallel to the Vessel in the Opposite Direction
	11	6	160	Surfacing	Towards Vessel	Swimming, Porpoising, Fast Travel, Bow-riding	Parallel to the Vessel in the Opposite Direction
	27	20	160	Porpoising	Towards Vessel	Jumping, Bow-riding	Parallel to the vessel in the Same Direction

Species	Detection No.	No. of Animals	Highest Observed Sound Pressure Level (dB)	Initial behavior	Initial direction in relation to vessel	Subsequent and Final behavior	Subsequent and Final direction in relation to vessel
	32	6	160	Surface Active	Towards Vessel	Jumping, Milling, Bow-riding	Parallel to the Vessel in the Opposite Direction
Striped Dolphin	12	80	160	Fast Travel	Variable	Swimming, Jumping	Away from the Vessel
Short-finned Pilot Whale	15	7	160	Fast Travel	Parallel to the Vessel in the Opposite Direction	Fast Travel	Parallel to the Vessel in the Opposite Direction
Pygmy Killer Whale	16	6	160	Fast Travel	Parallel to the Vessel in the Opposite Direction	Blowing, Moderate Travel	Parallel to the Vessel in the Opposite Direction
Unidentifiable Dolphin	30	2	160	Fast Travel	Parallel to the Vessel in the Opposite Direction	Breaching	Parallel to the Vessel in the Opposite Direction

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

In order to minimize the potential impacts to marine mammals and sea turtles during the MATRIX survey program, PSOs were prepared to implement mitigation measures whenever these protected species were detected approaching, entering, or within the exclusion zones designated in the IHA. There were 10 mitigation actions implemented for protected species during the survey program, including eight power-downs and two shutdowns, totaling two hours 33 minutes. The confirmation of the implementation of each Term and Condition of the Biological Opinion's Incidental Take Statement are described within this report.

Additional mitigation measures in the IHA required that:

- (1) The acoustic source would be shut down if a whale (i.e. Sperm whale or Baleen whale) was observed with a calf, with a "calf" defined as an animal that is both less than two-thirds the body size of an adult and observed to be in close association with an adult, at any distance;
- (2) The acoustic source would be shut down if an aggregation (i.e. six or more animals) of large whales was observed at any distance;
- (3) The acoustic source would be shut down if a marine mammal species not authorized for take was observed entering or approaching the Level B harassment zone;
- (4) The acoustic source would be shut down if an authorized marine mammal species reached its total allotted Level B harassment that entered or approached the vessel's respective Level B harassment zone.

Throughout the MATRIX seismic survey program, only one of these additional mitigation measures were required to be implemented: a shutdown for an aggregation of five adult sperm whales and one calf, described in Detection 13.

The IHA and ITS also outlined mitigation exceptions for five dolphin genera, including *Tursiops*, *Steno*, *Stenella*, *Lagenorhynchus*, and *Delphinus*. If observers could positively identify these species upon initial detection, a mitigation action of a power down would be required if they were observed approaching, entering, or within the 100 meter EZ. However, if there was any uncertainty to the species identification, a mitigation action of a shutdown would be implemented per normal procedures.

In the event that an injured or dead protected species was discovered during the course of the survey program, and the lead visual observer determined that the cause of death was unknown or unrelated to the activities of the vessel, the incident was to be immediately reported. The report would include a detailed description of the incident, including pictures when possible, and information about the vessel's activities within the 24 hours prior to the discovery of the injured/dead protected species. Throughout the MATRIX seismic survey program, there were no such sightings.

The monitoring and mitigation measures required by the IHA appear to have been an effective means to protect the marine species encountered during survey operations.

7. LITERATURE CITED

NMFS, 2018. Biological Opinion on the U.S. Geological Survey's Marine Geophysical Survey by the R/V Hugh R. Sharp in the Northwest Atlantic Ocean and National Marine Fisheries Service Permits and Conservation Division's Issuance of an Incidental Harassment Authorization pursuant to Section 101(a)(5)(D) of Marine Mammal Protection Act.

APPENDIX A

Incidental Harassment Authorization for the MATRIX Geophysical Survey



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

INCIDENTAL HARASSMENT AUTHORIZATION

The United States Geological Survey (USGS) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371(a)(5)(D)) to harass marine mammals incidental to a marine geophysical survey in the Atlantic Ocean, when adhering to the following terms and conditions.

1. This IHA is valid for a period of one year from the date of issuance.
2. This IHA is valid only for marine geophysical survey activity, as specified in the USGS IHA application and using an airgun array aboard the *R/V Hugh R. Sharp* with characteristics specified in the application.
3. General Conditions
 - (a) A copy of this IHA must be in the possession of USGS, the vessel operator (The University of Delaware) and other relevant personnel, the lead Protected Species Observer (PSO), and any other relevant designees of USGS operating under the authority of this IHA.
 - (b) The species authorized for taking are listed in Table 1. The taking, by Level B harassment only, is limited to the species and numbers listed in Table 1. Any taking exceeding the authorized amounts listed in Table 1 is prohibited and may result in the modification, suspension, or revocation of this IHA.
 - (c) The taking by serious injury or death of any species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA.
 - (d) During use of the airgun(s), if marine mammal species other than those listed in Table 1 are detected by PSOs, the acoustic source must be shut down to avoid unauthorized take.
 - (e) The USGS scientist-in-charge or his/her designee shall ensure that the vessel operator and other relevant vessel personnel are briefed on all responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements prior to the start of survey activity, and when relevant new personnel join the survey operations.

4. Mitigation Requirements

The holder of this Authorization is required to implement the following mitigation measures:

- (a) USGS must use at least three (3) dedicated, trained, NMFS-approved PSOs. The PSOs must have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with



regard to the presence of marine mammals and mitigation requirements. PSO resumes shall be provided to NMFS for approval.

- (b) At least one PSO must have a minimum of 90 days at-sea experience working as a PSO during a seismic survey, with no more than eighteen months elapsed since the conclusion of the at-sea experience. One experienced PSO shall be designated as the lead for the entire protected species observation team. The lead PSO shall serve as primary point of contact for the USGS scientist-in-charge or his/her designee.
- (c) Visual Observation:
 - (i) During survey operations (*e.g.*, any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), at least one PSO must be on duty and conducting visual observations at all times during daylight hours (*i.e.*, from 30 minutes prior to sunrise through 30 minutes following sunset).
 - (ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up, including for nighttime ramp-ups of the airgun array, and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.
 - (iii) PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.
 - (iv) PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours observation per 24-hour period.
 - (v) During good conditions (*e.g.*, daylight hours; Beaufort sea state 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating (except during transits across the shelf where no seismic activity shall occur during the survey) for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.
- (d) Exclusion Zone(EZ) and Buffer Zone – PSOs shall establish and monitor a 100 m EZ and an additional 100 m buffer zone beginning from the outside extent of the 100 m EZ. The zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals outside the EZ but within the 100 m buffer zone from any element of the airgun

array shall be communicated to the USGS scientist-in-charge or his/her designee to prepare for potential further mitigation measures as described below. During use of the acoustic source, occurrence of marine mammals within the EZ shall trigger further mitigation measures as described below.

- (i) Ramp-up – A ramp-up procedure is required at all times as part of the activation of the acoustic source. Ramp-up shall begin with starting one airgun with an additional airgun being activated every 5 minutes until all four airguns are in operation.
- (ii) If the airgun array has been shut down due to a marine mammal detection, ramp-up shall not occur until all marine mammals have cleared the EZ. A marine mammal is considered to have cleared the EZ if:
 1. It has been visually observed to have left the EZ; or
 2. It has not been observed within the EZ, for 15 minutes (in the case of small odontocetes) or for 30 minutes (in the case of mysticetes and large odontocetes including sperm, pygmy and dwarf sperm, beaked whales, and large delphinids)
- (iii) Thirty minutes of pre-clearance observation of the 100 m EZ and 100 m buffer zone are required prior to ramp-up. This pre-clearance period may occur during any vessel activity. If any marine mammal (including delphinids) is observed within or approaching the EZ or 100 m buffer zone during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the EZ or 100 m buffer zone or until an additional time period has elapsed with no further sightings (*i.e.*, 15 minutes for small odontocetes and 30 minutes for mysticetes and large odontocetes including sperm, pygmy and dwarf sperm, beaked whales, and large delphinids).
- (iv) During ramp-up, at least two PSOs shall conduct monitoring. If a marine mammal is observed within or approaching the 100 m EZ during ramp-up, a shutdown shall be implemented as though the full array were operational. Ramp-up may not begin again until the animal(s) has been observed exiting the 100 m EZ or until an additional time period has elapsed with no further sightings in the 100 m EZ (*i.e.*, 15 minutes for small odontocetes and 30 minutes for mysticetes and large odontocetes including sperm, pygmy and dwarf sperm, beaked whales, and large delphinids).
- (v) If the airgun array has been shut down for reasons other than mitigation (*e.g.*, mechanical difficulty) for a period of less than 30 minutes, it may be activated again without ramp-up if PSOs have maintained constant visual observation and no visual detections of any marine mammal have occurred within the 100 m EZ or 100 m buffer zone.

- (vi) Ramp-up at night and at times of poor visibility shall only occur where operational planning cannot reasonably avoid such circumstances. Ramp-up may occur at night and during poor visibility if the 100 m EZ and 100 m buffer zone have been continually monitored by visual PSOs for 30 minutes prior to ramp-up with no marine mammal detections.
 - (vii) The USGS scientist-in-charge or his/her designee must notify a designated PSO of the planned start of ramp-up. The designated PSO must be notified again immediately prior to initiating ramp-up procedures and the USGS scientist-in-charge or his/her designee must receive confirmation from the PSO to proceed.
- (e) Shutdown requirements – A 100 m EZ shall be established and monitored by PSOs. If a marine mammal is observed within or entering the 100 m exclusion zone all airguns shall be shut down.
- (i) The USGS scientist-in-charge or his/her designee must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the airgun array to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch.
 - (ii) When a shutdown is called for by a PSO, the shutdown must occur and any dispute resolved only following shutdown.
 - (iii) The shutdown requirement is waived for dolphins of the following genera: *Tursiops*, *Steno*, *Stenella*, *Lagenorhynchus* and *Delphinus*. Instead of shutdown, the acoustic source must be powered down to the smallest single element of the array if a dolphin of the indicated genera appears within or enters the 100-m exclusion zone. If there is uncertainty regarding identification (*i.e.*, whether the observed animal(s) belongs to the group described above), shutdown must be implemented. Power-down conditions shall be maintained until the animal(s) are no longer observed within the exclusion zone, following which full-power operations may be resumed without ramp-up. PSOs may elect to waive the power-down requirement if the animal(s) appear to be voluntarily approaching the vessel for the purpose of interacting with the vessel or towed gear, and may use best professional judgment in making this decision.
 - (iv) Upon implementation of a shutdown, the source may be reactivated under the conditions described above. Where there is no relevant zone (*e.g.*, shutdown due to observation of a calf), a 30-minute clearance period must be observed following the last observation of the animal(s).
 - (v) Shutdown of the array is required upon observation of a whale (*i.e.*, sperm whale or any baleen whale) with calf, with “calf” defined as an animal less

than two-thirds the body size of an adult observed to be in close association with an adult, at any distance.

- (vi) Shutdown of the array is required upon observation of an aggregation (*i.e.*, six or more animals) of large whales of any species (*i.e.*, sperm whale or any baleen whale) at any distance.
 - (vii) Shutdown of the array is required upon observations of a marine mammal species not authorized for take that is entering or approaching the Level B harassment zone shown in Table 2.
 - (viii) Shutdown of the array is required upon observations of an authorized marine mammal species that has reached its total allotted Level B harassment (Table 1) that is entering or approaching the vessel's respective Level B harassment zone (See Table 2).
- (f) Vessel Strike Avoidance – The USGS, PSOs, vessel operator, and crew must maintain a vigilant watch for all marine mammals and the vessel operator must slow down or stop the vessel or alter course, as appropriate, to avoid striking any marine mammal. These requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena.
- (i) The vessel must, to the maximum extent practicable, maintain a minimum separation distance of 100 m from large whales except for north Atlantic right whales which the vessel must maintain a minimum separation distance of 500 m. The following avoidance measures must be taken if a large whale is within 100 m of the vessel or a north Atlantic right whale is 500 m from the vessel:
 1. The vessel must reduce speed and shift the engine to neutral, when feasible, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.
 2. If the vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m.
 - (ii) The vessel must attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for animals described in 4(e)(iv) that approach the vessel. If an animal is encountered

during transit, the vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

- (iii) Vessel speeds must be reduced to 10 knots or less when mother/calf pairs or large assemblages of cetaceans are observed within 500 m of the vessel. Mariners may use professional judgment as to when such circumstances warranting additional caution are present.

(g) Stranding Measures

- (i) In the event of a live stranding (or near-shore atypical milling) event within 50 km of the survey operations, where the NMFS stranding network is engaged in herding or other interventions to return animals to the water, the Director of the Office of Protected Resources (OPR), NMFS (or designee) will advise the IHA-holder of the need to implement shutdown procedures for all active acoustic sources operating within 50 km of the stranding. Shutdown procedures for live stranding or milling marine mammals include the following:

1. If at any time, the marine mammal(s) die or are euthanized, or if herding/intervention efforts are stopped, the Director of OPR, NMFS (or designee) will advise the IHA-holder that the shutdown is no longer needed.
2. Otherwise, shutdown procedures will remain in effect until the Director of OPR, NMFS (or designee) determines and advises the IHA-holder that all live animals involved have left the area (either of their own volition or following an intervention).
3. If further observations of the marine mammals indicate the potential for re-stranding, additional coordination with the IHA-holder will be required to determine what measures are necessary to minimize that likelihood (e.g., extending the shutdown or moving operations farther away) and to implement those measures as appropriate.

(h) Miscellaneous Protocols

- (i) The airgun array must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Operational capacity of 840 in³ (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

- (ii) Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.*, ramp-up). Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring shall be conducted in accordance with the following requirements:

- (a) The USGS scientist-in-charge or his/her designee must provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.
- (b) PSOs must also be equipped with reticle binoculars (*e.g.*, 7 x 50) of appropriate quality (*e.g.*, Fujinon or equivalent), Big Eye binoculars, GPS, compass, and any other tools necessary to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals.
- (c) PSO Qualifications
 - (i) PSOs must have successfully completed relevant training, including completion of all required coursework and passing a written and/or oral examination developed for the training program.
 - (ii) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.
- (d) Data Collection – PSOs must use standardized data forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not

implemented, PSOs should submit a description of the circumstances. We require that, at a minimum, the following information be reported:

- (i) PSO names and affiliations;
- (ii) Dates of departures and returns to port with port name;
- (iii) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;
- (iv) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts;
- (v) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change;
- (vi) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon.
- (vii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.*, vessel traffic, equipment malfunctions);
- (viii) Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.*, pre-ramp-up survey, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.); and
- (ix) If a marine mammal is sighted, the following information should be recorded:
 1. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
 2. PSO who sighted the animal;
 3. Time of sighting;
 4. Vessel location at time of sighting;
 5. Water depth;
 6. Direction of vessel's travel (compass direction);
 7. Direction of animal's travel relative to the vessel;

8. Pace of the animal;
9. Estimated distance to the animal and its heading relative to vessel at initial sighting;
10. Identification of the animal (*e.g.*, genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species.
11. Estimated number of animals (high/low/best);
12. Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);
13. Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);
14. Detailed behavior observations (*e.g.*, number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);
15. Animal's closest point of approach and/or closest distance from the center point of the acoustic source;
16. Platform activity at time of sighting (*e.g.*, deploying, recovering, testing, shooting, data acquisition, other); and
17. Description of any actions implemented in response to the sighting (*e.g.*, delays, shutdown, ramp-up, speed or course alteration, etc.) and time and location of the action.

6. Reporting

- (a) USGS shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). Geospatial data regarding locations where the acoustic source was used must be provided as an ESRI shapefile with all necessary files and appropriate metadata. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the data collected as required under condition 5(d) of this IHA. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly

to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments from NMFS on the draft report.

(b) Reporting injured or dead marine mammals:

(i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not prohibited by this IHA (if issued), such as serious injury or mortality, USGS shall immediately cease the specified activities and immediately report the incident to the NMFS Office of Protected Resources (301-427-8401) and to the Greater Atlantic Regional (978-282-8478) and Southeastern Regional (877-433-8299) stranding coordinators as soon as feasible. The report must include the following information:

1. Time, date, and location (latitude/longitude) of the incident;
2. Species identification (if known) or description of the animal(s) involved;
3. Condition of the animal(s) (including carcass condition if the animal is dead);
4. Observed behaviors of the animal(s), if alive;
5. If available, photographs or video footage of the animal(s); and
6. General circumstances under which the animal was discovered.

(ii) In the event of a ship strike of a marine mammal by any vessel involved in the activities covered by the authorization, the IHA-holder shall report the incident to OPR, NMFS and to regional stranding coordinators as soon as feasible. The report must include the following information:

1. Time, date, and location (latitude/longitude) of the incident;
2. Species identification (if known) or description of the animal(s) involved;
3. Vessel's speed during and leading up to the incident;
4. Vessel's course/heading and what operations were being conducted (if applicable);
5. Status of all sound sources in use;
6. Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;

7. Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;
 8. Estimated size and length of animal that was struck;
 9. Description of the behavior of the marine mammal immediately preceding and following the strike;
 10. If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;
 11. Estimated fate of the animal (*e.g.*, dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and
 12. To the extent practicable, photographs or video footage of the animal(s).
- (iii) If NMFS determines that the circumstances of any marine mammal stranding found in the vicinity of the activity suggest investigation of the association with survey activities is warranted (example circumstances noted below), and an investigation into the stranding is being pursued, NMFS will submit a written request to the IHA-holder indicating that the following initial available information must be provided as soon as possible, but no later than 7 business days after the request for information.
1. Status of all sound source use in the 48 hours preceding the estimated time of stranding and within 50 km of the discovery/notification of the stranding by NMFS; and
 2. If available, description of the behavior of any marine mammal(s) observed preceding (*i.e.*, within 48 hours and 50 km) and immediately after the discovery of the stranding.

In the event that the investigation is still inconclusive, the investigation of the association of the survey activities is still warranted, and the investigation is still being pursued, NMFS may provide additional information requests, in writing, regarding the nature and location of survey operations prior to the time period above.

- (iv) Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with USGS to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. USGS may not resume their activities until notified by NMFS;
- (v) In the event that USGS discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is

unknown and the death is relatively recent (*e.g.*, in less than a moderate state of decomposition), USGS shall immediately report the incident to the NMFS Office of Protected Resources. The report must include the same information identified in condition 6(b)(i) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with USGS to determine whether additional mitigation measures or modifications to the activities are appropriate.

(vi) In the event that USGS discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), USGS shall report the incident to the NMFS Office of Protected Resources within 24 hours of the discovery. USGS shall provide photographs or video footage or other documentation of the sighting to NMFS.

7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.



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

AUG 06 2018

Date

Attachments

Table 1 Numbers of Incidental Take Authorized

Species	Level B take **	Level A take
Humpback whale	3	0
Sei whale	3	0
Fin whale	5	0
Sperm whale	161	0
<i>Kogia</i> spp.	9	0
Beaked whales	128	0
Northern bottlenose whale*	4*	0
Rough-toothed dolphin	10	0
Common bottlenose dolphin	757	0
Clymene dolphin	122	0
Atlantic spotted dolphin	1598	0
Pantropical spotted dolphin	50	0
Spinner dolphin*	91*	0
Striped dolphin	1459	0
Short-beaked common dolphin	1620	0
Fraser's dolphin*	204*	0
Atlantic white-sided dolphin*	48*	0
Risso's dolphin	237	0
Melon-headed whale*	50*	0
Pygmy killer whale*	6*	0
False killer whale*	28*	0
Killer whale*	7*	0
Pilot whales	288	0

*Number represents Level B take of a single group for rare species in the action area.

Table 2 Modeled radial distances [m] to Level B harassment thresholds.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Radii (m)
			160 dB
Base Configuration (Configuration 1) Four 105 in³ GI-guns	3	>1000 m	1091m
		100–1000 m	1637m
GG Configuration (Configuration 2) Four 210 in³ GI-guns	3	>1000 m	1244m
		100–1000 m	1866m

APPENDIX B: Basic Data Summary Form

BASIC DATA FORM			
RPS Project Number		200126	
Seismic Contractor		United States Geophysical Surveys (USGS)	
Area Surveyed During Reporting Period		39°.18 NE, 70°70 SE 34°48 NW; 75°38 SW	
Survey Type		2-D Research	
Vessel and/or Rig Name		R/V <i>Hugh R. Sharp</i>	
Permit Number		06 August 2018	
Location / Distance of Airgun Deployment		Aft of PSO tower: 41 meters	
Water Depth	Min	100	
	Max	3,500	
Dates of project		08 August 2018	THROUGH 28 August 2018
Total time airguns operating – all power levels:		302:11	
Time airguns operating on survey lines:		294:48	
Time airguns operating not on a survey line:		00:00	
Amount of time in ramp-up:		05:00	
Number daytime ramp-ups:		11	
Number of night time ramp-ups:		4	
Number of ramp-ups from mitigation source:		0	
Amount of time conducted in airgun testing:		00:53	
Duration of visual observations:		264:10	
Duration of observations while source active:		166:57	
Duration of observation during source silence:		97:13	
Lead Protected Species Observer:		Bianca Mares	
Protected Species Observers:		Lilia Oyosa, Lluvia Durantes	
Number of Marine Mammals Visually Detected:		30	
Number of Sea Turtles detected:		3	
Total Number of Protected Species Detections:		33	
List Mitigation Actions		Eight power-downs (00:44) and two shutdowns (01:49)	
Duration of operational downtime due to mitigation:		02:33 (production loss)	

APPENDIX C: Survey Lines Acquired

Survey Line	Date Acquisition Commenced	Time Acquisition Commenced (UTC)	Date Acquisition Completed	Time Acquisition Completed (UTC)
MX01	2018-08-10	05:14	2018-08-11	16:29
MX02	2018-08-11	20:08	2018-08-12	05:15
MX03	2018-08-12	06:20	2018-08-13	02:31
MX04	2018-08-13	18:18	2018-08-13	21:29
MX05	2018-08-13	21:31	2018-08-14	02:27
MX06	2018-08-14	03:49	2018-08-14	18:17
MX07	2018-08-14	19:22	2018-08-15	18:43
MX08	2018-08-15	19:58	2018-08-16	01:39
MX09	2018-08-16	03:51	2018-08-17	08:46
MX10	2018-08-17	10:02	2018-08-17	16:00
MX11	2018-08-20	00:09	2018-08-20	11:04
MX12, part 1	2018-08-20	12:34	2018-08-21	12:10
MX13	2018-08-23	11:55	2018-08-24	18:04
MX14	2018-08-24	21:02	2018-08-25	00:56
MX12, part 2	2018-08-25	02:10	2018-08-25	09:40
MX15	2018-08-25	11:43	2018-08-25	23:22
MX16	2018-08-26	00:10	2018-08-26	21:24
MX17	2018-08-26	22:02	2018-08-27	02:42
MX18	2018-08-27	03:32	2018-08-28	02:54
MX19	2018-08-28	03:46	2018-08-28	10:08

APPENDIX D: Summary of Visual Detections

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	CPA Source / Source Activity	Mitigation Action	Comments
1	2018-08-08	20:56	Loggerhead Sea Turtle	1	38.51152°N 074.42803°W	Silent	Silent	None	Detection last one minute. Vessel was in transit to project area, source was onboard.
2	2018-08-08	21:20	Unidentified Shelled Sea Turtle	1	38.84083°N 074.59950°W	Silent	Silent	None	Detection last one minute. Vessel was in transit to project area, source was onboard.
3	2018-08-09	12:27	Atlantic Spotted Dolphin	25	38.30448°N 072.48195°W	Silent	Silent	None	Detection last 21 minutes. Vessel was in transit to project area, source was onboard.
4	2018-08-10	11:48	Sperm Whale	3	37.70973°N 072.87253°W	Full volume on line	Full volume on line	none	Detection lasted 6 minutes. No mitigation actions were required. Whales never entered EZ or Take zone. Mitigation actions not needed.
5	2018-08-10	12:39	Sperm Whale	1	37.68353°N 072.89084°W	Full volume on line	Full volume on line	none	Detection lasted 7 minutes. No mitigation actions were required. Whales never entered EZ or Take zone. Mitigation actions not needed.
6	2018-08-10	16:39	Sperm Whale	3	36.20933°N 073.92617°W	Silent	Silent	none	Detection lasted 54 minutes. Source was silent. No mitigation actions necessary.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	CPA Source / Source Activity	Mitigation Action	Comments
7	2018-08-13	21:34	Common Bottlenose Dolphin	6	35.83561°N 074.48568°W	Full volume on line	Reduced Volume While on line	Power down	Detection lasted three minutes. Sourced was powered down, mitigation action lasted three minutes. Level B Take for 6 common bottlenose dolphins.
8	2018-08-13	22:50	Atlantic Spotted Dolphin	15	35.86345°N 074.58376°W	Full volume on line	Silent	Shut down	Detection lasted four minutes. A shutdown was requested because identification of the dolphins wasn't confirmed until they were closer. Total production lost was 54 minutes.
9	2018-08-13	23:54	Common Bottlenose Dolphin	20	35.8845°N 074.00000°W	Full volume on line	Full volume while on line	None	Detection lasted five minutes. Sourced was at full power during the entire detection. Dolphins never entered EZ, mitigation action not needed. Level B Take for 20 common bottlenose dolphins.
10	2018-08-13	11:26	Common Bottlenose Dolphin	5	36.52067°N 074.28833°W	Full volume on line	Full volume on line	Power down	Detection lasted two minutes. Sourced was powered down, mitigation action lasted two minutes. Level B Take for five common bottlenose dolphins.
11	2018-08-14	23:37	Atlantic Spotted Dolphin	6	36.52067°N 074.28833°W	Full volume online	Reduced volume while on survey line	Power Down	Detection lasted 17 minutes. Sourced was powered down, mitigation action lasted 17 minutes. Level B Take for six Atlantic spotted dolphins.
12	2018-08-16	15:34	Striped Dolphin	80	37.07265°N 073.09293°W	Full volume online	Full volume online	Power Down	Detection lasted 44 minutes. Sourced was powered down, mitigation action lasted five minutes. Level B Take for 80 striped dolphins.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	CPA Source / Source Activity	Mitigation Action	Comments
13	2018-08-16	16:53	Sperm Whale	6	37.07265°S 073.09293°E	Full volume online	Not firing/ Silent	Shut Down	Detection lasted eight minutes. Sourced was shut down, mitigation action lasted three minutes. Production loss of 55 minutes. Level B Take for six sperm whales.
14	2017-11-15	21:46	Sperm Whale	3	37.25919°S 073.48419°E	Full volume online	Full Volume Online	None	Detection lasted 17 minutes. No mitigation actions implemented. Level B take for three sperm whales.
15	2018-08-17	10:49	Short Finned Pilot Whale	7	37.74700° N 074.13383° W	Full volume online	Full volume online	None	Detection lasted five minutes. No mitigation actions implemented.
16	2018-08-17	13:47	Pygmy Killer Whale	6	38.07263°N 074.23098° W	Full volume online	Full volume online	None	Detection lasted six minutes. No mitigation actions implemented. Level B take for six pygmy killer whales.
17	2018-08-17	19:34	Common Dolphin	17	38.07263°N 074.23098° W	Silent	Silent	None	Detection lasted 16 minutes. Source was onboard. No mitigation actions implemented.
18	2018-08-17	19:40	Fin Whale	4	38.11117°N 074.28383° W	Silent	Silent	None	Detection lasted 36 minutes. Source was onboard. No mitigation actions implemented.
19	2019-08-19	20:10	UID Sea Turtle	1	38.11117°N 074.28383° W	Silent	Silent	None	Detection lasted one minute. Source was onboard. No mitigation actions implemented.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	CPA Source / Source Activity	Mitigation Action	Comments
20	2018-08-19	12:30	Common Dolphin	3	38.55844°N 074.23493° W	Silent	Silent	None	Detection lasted two minutes. Source was onboard. No mitigation actions implemented.
21	2018-08-19	12:31	Fin Whale	1	38.55844°N 074.23493° W	Silent	Silent	None	Detection lasted 15 minutes. Source was onboard. No mitigation actions implemented.
22	2018-08-19	15:37	UID Dolphin	6	38.38762°N 073.73731° W	Silent	Silent	None	Detection lasted five minutes. Source was onboard. No mitigation actions implemented.
23	2018-08-19	16:35	UID Dolphin	6	38.33122°N 073.62248° W	Silent	Silent	None	Detection lasted five minutes. Source was onboard. No mitigation actions implemented.
24	2018-08-20	19:11	Sperm Whale	1	38.63771°N 072.4170° W	Full volume on line	Full volume on line	None	Detection lasted 14 minutes. No mitigation actions implemented. Level B take for one sperm whale.
25	2018-08-21	15:50	Sperm Whale	2	38.00471°N 071.79223° W	Silent	Silent	None	Detection lasted four minutes. Source was onboard. No mitigation actions implemented.
26	2018-08-21	17:42	Common Bottlenose Dolphin	12	38.45787°N 071.34858° W	Silent	Silent	None	Detection lasted five minutes. Source was onboard. No mitigation actions implemented.
27	2018-08-25	20:06	Atlantic Spotted Dolphin	20	38.56716°N 071.34442° W	Full volume online	Full volume Online	Power Down	Detection lasted five minutes. Sourced was powered down, mitigation action lasted three minutes. Level B Take for 20 Atlantic spotted dolphins.

Record No.	Date	Time (UTC)	Species	Group Size	Vessel Position	Source Activity Initial Detection	CPA Source / Source Activity	Mitigation Action	Comments
28	2018-08-25	21:49	Sperm Whale	1	37.77633°N 071.88550° W	Full volume online	Full volume Online	None	Detection lasted four minutes. Source remained active during detection. No mitigation actions implemented. Level B Take for one sperm whale.
29	2018-08-26	15:02	Common Bottlenose Dolphins	8	37.77633°N 071.88550° W	Full volume online	Reduced volume online	Power Down	Detection lasted six minutes. Sourced was powered down, mitigation action lasted six minutes. Level B Take for 8 common bottlenose dolphins.
30	2018-08-27	13:28	UID Dolphin	2	37.61477°N 072.97665° W	Full volume online	Full volume online	None	Detection lasted two minutes. Source was active during entire detection. No mitigation actions implemented. Level B Take for two unidentifiable dolphins.
31	2018-08-27	16:24	Common Bottlenose Dolphins	25	37.71583°N 073.17233° W	Full volume online	Full volume online	Power Down	Detection lasted 11 minutes. Sourced was powered down, mitigation action lasted five minutes. Level B Take for 25 common bottlenose dolphins.
32	2018-08-27	18:08	Atlantic Spotted Dolphin	6	37.77150°N 073.28000° W	Full volume online	Full volume online	Power Down	Detection lasted five minutes. Sourced was powered down, mitigation action lasted five minutes. Level B Take for 6 Atlantic spotted dolphins.
33	2018-08-27	18:53	Fin Whale	1	37.79250°N 073.32100° W	Full volume online	Full volume online	None	Detection lasted 35 minutes. Source was active during entire detection. No mitigation actions implemented. Level B Take for one fin whale.

APPENDIX E: Photographs of Visually Identified Protected Species Detected



Figure 1: Visual Detection #1; Loggerhead sea turtle ; 8 August 2018



Figure 2: Visual Detection #2; UID Sea turtle; 8 August 2018



Figure 3: Visual Detection #3; Atlantic Spotted Dolphin; 9 August 2018



Figure 4: Visual Detection #4; Sperm Whale; 10 August 2018



Figure 5: Visual detection #6; Sperm Whales; 11 August 2018.



Figure 6: Visual detection #11; Atlantic Spotted Dolphin; 14 August 2018.



Figure 7: Visual detection #12; Striped Dolphin; 16 August 2018.



Figure 8: Visual detection #13; Sperm Whale; 16 August 2018.



Figure 9: Visual detection #15; Short finned pilot whales; 17 August 2018.



Figure 10: Visual detection #16; Pygmy Killer Whale; 17 August 2018.



Figure 11: Visual detection #18; Fin whale; 17 August 2018.



Figure 12: Visual detection #20; Short beaked common dolphin; 17 August 2018.



Figure 13: Visual detection #24; Sperm whale; 20 August 2018



Figure 14: Visual detection #25; Sperm whale, 21 August 2018.



Figure 15: Visual detection #27; Atlantic Spotted Dolphins; 25 August 2018.



Figure 16: Visual detection #28; Sperm whale; 25 August 2018.



Figure 17: Visual detection #29; Common bottlenose dolphin; 26 August 2018.



Figure 18: Visual detection #32; Atlantic Spotted Dolphin; 27 August 2018.



Figure 19: Visual detection #33; Fin Whale; 27 August 2018.

APPENDIX F: Species of Birds and Other Wildlife Observed during the Northwest Atlantic MATRIX Seismic Survey Programs.

Birds: Common Name	Family	Genus	Species	Approximate Number Individuals Observed	Approximate Number of Days Species Was Observed
American redstart	Parulidae	<i>Setophaga</i>	<i>ruticilla</i>	2	2
Barn swallow	Hirundinidae	<i>Hirundo</i>	<i>rustica</i>	2	2
Black-capped petrel	Procellariidae	<i>Pterodroma</i>	<i>hasitata</i>	12	4
Brown pelican	Pelecanidae	<i>Pelecanus</i>	<i>occidentalis</i>	1	1
Cedar waxwing	Bombycillidae	<i>Bombycilla</i>	<i>cedrorum</i>	1	1
Cory's shearwater	Procellariidae	<i>Calonectris</i>	<i>borealis</i>	19	12
Great shearwater	Procellariidae	<i>Ardenna</i>	<i>gravis</i>	14	6
Laughing gull	Laridae	<i>Leucophaeus</i>	<i>atricilla</i>	2	2
Masked booby	Sulidae	<i>Sula</i>	<i>dactylatra</i>	1	1
Red necked phalarope	Scolopacidae	<i>Phalaropus</i>	<i>dobatus</i>	12	1
Rock pigeon	Columbidae	<i>Columba</i>	<i>livia</i>	1	1
White-tailed tropicbird	Phaethontidae	<i>Phaethon</i>	<i>lepturus</i>	1	1
Yellow warbler	Parulidae	<i>Setophaga</i>	<i>petechia</i>	1	1
Fish: Common Name	Family	Genus	Species	Approximate Number Individuals Observed	Approximate Number of Days Species Was Observed
Albacore tuna	Scombridae	<i>Thunnus</i>	<i>alalunga</i>	12	2
Balloon fish	Tetraodontidae	<i>UID</i>	<i>UID</i>	1	1
Cobia fish	Rachycentridae	<i>Rachycentron</i>	<i>canadum</i>	1	1
Flying fish	Exocoetidae	<i>UID</i>	<i>UID</i>	578	18
Mahi	Coryphaenidae	<i>Coryphaena</i>	<i>hippurus</i>	2	1
Porcupine fish	Diodontidae	<i>UID</i>	<i>UID</i>	1	1
Tripletail	Lobotidae	<i>Lobotes</i>	<i>surinamensis</i>	1	1
UID shark	N/A	<i>UID</i>	<i>UID</i>	1	1
Marine Invertebrates: Common Name	Family	Genus	Species	Approximate Number Individuals Observed	Approximate Number of Days Species Was Observed
Cannonball jellyfish	Stomolophidae	<i>Stomolophus</i>	<i>meleagris</i>	15	3
Moon jellyfish	Ulmaridae	<i>Aurelia</i>	<i>aurita</i>	42	4
Portuguese man-o-war	Physaliidae	<i>Physalia</i>	<i>physalis</i>	4	2