Protected Species Observer Technical Report
Deepwater Wind Skipjack Wind Project
Delaware Lease Area OCS-A 0482
Maryland and Delaware 2018

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Acronyms and Abbreviations

AMP	Alternative Monitoring Plan
Bft	Beaufort
BH	Bore Hole
BOEM	Bureau of Ocean Energy Management
bsf	Below sea floor
CPA	Closest Point of Approach
CPT	Cone Penetration Test
CSA	Continental Shelf Associates, Inc.
dB	decibel(s)
DCPT	Downhole Cone Penetration Test
Delphinoid	Super family including dolphins and harbor porpoise
DMA	Dynamic Management Area
DP	Dynamic Positioning
DPT	Dynamic Positioning Thrusters
DVR	Digital Video Recorder
EZ	Exclusion Zone
ESA	Endangered Species Act
ft	foot/feet
G&G	Geophysical and Geotechnical
GZA	GZA GeoEnvironmental, Inc.
h	hour(s)
HD	High-definition
HF	High-frequency
HRG	High-resolution Geophysical
Hz	hertz
IHA	Incidental Harassment Authorization
IR	Infrared
ITS	Incidental Take Statement
JSA	Job safety analysis
kHz	kilohertz
km	kilometer(s)
LF	Low-frequency
MD	Maryland
MF	Mid-frequency
MMPA	Marine Mammal Protection Act
m	meter(s)
min	minute(s)
MMPA	Marine Mammal Protection Act
Mn	*Megaptera novaeangliae*, humpback whale
M/V	Merchant Vessel
NA IDQ	National Instruments Data Acquisition
NARW	North Atlantic right whale (*Eubalaena glacialis*)
NGO	Non-governmental Organization

NJ	New Jersey
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NVD	Night Vision Device
OSV	Offshore Support Vessel
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
POC	Point of Contact
PSO	Protected Species Observer
RADES™	Real-time Automated Distance Estimation Software
RB	Reticle Binoculars
RHVM	Remote High-definition Visual Monitoring
rms	Root Mean Square
SAP	Site Assessment Plan
SCPT	Seismic Cone Penetration Test
SMA	Seasonal Management Area
SSV	Sound Source Verification
TDOA	Time Difference of Arrival
Tt	*Tursiops truncatus*, bottlenose dolphin
UE	Unaided Eye
U.S.C.	U.S. Code
VHF	Very High Frequency
WTG	Wind Turbine Generator

1 Introduction

1.1 Background

Deepwater Wind/Garden State Offshore Energy, LLC (Deepwater Wind) selected Oceaneering International, Inc. (Oceaneering) and GZA GeoEnvironmental, Inc. (GZA) to conduct geophysical and geotechnical (G&G) surveys for the development of the Skipjack Wind Farm, an offshore wind energy project, herein referred to as Skipjack Wind Project. The G&G surveys were conducted from July 2018 to January 2019 and occurred off the Maryland and Delaware coasts in the Bureau of Ocean Energy Management (BOEM) Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf Lease Area OCS-A-0482, referred to throughout this report as the Lease Area (Figure 1). This Lease Area was recently split into OCS-A-0482 and OCS-A-0519, but herein refers to both Lease Areas as the Lease Area.

The purpose of the G&G surveys was to provide seabed and sub-surface soils information to optimize the siting and development of the Skipjack Wind Farm and two potential cable shore approaches (i.e., cable approach). Geotechnical surveys were conducted from the Merchant Vessel (*M/V*) *Danielle Miller* (*Danielle Miller*) and the stationary lift boat, *GZA Seacor Supporter* (*Seacor Supporter*). High-resolution geophysical (HRG) surveys were conducted by the *Danielle Miller* and the *M/V Samantha Miller (Samantha Miller)*. The *Samantha Miller* was limited to operating during daylight hours and returned to the dock each evening. The *Seacor Supporter* and the *Danielle Miller* conducted operations 24 hours (h)-per-day.

The scope of work for the geotechnical investigation involved the use of shallow seabed cone penetration testing (CPT), vibracores, and drill coring. HRG efforts included multibeam depth sounders, shallow penetration sub-bottom (e.g., chirp) profiling, medium penetration sub-bottom profiler or sparker energy sources, side scan sonar, and magnetometer surveying of the Lease Area and cable approach.

Smultea Environmental Sciences, LLC. (Smultea Sciences) was contracted by Deepwater Wind through CSA Ocean Sciences, Inc. (CSA) to conduct monitoring and mitigation for protected species including marine mammals, sea turtles, and Atlantic sturgeon. Protected Species Observers (PSOs), passive acoustic monitoring (PAM) equipment and technicians, and night vision equipment were provided, as required by the BOEM Lease OCS-A-0482 (https://www.boem.gov/SIGNED-Fully-Executed-Lease-Amendment-OCS-A-0490/) (https://www.boem.gov/Assignment-of-Lease-OCS-A-0482/). The primary on-site responsibilities of the PSO and PAM teams were to monitor for protected marine species and implement mitigation measures to avoid and minimize potential adverse impacts to those species by conducting visual observations 24-h per day and PAM during nighttime and daylight periods when exclusion zone (EZ) visibility was limited.

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) issued an Incidental Harassment Authorization (IHA) to Ocean Wind on 15

May 2018 under the authority of section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1361 *et seq*.). This IHA was issued to allow takes of small numbers of marine mammals, by Level B harassment, incidental to HRG and geotechnical survey investigations. The activities for the Skipjack Wind Project permitted under the IHA are described in the project IHA Application (https://www.fisheries.noaa.gov/action/incidental-take-authorization-garden-state-offshore-energy-geophysical-survey-skipjack-wind) and Site Assessment Plan submitted to BOEM.

Prior to starting the G&G survey, an acoustic field verification test (i.e., Sound Source Verification [SSV]) was performed to measure the sound levels produced by the G&G sound sources and verify that the proposed 500-m EZ identified in the NMFS-issued IHA was sufficient for mitigating impacts to protected marine species (as required by BOEM and NMFS).

1.2 BOEM and NMFS Reporting Requirements

This Protected Species Technical Report summarizes information required by the NMFS-issued IHA and BOEM Lease OCS-A-0482 as identified in Appendix A, *NMFS and BOEM Protected Species Reporting Requirements*. Data recorded in the field were collected by Smultea Sciences and provided to Deepwater Wind in a Microsoft Excel database that includes the specific data elements identified in BOEM Lease OCS-A-0482.

1.3 Report Organization

This Protected Species Observer Technical Report fulfills the G&G survey reporting requirements identified in the NMFS-issued IHA for this project, BOEM Lease Information, and Alternative Monitoring Plan (AMP). For this report "inside the Lease Area" is defined as any area within Lease Area OCS-A-0482 (outlined in green in Figure 1). The definition of the term "Survey Areas" as used throughout this report includes the Lease Area, the potential cable approach, and the transit routes of project vessels between the two.

To addresses the reporting requirements of the IHA, Lease, and AMP, this report includes the following sections: Survey Overview, Monitoring and Mitigation Program, Results, Take Assessment, Discussion, Recommendations, and Literature Cited. Appendices A-I provide additional information including a list of BOEM/IHA requirements; photos of the three project vessels; supplementary tables with the behavioral state of species observed during the surveys; and list of data variables and their definitions; the daily PSO/PAM report template; a list of the G&G survey equipment; the AMP effectiveness report required per the Lease stipulations; North Atlantic right whale (NARW) sighting reports; and selected protected species photographs taken during the G&G surveys by the PSO/PAM team.

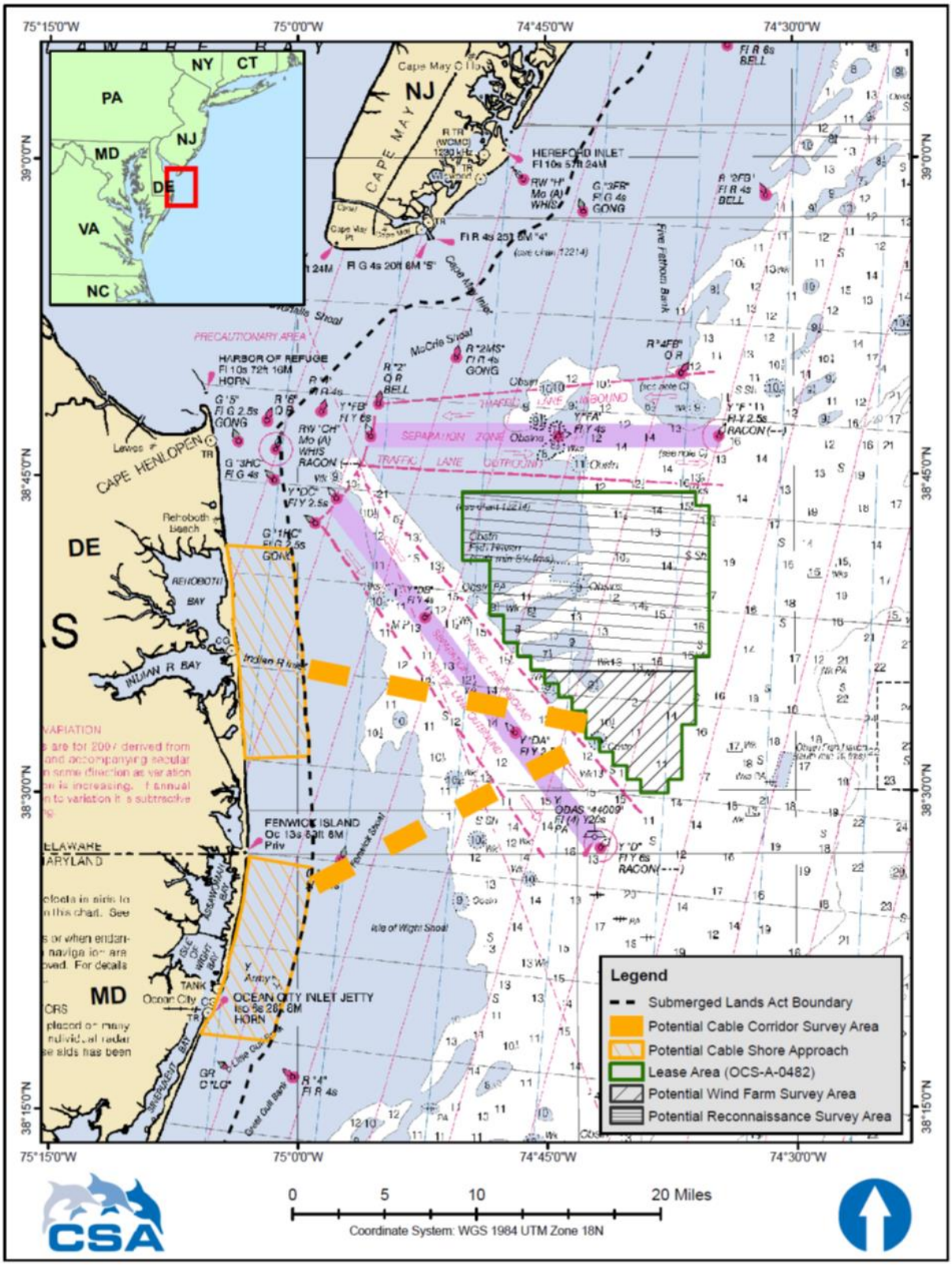

Figure 1. Skipjack Wind Farm Lease Area.

2 Survey Overview

2.1 Summary of Geotechnical and Geophysical Survey Activities

The Skipjack Wind Project G&G surveys were performed from July 2018 to January 2019 using three marine vessels: the *Samantha Miller*, the *Danielle Miller*, and the *Seacor Supporter* (Appendix B).

The completed scope for the Skipjack Wind Farm aboard the *Danielle Miller* included 366 HRG lines, 51 seabed CPT, and 51 shallow vibracores. The *Samantha Miller* scope entailed 265 shallow HRG lines and the *Seacor Supporter's* comprised seven geotechnical boring locations. Surveys were conducted in water depths of 16 to 28 meters (m) (52 to 92 feet [ft]) at the Lease Area and 12 to 28 m (39 to 92 ft) along potential cable shore approaches.

Surveys aboard the *Danielle Miller*, a 40-m Offshore Support Vessel (OSV)/Survey vessel, occurred between 11 August 2018 and 22 November 2018 for HRG, and 28 November 2018 to 19 January 2019 for shallow geotechnical (Table 1). Deep geotechnical surveys were conducted in the Lease Area aboard the *Seacor Supporter*, a 40-m Class 200' liftboat, between 23 September 2018 and 19 October 2018. Further HRG surveys were completed along the potential cable shore approaches aboard the *Samantha Miller,* a 19.81-m research and offshore supply vessel used for inshore geophysical work and sediment profile imaging, between 24 July 2018 and 26 August 2018. Start dates within this report for the *Samantha Miller* and the *Danielle Miller* reflect when protected species monitoring began, but not necessarily when the G&G surveys initiated. PSO monitoring was conducted in accordance with vessel strike avoidance mitigation requirements as the vessels transited between the dock and the Survey Area, to attempt an SSV, or to check weather suitability to begin operations. The *Seacor Supporter* was jacked up and in position when the protected species team boarded the vessel and monitoring began. Detections made before G&G surveys began were recorded using the same methodology as when equipment was operating, detailed further in Section 3.4.

PSO visual efforts occurred 24-h-per-day aboard the *Danielle Miller* and *Seacor Supporter* throughout the survey and during the *Danielle Miller's* transits per BOEM Lease OCS-A0482 and IHA requirements, and the AMP. Due to the limitations caused by the vessel's spud design, the *Supporter* did not transit to the dock. Instead, crew changes and re-supplies were carried out by the 31.7-m utility vessel *M/V Matthew Hughes*. Nighttime and limited-visibility visual efforts were augmented with night vision devices (NVDs) (Section 3.2.2) and infrared thermal camera systems (Section 3.2.3). PAM was also conducted at night and during daylight hours when visibility was limited (i.e., fog). The only exception to 24-h visual observations occurred when operations were suspended, usually for weather, and the *Danielle Miller* was at anchor or the *Seacor Supporter* was spuds down. The *Samantha Miller* was limited to daylight operations and transited daily between the dock and Survey Area. PSO visual efforts aboard the *Samantha Miller* occurred approximately 12-h-per-day, depending on weather. A PAM system was always available for use but was not needed as limited visibility did not occur during the *Samantha Miller's* surveys. Visual monitoring

during darkness which required the use of NVDs occurred once to complete transit from the dock.

Table 1. Geophysical and geotechnical summary of event dates during the Skipjack Wind Farm Project 2018.

Event	Date
Skipjack Wind Project: Geophysical	
Samantha Miller mobilization from dock at Ocean City, MD; PSO/PAM team board vessel, begin first day of PSO visual effort during daylight periods	24 July 2018
Sound Source Verification (SSV) with 24-h PSO visual effort (no PAM effort)	26 July 2018
SSV Report submitted to BOEM	3 August 2018
Geophysical operations begin, PSO team stays onshore each night, observes all daylight periods from *Samantha Miller*.	28 July 2018
Demobilization at Ocean City, MD. PSO/PAM monitoring complete.	26 August 2018
Danielle Miller mobilization and kick-off meeting. Depart dock in Philadelphia, NJ, and transit to Lease Area with first day of 24-h PSO monitoring effort	11 August 2018
Sound Source Verification (SSV) with 24-h PSO visual effort (no PAM effort).	11 - 19 August 2018
Geophysical operations begin.	12 August 2018
Demobilization at Philadelphia, PA to switch to geotechnical phase.	22 November 2018
Skipjack Wind Project: Geotechnical	
Seacor Supporter mobilization from dock; PSO and PAM team board the vessel.	22 September 2018
Geotechnical operations begin with 24-h monitoring effort	23 September 2018
Demobilization at Ocean City, MD. PSO/PAM monitoring complete	19 October 2018
Danielle Miller mobilization from dock in Ocean City, MD. Depart and transit to Lease Area with first day of 24-h PSO monitoring effort during geotechnical operations.	28 November 2018
Demobilization at Philadelphia, PA dock, PSO/PAM monitoring complete.	19 January 2019

3 Monitoring and Mitigation Program

This section describes the protected species monitoring methods and mitigation measures implemented to address requirements specified in the NMFS-issued IHA, BOEM Lease, and AMP. Sections 3.1 through 3.4 pertain to the protected species monitoring methods including a description of the responsibilities and qualifications of PSOs, visual observation and PAM methods, and data collection protocols for species sightings and detection rates. A "detection" is defined as a group of one or more individuals detected visually or acoustically by PAM. The mitigation measures established by BOEM, NMFS, and Deepwater Wind implemented during the surveys are provided in Section 3.5. Methods for estimating potential exposures of protected species to acoustic impacts and a calculation of lost downtime for the Skipjack Wind Project are presented in Sections 3.6 and 3.7.

The *Mysticetus*™ System (*Mysticetus*) data collection template used during the survey contained prompts for all the BOEM-and NMFS-required data elements (see Appendix A and D). All data recorded in the field was provided at the end of the project to Deepwater Wind and CSA in a Microsoft Excel database, including the data elements specified in BOEM Lease OCS-A-0482 (Appendix A).

3.1 Protected Species Observers

Four PSOs and two PAM technicians were stationed on the *Danielle Miller* and *Seacor Supporter*. Four PSOs (at least one of which was cross trained in PAM) were aboard the *Samantha Miller*. All PSOs and PAM operators were responsible for monitoring for protected species and requesting relevant mitigation measures as described in Section 3.4. All PSOs/PAM technicians met minimum requirements identified by BOEM and NMFS, including training in the shipboard identification and behavior of protected species, as well as previous field experience as a PSO or PAM technician on vessel and/or aerial surveys in the Atlantic Ocean and/or Gulf of Mexico. Credentials of PSOs/PAM technicians were provided to BOEM and NMFS for approval prior to the start of field project observations. PSOs were trained on project specific details, requirements, and sighting identification information for protected species occurring in the Lease Area prior to mobilization. Species identification guides and references were available to PSOs on the vessel during the surveys.

3.2 Visual Observation Methods

Visual observations were conducted prior to, during, and after G&G activity as well as during all periods when G&G activity did not occur, 24-h per day. PSO qualifications are discussed in Section 3.1. PSOs rotated observation shifts every 1 to 4 h to avoid observer fatigue and to effectively monitor the Survey Area and implement mitigation measures. Detailed information on all protected species sightings was recorded following the protocols outlined in Section 3.4. Visual observations of protected species were made with one or more of the following methods: unaided eye (UE) supplemented with reticle binoculars (RB) (Section 3.2.1); a night vision device (NVD) (Section 3.2.2); or an infrared (IR) thermal device (Section 3.2.3). Data were recorded following the protocols described in Section 3.4.

3.2.1 Unaided Eye (UE) and Reticle Binoculars (RB)

During daylight hours, PSOs systematically scanned around the vessel in a sweeping pattern primarily with the UE, occasionally sweeping with Fujinon™ 7 × 50 RB. This combined visual effort is termed UE/RB herein. RB provide referenced distance reticles and magnification stronger than is possible with the UE thus enabling PSOs to confirm species identification, estimate the distances to the animal or animals, estimate group composition and/or size, and describe the behavior of the animal(s). The trade-off for increased magnification using the RB was a narrower field of view than without.

3.2.2 Night Vision Device (NVD)

During nighttime, visual PSOs used a pair of PVS-7 Generation III Armasight night vision device (NVD) binoculars. When using the NVD, PSOs systematically scanned around the vessel in a sweeping pattern, alternating scan sweeps between the NVD and the naked eye. The naked eye was used to supplement the NVD when the vessel's operating lights (i.e., artificial lights) illuminated the water sufficiently to see protected species. NVDs were used as a backup visual system during nighttime hours if the thermal IR camera system (Section 3.2.3) malfunctioned or was ineffective due to weather conditions. Visual observations with NVDs were also conducted at night when the vessel was underway with no active operations taking place (e.g., transit to and from the Survey Area) to ensure compliance with vessel strike avoidance measures. Beginning 01 November 2018, a third dedicated visual observer using NVDs was added to the *Danielle Miller's* night operations protocol to increase monitoring effort for NARW during their peak migration season. This third observer using NVDs was on watch during the darkest hours of night considered the highest potential risk situations for NARW encounters. Observers positioned themselves in areas of the vessel where vessel floodlight interference with the NVDs could be minimized (e.g., primarily on the bridge outside the wheelhouse, and occasionally the monkey deck or the bow, weather-permitting).

3.2.3 Infrared (IR) Device

Visual monitoring during nighttime and periods of reduced visibility occurred with a remote high-definition visual monitoring (RHVM) thermal camera system (Seiche Limited) on the *Danielle Miller* and *Seacor Supporter*. Two camera systems, each providing 150° of coverage, were positioned near the center of the vessel at an elevated location in an area with minimal obstruction to ensure the maximum amount of coverage of the EZ and waters surrounding the vessel. Each camera system was made up of a pan and tilt head with two cameras, one high-definition (HD) visual camera (SNZ-5200 20x zoom network unites with varifocal lens) and one IR camera (FLIR A615 with 15° field of view lens). The HD camera had a variable focal length and a display resolution of 1280 x 720 pixels. The IR camera had a focal length of 50 millimeters and a display resolution of 640 x 480 pixels. The IR thermal sensitivity was 0.05° Kelvin. The cameras were linked to a display system consisting of one screen per camera system by a Cat7 link. Image stabilization by horizon detection and an inertial measurement unit ensured all images were displayed in real time with the horizon in the correct orientation.

Real-time Automated Distance Estimation at Sea (RADES™) software, developed by Seiche Limited, was used to manipulate the cameras. Cameras were set to pan and tilt automatically until a protected species was detected. PSOs had the option to stop scanning and control the pan and tilt of the camera manually. RADES software was able to calculate the distance to any object in the image, allowing PSOs to confirm sighting distance of protected species to the vessel. An overlay of the EZ was displayed on the image to indicate where the animal was in relation to the EZ. PSOs monitored real-time images received from the thermal imaging cameras on display screens which captured both video and still images.

3.3 Passive Acoustic Monitoring Methods

Real-time PAM for cetaceans during survey operations was conducted by deploying a 250-m hydrophone array (MSeis® Night Hawk III) containing 4 wideband pre-amplified hydrophones. The frequency sensitivity on the hydrophones was capable of detecting the range of marine mammal species that could occur in and near the Lease Area. Frequency sensitivity of one hydrophone pair ranged from low- to mid-frequency (10 Hz - 30 kHz). Frequency sensitive of the other hydrophone pair ranged from mid- to high frequency (2 kHz – 200 kHz). The measured range over which the frequency response is flat is relatively large and flat until beyond 200 kHz (at around 230 kHz) (CSA 2018). The flat frequency detection response ranges from 6 Hertz (Hz) to 180,000 Hz, +/- 3 decibels (dB), with a sensitivity of -171 dB (re: 1 V/μPa) (Figure 2. Receiving voltage response of hydrophones with a flat frequency response from 6 Hz–180,000 Hz +/- 3 dB and a sensitivity of -201 dB (re: 1V/μPa) prior to 30 dB pre-amplification.). This PAM system was designed to document vocalizations of all cetacean species ranging from low-frequency (LF) mysticete calls to ultrasonic porpoise clicks. The array also contained one depth sensor that provided real-time data via the array cable (Figure 3). Spacing between the four hydrophone sensors in the array was based on the following configuration (Figure 3):

a. 1.5 m between hydrophone 1 and hydrophone 2
b. 6.0 m between hydrophone 2 and 3
c. 1.5 m between hydrophone 3 and hydrophone 4

Spacing between hydrophone elements was used for Time Difference of Arrival (TDOA) calculations which was user selectable at a range from 1.5 to 9 m; this flexibility in hydrophone spacing selection for localization provided a flexible aperture applicable to a wide range of call frequencies/species. The array system was powered with a 24-volt analog/digital signal acquisition unit that output separate channels for each hydrophone.

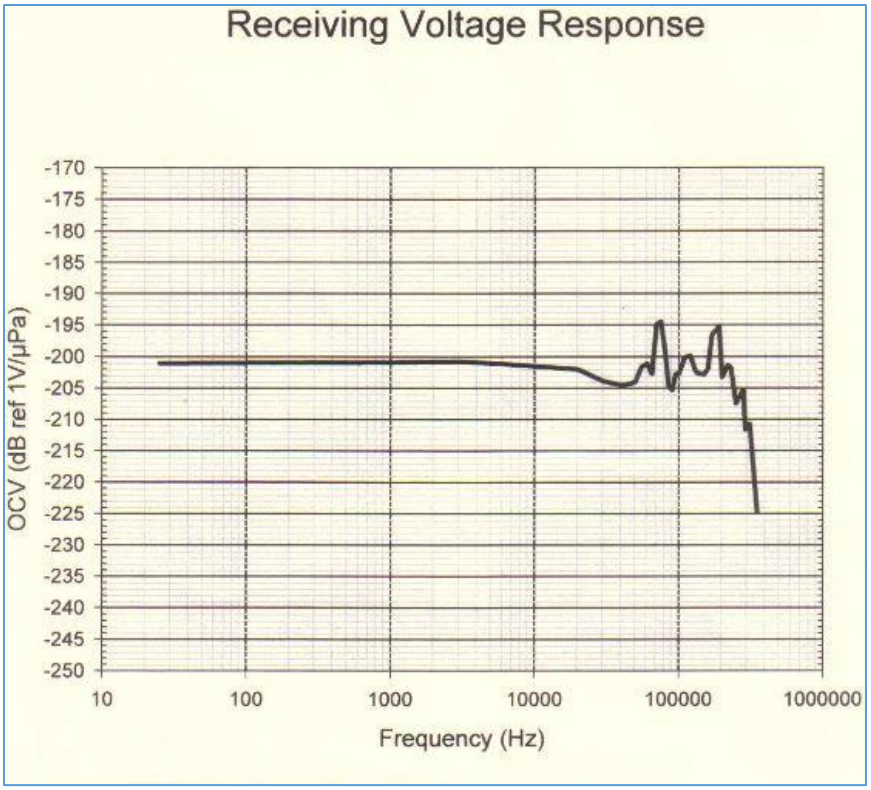

Figure 2. Receiving voltage response of hydrophones with a flat frequency response from 6 Hz–180,000 Hz +/- 3 dB and a sensitivity of -201 dB (re: 1V/µPa) prior to 30 dB pre-amplification.

The PAM system on the *Samantha Miller*, although not needed during that vessel's survey operations, was readily available. The PAM system on the *Seacor Supporter* was deployed using a static, vertical array cable while the vessel was stationary conducting geotechnical operations. The same method was used to deploy the PAM system on the *Danielle Miller* while the vessel was stationary conducting geotechnical operations.

During HRG operations, the array cable was towed from a retractable boom arm off the port side of the vessel. The deployed length of the hydrophone cable from the *Danielle Miller* varied between 55 and 100 m to maximize the distance between the hydrophones and the furthest reaching sound source and to minimize the risk of the cable hitting the sea bottom. The tow depth of the hydrophone ranged from 5 to 13 m depending on current and speed. This towed array configuration allowed for potential localization of vocalizing marine mammals based on the time of arrival of the signal at each hydrophone, with right/left ambiguity.

The vertical array cable did not have the ability to localize calling marine mammals. While methods have recently been developed to utilize a vertical hydrophone array for marine mammal localization tasks (e.g., Macaulay et al. 2015), logistical constraints as well as current hardware and software limitations precluded our ability to incorporate such a system in certain circumstances. Thus, during this survey, distance estimation from the vertical PAM system was not possible unless visually confirmed by the PSO team. Prior surveys in earlier

years indicated that it was not possible to safely deploy a horizontal floating array from the stationary vessel given unpredictability in currents and potential for entanglement with other vessel gear (e.g., rudders, thrusters).

A custom-designed MSeis® Signal Conditioner was used to split the incoming signal from hydrophone 4 into two signals -- one for mid-frequency (MF) and one for high-frequency (HF) (Figure 3). The HF sound digitization occurred internally in the signal conditioner using a NI DAQ board and was subsequently processed at a sample rate of 400 kHz, resulting in a usable Nyquist frequency bandwidth of 200 kHz. The MF signal from hydrophone 4 was fed into an Akai™ EIE Pro sound audio interface along with hydrophone 3 for amplification and digitization for the MF system. The MF signals were then acquired by a second personal computer (PC) and processed at a sample rate of 96 kHz, resulting in a usable Nyquist frequency bandwidth of 48 kHz. Additionally, the MF signal from hydrophone 4 was decimated to 6 kHz (resulting in a usable Nyquist frequency bandwidth of 3 kHz) for review of LF signals.

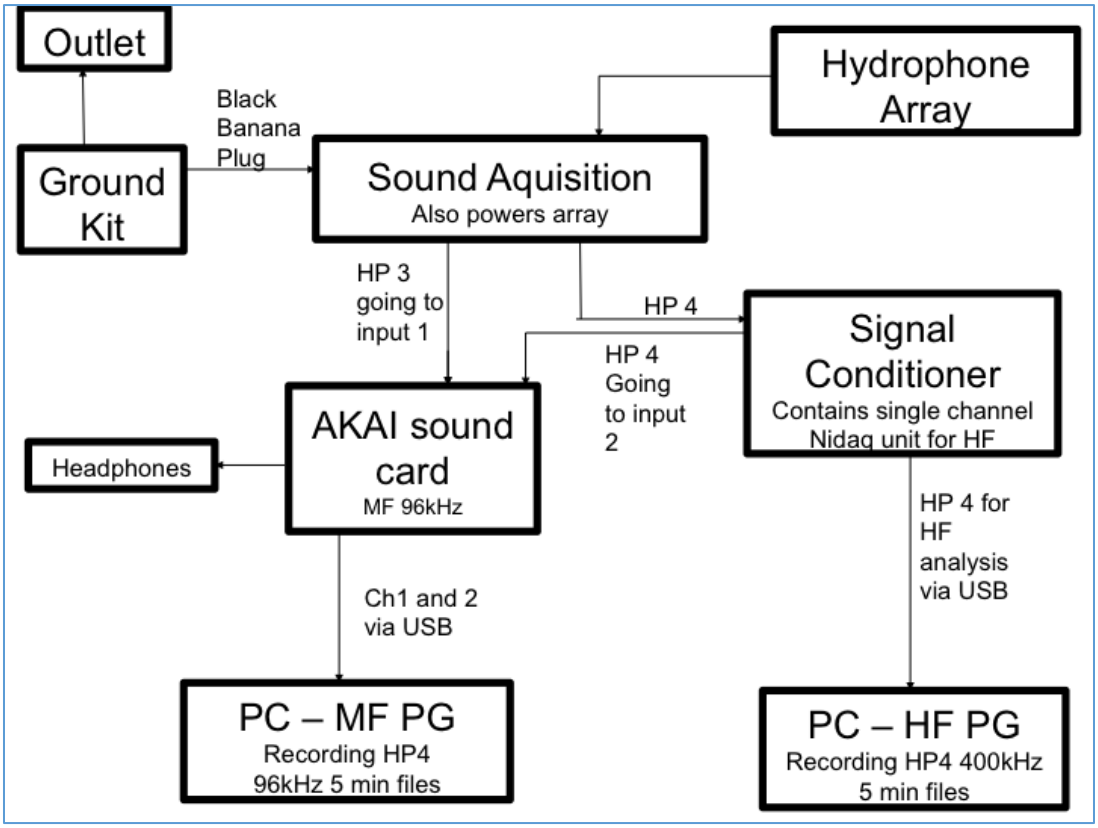

Figure 3. Passive acoustic monitoring (PAM) system set up diagram.

PAMGuard™ software was used to monitor, detect, and classify vocalizing marine mammals in near real-time via custom-designed routines for HF, MF, and LF. Optimal gain and additional low/high pass filter settings were assessed and implemented after initial review of acoustical data was completed.

Marine mammal call detection was conducted both aurally with the Akai EIE Pro headphone output and visually via the PAMGuard™ display using both manual and automated techniques (Figure 3). Trained acoustic technicians actively scanned for marine mammal vocalizations on three simultaneous, real-time scrolling spectrograms optimized for LF (6 Hz–3 kHz), MF (3–48 kHz), and HF (48–200 kHz). In addition, semi-automated call detectors were simultaneously run to flag any incoming signals meeting prescribed frequency, time, and amplitude parameters. All acoustic data collected during the proposed operation were recorded on computer hard drives for subsequent review and description, as needed. When marine mammal vocalizations were detected, confirmed, and (when possible) classified to species, the PAM operator informed the lead visual PSO (herein referred to as Lead PSO) on duty. The Lead PSO would attempt to visually confirm the acoustic detection and would also implement the necessary mitigation procedures (Section 3.5).

3.4 Data Collection Protocols

Mysticetus was used as the core data collection tool to record PSO data and integrate survey and environmental data in real time from all platforms (PAM, IR, NVD, UE/RB) into one database and shared map display. Mysticetus data fields and definitions are defined in Appendix D. Mysticetus is designed specifically to increase efficiency and resolve ambiguity in locations/distances of protected species sightings relative to mitigation distances/zones by displaying this information in real-time on a personal computer screen immediately after data are entered by the user (www.mysticetus.com). Mysticetus also provides screen/map-sharing of detection occurrences, locations, and/or species, etc., between PSO visual detections (UE/RB, NVD, IR) and PAM detections. This helped quickly cue in the PAM and visual teams to detections and identify shared detections. Mysticetus automatically plotted Dynamic Management Area (DMA) polygons on the PSO maps.

The Mysticetus data collection template used during the survey contained prompts for all the BOEM-and NMFS-required data elements, including those identified in Appendix A of this document and the BOEM Lease OCS-A-0482. All data recorded in the field was provided to Deepwater Wind in a Microsoft Excel database.

The PSO data collection protocol included documenting all sightings (using/RB, NVD, and IR) and PAM detections during both sound source on and off periods (Table 2). Sighting locations were also plotted on a bathymetric map relative to the vessel and EZ based on bearing and reticle or distance data input by the user. *Mysticetus* displays of detection occurrences, locations, distances, and/or species can also be shared between PCs to help the PSO team identify shared detections and prevent detections from being counted more than once.

The *Mysticetus* data collection template (Appendix D) used during the survey contained prompts for all the BOEM-and NMFS-required data elements, including those identified in Appendix A of this document and the BOEM Lease OCS-A-0482. All data recorded in the field was provided to Deepwater Wind in a Microsoft Excel database.

Table 2. Definitions of data collection and analysis terminology.

Unaided Eye (UE)/ Reticle Binocular (RB)	Periods when at least one PSO was visually monitoring with unaided eye (UE) with occasional use of reticle binoculars (RB).
NVD Effort	Periods when PSOs monitored with the NVDs, alternating with periodic eye breaks.
PAM Effort	Periods when one PAM technician was acoustically monitoring using two remote monitors and a laptop running PAMGuard and *Mysticetus* within the vessel.
IR Effort	Periods when one PSO was remotely visually monitoring video feed on two visual monitors below deck from the two infra-red (IR) thermal camera systems mounted above deck.
Lease Area	The Lease Area polygon as defined in BOEM Lease OCS-A-0482 (see Figure 1).
Survey Area	The term "Survey Area" includes the Lease Area, the two potential cable shore approaches, and the paths vessels took in between (i.e., the entire area where the vessel traveled while PSO and/or PAM monitoring occurred).
Inside Lease Area Effort	Periods when at least one PSO was visually or acoustically monitoring while within the Lease Area.
Outside Lease Area Effort	Periods when at least one PSO was visually or acoustically monitoring while outside the Lease Area (i.e. transit to/from port or anywhere in the Survey Area).
Group (i.e., Sighting)	One or more individuals seen close together and coordinated in a similar manner (i.e., coordinated surfacing, orientation, behavior, etc.).
UE/RB Sightings(s)	The number of protected species groups (or individuals) visually observed using the UE/RB.
NVD Sighting(s)	A protected species group (or individuals) sighted using NVD.
IR Sighting(s)	A protected species group (or individuals) sighted using IR.
PAM Detection	An acoustic detection(s) of a marine mammal(s) vocalization(s) using PAM, separated by <30 min between vocalizations (all acoustic detections occurring within 30 min of one another were considered one detection). Note that group size of PAM detections could not be determined unless the PAM detection was linked with a visually-, IR-, or NVD-confirmed visual sighting. Thus, default group size for a PAM detection was 1.
UE/RB Detection Rate	The number of protected species groups (or individuals) sighted through UE (or RB) per hour of per person PSO visual effort.
NVD Detection Rate	The number of protected species groups (or individuals) visually detected using the NVDs per hour of per-person NVD effort.
IR Detection Rate	The number of protected species groups (or individuals) visually detected using IR per hour of per-person IR effort.
PAM Detection Rate	The number of protected species groups (or individuals) acoustically detected (defined above) per hour of per-person PAM effort.

Protected species movement relative to the vessel, as well as initial and secondary behavior states/events based on descriptions by Altmann (1974), were recorded for each sighting. PSOs were provided pre-defined terms and ethograms to maintain consistency in the data collection terminology that were displayed on the laptop in *Mysticetus*. Initial behavior states included rest/slow travel (no wake), travel (including medium and fast travel, as

possible to decipher), surface-active travel (traveling with splashes created by breaches, tail slaps, porpoising, etc.), milling, and unknown/other. Behavioral descriptions followed those described in previous 90-day reports associated with oil and gas and G&G operations (e.g., Aerts et al. 2008; Blees et al. 2010; Lomac-MacNair et al. 2014).

3.5 Data Analysis

Sightings and effort data were analyzed using a number of approaches. Overall detection rates of protected species were calculated as the number of groups visually or acoustically detected per hour of actual effort throughout the study period (excluding simultaneous overlapping effort) to maximize sample size and detection rates for all pooled detections in the Survey Area (i.e., both inside and outside the Lease Area). Per-PSO detection rate was also calculated and applied as a metric to assess and compare effectiveness of the various equipment methods (e.g., UE/RB, IR, NVD, PAM) used to detect protected species, as required by the BOEM Lease and AMP (Appendix A). Hours were used for detection rate analysis rather than distance (km) traveled because two of the three vessels alternated between being stationary at survey stations and transiting between the survey stations and port. In addition, all vessels followed relatively erratic routes, covering the same areas repeatedly, so distance was not considered appropriate for this analysis. PAM detections that were not visually confirmed (including with IR or NVD), and thus group size was undetermined, were recorded as a minimum estimate of one individual unless it was clear there was more than one individual (i.e., overlapping calls).

The distribution of sightings relative to the location and operational status (on or off, type of equipment) of the sound source was assessed using several variables including bearing and distance from the observer (converted to distance from the sound source by *Mysticetus*), initial and subsequent re-sight distances, and observed closest point of approach (CPA) of the animal(s) to the sound source. Environmental variables were recorded every 30 min, when conditions changed, and during a protected species detection. Environmental variables included all those identified in Appendix A per the IHA and Lease stipulations. Periods of night (darkness) and day (daylight) were defined by the predicted times for nautical twilight at the operational location. Periods of time where visual observations with just UE were feasible typically corresponded with the nautical twilight periods.

3.6 Mitigation and Reporting Measures

Mitigation and reporting were carried out in accordance with requirements established in the BOEM Lease, the AMP, and the IHA with respect to the species detected, if sources were operational at frequencies <200 kHz, or if the vessel was in transit. The AMP addressed measures specific to nighttime and reduced visibility operations allowing for 24-h operations with the implementation of these enhanced measures. Table 3 details the mitigation measures implemented for this project as feasible and/or safe to avoid causing injury, mortality, or significant disturbance to protected species. These measures are distinguished base on the type of source operating (i.e., geophysical or geotechnical). Per agency stipulations (e.g., Lease 0482), a 500 m EZ was established for all marine mammals and sea turtles for geophysical equipment operating at frequencies <200 kHz and above NMFS

exposure thresholds. For the geotechnical survey, as a precautionary measure and to maintain compliance with Lease stipulations, an EZ of 200 m was established around operational geotechnical equipment (Table 3).

Table 3. Mitigation measures for geophysical and geotechnical survey operations.

Requirement	Geophysical Mitigation	Geotechnical Mitigation
EZ	500 m for all marine mammals and sea turtles. Provisions made at the discretion of the PSO for delphinoid cetaceans and pinnipeds that voluntarily approach the vessel. Effective 01 November 2018, 1,000-m for NARWs.	200 m for all marine mammals and sea turtles. Provisions made at the discretion of the PSO for delphinoid cetaceans and pinnipeds that voluntarily approach the vessel.
Pre-operation EZ monitoring	60 min	60 min
Shutdown	Shut down survey equipment operating < 200 kHz for non-delphinoid cetaceans and sea turtles within, entering, or approaching the EZ. Restart survey equipment once the EZ has been clear of all marine mammals and sea turtles for 60 min. Effective 01 November 2018, shutdown for NARWs visually detected at 1,000 m and for NARWs acoustically detected at any distance.	Shut down survey equipment operating < 200 kHz (as feasible/safe) for non-delphinoid cetaceans and sea turtles within, entering, or approaching the EZ. Restart survey equipment once the EZ has been clear of all marine mammals and sea turtles for 60 min.
Non-mitigation-related shutdown	If pause in equipment operating at <200 kHz is >20 min, perform 60-min pre-operation EZ monitoring. If pause in such equipment is <20 min, restart as soon as practicable provided diligent monitoring and no marine mammals or sea turtles entered the EZ. If monitoring conditions were not met or marine mammal or sea turtle entered the EZ, perform 60-min pre-operation EZ monitoring.	
	The monitoring methods described in Sections 3.2 and 3.3 provided comprehensive monitoring 24-h per day to effectively implement mitigation measures. While EZ clearance and mitigation measures were only required for HRG sources operating below 200 kHz,	

Requirement	Geophysical Mitigation	Geotechnical Mitigation
	monitoring was maintained regardless of the source whenever a sound source was operating. Further, Deepwater Wind recommended that survey operations teams not start any sound-producing equipment if animals were detected in the EZ.	

3.6.1 Dynamic Positioning Vessel Thrusters

Noise produced by dynamic positioning (DP) thrusters used during the G&G surveys was not expected to result in Level B harassment of marine mammals known to inhabit the Survey Area, therefore, NMFS did not anticipate the need for the IHA to provide for takes during the use of DP thrusters (https://www.fisheries.noaa.gov/action/incidental-take-authorization-garden-state-offshore-energy-geophysical-survey-skipjack-wind). DP thrusters were typically used to position the GT vessel while on station at coring sites.

3.6.2 Vessel Strike Avoidance Measures

Under BOEM Lease stipulation 4.1.1.1. and the NMFS-issued IHA Mitigation Requirement 4(h), all vessel operators are required to maintain a minimum separation distance between a vessel underway and any marine mammal or sea turtle species to avoid potential vessel strikes. The PSOs conducted vessel strike avoidance watches 24-h per day regardless of vessel activity and alerted vessel crew during species detections as appropriate. The minimum separation distances were maintained as follows per Lease stipulations 4.1.1.1. through 4.1.1.7 (and Amendment 2014) and IHA Mitigation Requirement 4(h):

- 500 m from any sighted NARWs;
- 100 m from any non-delphinoid cetaceans (i.e., mysticetes [baleen whales] and sperm whales);
- 50 m from any delphinoid cetaceans, sea turtles and pinnipeds.

Additionally, as required by the BOEM Lease and IHA, PSOs also ensured that all project vessels greater than 65 feet (19.8 m) in length operated at speeds of 10 knots or less to comply with Seasonal Operating Restrictions enforced from 01 November - 31 July 2018 which provide extra protection for NARWs. As a component of the speed restrictions and separation distances, the PSOs regularly monitored for the presence of Dynamic Management Area (DMAs) and NARWs reported in or near the Survey Area (see Section 3.5.4).

3.6.3 Voluntary Mitigation Measures

While EZ clearance and mitigation measures were only required for HRG sources operating <200 kHz, monitoring was maintained regardless of the source whenever a sound source was operating. Further, Deepwater Wind recommended that survey operations teams not start any sound-producing equipment (regardless of frequency) if animals were detected in the EZ. In addition, voluntary mitigation measures were implemented for NARW as described in Section 3.6.4.

3.6.4 North Atlantic Right Whale

Deepwater Wind voluntarily imposed enhanced protection for the NARW, extending the EZ required by BOEM and NMFS from 500 to 1,000 m during geophysical survey operations from 01 November 2018 until the completion of geophysical efforts later that month.

All sightings of NARWs made from the vessels were promptly reported to the designated Deepwater Wind Point of Contacts (POCs). A one-page summary with details of the NARW sighting, including any photos, was prepared by Smultea Sciences and the Lead PSO onboard the vessel so Deepwater Wind could submit the information to NMFS (see Appendix H).

At least every 4 h during a 24-h period, PSOs checked the NMFS NARW reporting systems via the NMFS website (https://www.nefsc.noaa.gov/psb/surveys/) and/or Whale Alert application (http://www.whalealert.org/), depending on the availability of internet and/or cellular signal. The PSOs also monitored for DMA establishment via any Notices to Mariners communicated to the bridge crew. This effort was documented in the electronic *Mysticetus* data collection form. In the event a DMA was established in or near the Survey Area, the Lead PSO immediately informed the designated Deepwater Wind POC on the vessel. Every time a PSO checked for a DMA, it was documented in a specific data entry cell in *Mysticetus*, and automatically associated with a date, time, and GPS position with any relevant comments.

The nearest Seasonal Management Area (SMA) was located outside the Survey Area. All guidelines with respect to SMAs were followed by project vessels during surveys performed near edges of, or transiting through, the SMA.

3.6.5 Agency-Required Reporting

The PSO/PAM Team complied with NMFS IHA and Lease reporting requirements as summarized in Appendix A. This included reporting any sightings of injured or dead protected species to NMFS within 24 h.

3.6.6 Stationary Geotechnical Operations

Geotechnical drilling operations were conducted by the *Seacor Supporter*, which routinely operated while held stationary with spuds down. When transiting between sampling locations, the vessel maintained a speed of less than 10 knots (see Appendix B for a photo of this vessel). During geotechnical surveys, the *Seacor Supporter* used numerous pieces of drill equipment that propagated sound through the water column, including casing adjustment, hole maintenance, soil sampling, downhole geophysical logging, drilling preparation, and active advancement of the drill bit. Since the acoustic properties of sound produced by the drilling operations were not specifically applicable under the frequency provisions of the BOEM Lease or IHA, conservative mitigation measures were adopted. Operational and safety factors dictated that complete and rapid shutdown of all drilling equipment was not feasible. However, the central noise emitting feature, advancement of the drill bit, could be halted while other parts of the equipment continued operating. This would reduce the noise produced by the source to acceptable levels without compromising

safety. Accordingly, PSOs and PAM operators focused mitigation on the advancement of the drill bit, which was considered mitigatable noise. Other ancillary equipment was not considered mitigatable but could be shut down if safe to do so to further reduce potential acoustic impacts. PSOs and drill operators used quick reference guidelines and placards during field operations to remain within compliance.

3.7 Estimating Potential Exposures

The MMPA defines two levels of harassment. Level A harassment is statutorily defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild. The MMPA defines Level B harassment as any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. In 2016, NMFS published acoustic guidance thresholds for marine mammals for use in impact assessment (NMFS, 2016). These acoustic criteria were purposely developed to be protective of all marine mammal species from exposure to high sound pressure levels, primarily to address the regulatory requirements of the MMPA.

NMFS defines a Level B harassment, or a "take by harassment," for marine mammals as any exposure that could potentially result in temporary threshold shift (TTS) or the disturbance of the animals. Level B threshold metrics are defined in root-mean-square sound pressure levels (SPL_{rms}) for both non-impulsive and impulsive sources. For non-impulsive sources, Level B harassment is thought to occur at a received $SPL_{rms} \geq 120$ decibels referenced to 1 micro Pascal (dB re 1 μPa) and at received $SPL_{rms} \geq 160$ dB re 1 μPa for impulsive sources (NMFS 2012). Because TTS and behavioral thresholds have not been separated within the regulatory criteria (i.e., both TTS and behavioral disturbance constitute Level B exposure) and because pure behavioral disturbance thresholds have not yet been defined, the regulatory framework uses interim guidance to define Level B thresholds (NMFS, 2005). Level B thresholds applied in estimating potential exposures of marine mammals involved operation of equipment at frequencies <200 kHz and at levels exceeding SPL_{rms} 160 dB re 1 μPa.

Distances to the Level A and Level B exposure thresholds for marine mammals applied during this G&G survey for equipment meeting or exceeding NMFS exposure guidelines were estimated and submitted to NMFS as part of the project IHA application (Deepwater/CSA 2018). These distances by equipment are presented in Table 4 and were used to estimate numbers of marine mammals exposed to the respective Level A and Level B thresholds. The estimated number of animals detected within these distances were considered potential exposures. Potential exposure numbers were estimated and presented to assist NMFS in assessing levels of potential Level A and Level B "take".

Equipment expected to be used during the geophysical and geotechnical surveys for Skipjack were identified in the project IHA application to NMFS (CSA 2017) and are listed in Appendix F. However, not all equipment identified in the IHA application was used during the actual field surveys. Furthermore, other models of the same genre of equipment were sometimes used during the actual survey instead of those identified in the IHA application,

based on equipment availability, etc. Table 5 lists the actual G&G equipment used during the surveys and identifies the equivalent equipment proposed in the IHA application, based on operating characteristics including sound frequency range. Only equipment operating at frequencies < 200 kHz were used to estimate potential exposures of individuals. Equipment which produced noise considered audible to marine mammals during the surveys and associated distances to the Level A and Level B acoustic threshold criteria for each type of equipment are presented in Tables 4-6. Individuals detected within these threshold distances were considered potential exposures.

A custom Microsoft Excel worksheet table was used to summarize protected species detections using QA/QC'd datafiles exported from *Mysticetus*. The table filtered for detections that occurred while a source was operating (i.e., on) at frequencies < 200 kHz. A value of 1 to 3 was then applied to each detection based on the EZ distance associated with that type of equipment (Table 6). Values of 1 included detections ≤ 447 m from the source, while values of 2 and 3 represented detections ≤ 142 m and ≤ 71 m from the source, respectively. If multiple pieces of equipment were operating simultaneously, the equipment with the largest EZ was assigned to the detection. Next, a formula compared the detection CPA distance against the equipment EZ distance. If the CPA distance was equal to or less than the equipment EZ distance, the detection was flagged as a potential exposure. For detections when we could not determine from the field notes which specific piece of equipment was in use during that detection, we conservatively applied the maximum 447 m EZ (i.e., our potential exposure worst case scenario).

The number of potential exposures to geophysical equipment operating < 200 kHz during the Skipjack Wind Project was based on direct observations/counts and separate acoustic detections of protected species (see Sections 3.2 and 3.3 for monitoring methods) within the Level A or Level B isopleths of the equipment operating at that time (when known). Detections made while equipment was operating were also grouped into distance categories of 1) < 500 m, 2) 500-1,000 m, and 3) > 1,000 m, based on the detection CPA. This enabled a quick analysis of the number of detections with respect to the default EZ identified in the Lease (500 m) and incremental increasing distances.

All detections were positively identified to the lowest taxonomic designation possible. Acoustic detections were reported separately, as distance to acoustic detections could not be determined using only PAM during the surveys.

Table 4. Estimated distances to NMFS Level A and Level B exposure acoustic thresholds by types of equipment used during G&G surveys (CSA 2018).

Source	Distance to Level A Threshold (m)				Distance to Level B Threshold (m)
Hearing Group[1/]	Low-frequency (LF) cetacean	Mid-frequency (MF) cetacean	High-frequency (HF) cetacean	Pinniped[2/] (PI)	All
Impulsive Sources					
TB Chirp	1.25	0	4.64	0.01	70.79
EdgeTech Chirp	0	0	0.3	0	6.31
AA Boomer	0	0	0.01	0	5.62
AA S-Boom	0.04	0.01	3.41	0.02	141.25
Bubble Gun	0	0	1.17	0	63.1
800J Spark	0.22	0	5.41	0.08	141.25
AA Dura Spark	6.57	0.04	25.12	1.78	446.69

[1/] See NMFS (2018) for species belonging to each hearing group.
[2/] Pinnipeds include seals, sea lions and walruses.

Table 5. High resolution geophysical (HRG) sources operated during the survey period and the corresponding IHA-evaluated equipment category used to determine potential Level B exposure distances (CSA 2018).

Operating Equipment during Survey	Equipment Category from IHA Application	Distance (m) to Level B Exposure
USBL	TB Chirp	71
MBES	TB Chirp	71
Knudsen chirp	ET Chirp	7
ET 512	ET Chirp	7
Boomer and Streamer	S-Boom	142

Table 6. Equipment-specific categories relative to Level B isopleth distance applied to equipment operating at < 200 kHz during the geophysical survey in the Survey Area.

Equipment Category[1/]	Distance to Level B Isopleth from Sound Source	Operating Equipment (< 200 kHz)	Description
Samantha Miller			
3	71 m	Chirp 512 / Sub-bottom profiler	EdgeTech 512i (0.5-12kHz) Chirp Sub-bottom profiler - for high resolution vertical profiling.
3	71 m	Chirp 424 / Side Scan	EdgeTech 4200 – 300/600 kHz Side-scan Sonar systems - with mag interface
3	71 m	USBL	CNAV-3050 DGNSS positioning systems
Danielle Miller			
3	71 m	USBL	"CNAV-3050 DGNSS positioning systems IXSEA GAPSII USBL underwater tracking system with four (4) beacons, topside, integrated with Octans IMU"
3	71 m	Chirp / Sub-bottom profiler	EdgeTech DSS-2000 Combined Sonar with 2-16 kHz Chirp Sub-bottom profiler, 300/600 kHz Side-scan sonar system, and Magnetometer interface. one primary and one backup.
2	142 m	S-Boom / Boomer < 1000J	Applied Acoustics S-boom Triple Plate Boomer with single channel hydrophone array and CSP 1250 Energy Source
1 [2/]	447 m	Unknown	

[1/] Equipment categories were applied to assist in estimating numbers of exposures by pooling equipment sharing the same EZ distances.

[2/] Although no operating G&G equipment during the actual survey was associated with a 447-m Level B isopleth, we conservatively applied this distance for estimating exposures for detections where the operating source was unidentified/not known.

3.8 Calculation of Lost Downtime

Lost downtime was defined as time when survey operations were delayed or stopped due to PSO and PAM mitigation and monitoring requirements. For example, when equipment was shut down due to a protected species observed within or approaching the EZ, requiring a mitigation action resulting in a loss of production time. This metric has been applied in other documents as a metric of interest to BOEM to better understand how mitigation and monitoring may affect loss of production during field operations. Weather and equipment maintenance contribute additional down time to the surveys but was not included in this calculation which focused solely on downtime lost to mitigation requirements.

Lost downtime was calculated following methods described in Barkaszi and Kelly, in press. This involved tallying the number of delay and shutdown events by species or taxonomic grouping, finding the total duration (in hours) for which production was lost due to these events, and estimating the mean loss of production per event, when operations could not commence as a result of these mitigation measures. For the geophysical and geotechnical surveys addressed herein, this included clearance and pre-clearance periods, delays, and shutdowns (ramp-ups could not be performed for the mitigated equipment used during the surveys).

4 Results

A total of 397 detections of an estimated 2,737 individuals were observed in the Survey Area during the G&G survey periods (Table 7, Figure 4). The most common sightings consisted of delphinids (including unidentified delphinids) followed by whales (including unidentified whales) and sea turtles. This included one confirmed and one probable NARW sighting. Confirmed bottlenose dolphins were detected nearly exclusively in nearshore waters (less than 20 km from shore) with bottom depths less than approximately 30 m. In contrast, other species were detected predominantly within the offshore Lease Area in waters ranging from 16 to 28 m in bottom depth. Results are discussed separately for geophysical surveys and geotechnical surveys.

Table 7. All detections of protected species in the Survey Area during all monitoring effort during the geophysical and geotechnical survey periods.[1/]

Species Common Name	Scientific Name	Number of Detections	Number of Estimated Individuals	Mean Group Size of Detections
***Samantha Miller* (Geophysical Survey)**				
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	1	6	6.0
Bottlenose dolphin	*Tursiops truncatus*	164	1,833	11.2
Humpback whale	*Megaptera novaeangliae*	2	2	1.0
Unidentified dolphin	(Family) Delphinidae	1	8	8.0
Unidentified sea turtle	(Family) Cheloniidae	1	1	1.0
***Samantha Miller* Total**		**169**	**1,850**	**5.44**
***Danielle Miller* (Geophysical Survey Portion)**				
Bottlenose dolphin	*Tursiops truncatus*	45	544	12.1
Common dolphin	Delphinids	5	15	3.0
Green turtle	*Chelonia mydas*	9	9	1.0
Humpback whale	*Megaptera novaeangliae*	10	15	1.5
Leatherback turtle	*Dermochelys coriacea*	14	14	1.0
Loggerhead turtle	*Caretta caretta*	37	37	1.0
Other	--	1	1	1.0
Sperm whale	*Physeter macrocephalus*	1	1	1.0
Unidentified delphinid	(Family) Delphinidae	1	1	1.0
Unidentified dolphin	(Family) Delphinidae	6	14	2.3
Unidentified sea turtle	*Chelonioidea* (sp)	10	10	1.0
Unidentified whale	(Order) Cetacea	9	9	1.0

Species Common Name	Scientific Name	Number of Detections	Number of Estimated Individuals	Mean Group Size of Detections
***Danielle Miller* Geophysical Total**		**148**	**670**	**2.2**
Geophysical Total		**317**	**2,520**	**3.3**
***Seacor Supporter* (Geotechnical)**				
Bottlenose dolphin	*Tursiops truncatus*	3	10	3.3
Fin whale	*Balaenoptera physalus*	1	1	1.0
Humpback whale	*Megaptera novaeangliae*	2	2	1.0
Leatherback Turtle	*Dermochelys coriacea*	1	1	1.0
Loggerhead Turtle	*Caretta caretta*	12	12	1.0
North Atlantic right whale	*Eubalaena glacialis*	1	1	1.0
Unidentified dolphin	(Family) Delphinidae	13	32	2.5
Unidentified sea turtle	*Chelonioidea (sp)*	4	4	1.0
Seacor Supporter Total		**37**	**63**	**1.5**
***Danielle Miller* (Geotechnical Portion)**				
Common dolphin	*Delphinus delphis*	7	80	11.4
Fin whale	*Balaenoptera physalus*	7	7	1.0
Gray seal	*Halichoerus grypus*	1	1	1.0
Harbor porpoise	*Phocoena phocoena*	2	2	1.0
Humpback whale	*Megaptera novaeangliae*	10	16	1.6
Sei whale	*Balaenoptera borealis*	1	1	1.0
Unidentified dolphin	(Family) Delphinidae	6	38	6.3
Unidentified whale	(Order) Cetacea	9	9	1.0
Danielle Miller Geotechnical Total		**43**	**154**	**3.0**
Geotechnical Total		**80**	**217**	**2.3**
Survey Total (Geotechnical & Geophysical)		**397**	**2737**	**2.7**

[1/] Includes all detections of protected species made during all monitoring effort in and out of the Lease area and nearshore cable approach when sound sources were both on and off, including during transits. In addition to the above sightings, a dead and severely decomposed large unidentified mammal or leatherback turtle (based on body size) was seen floating near the *Danielle Miller.*

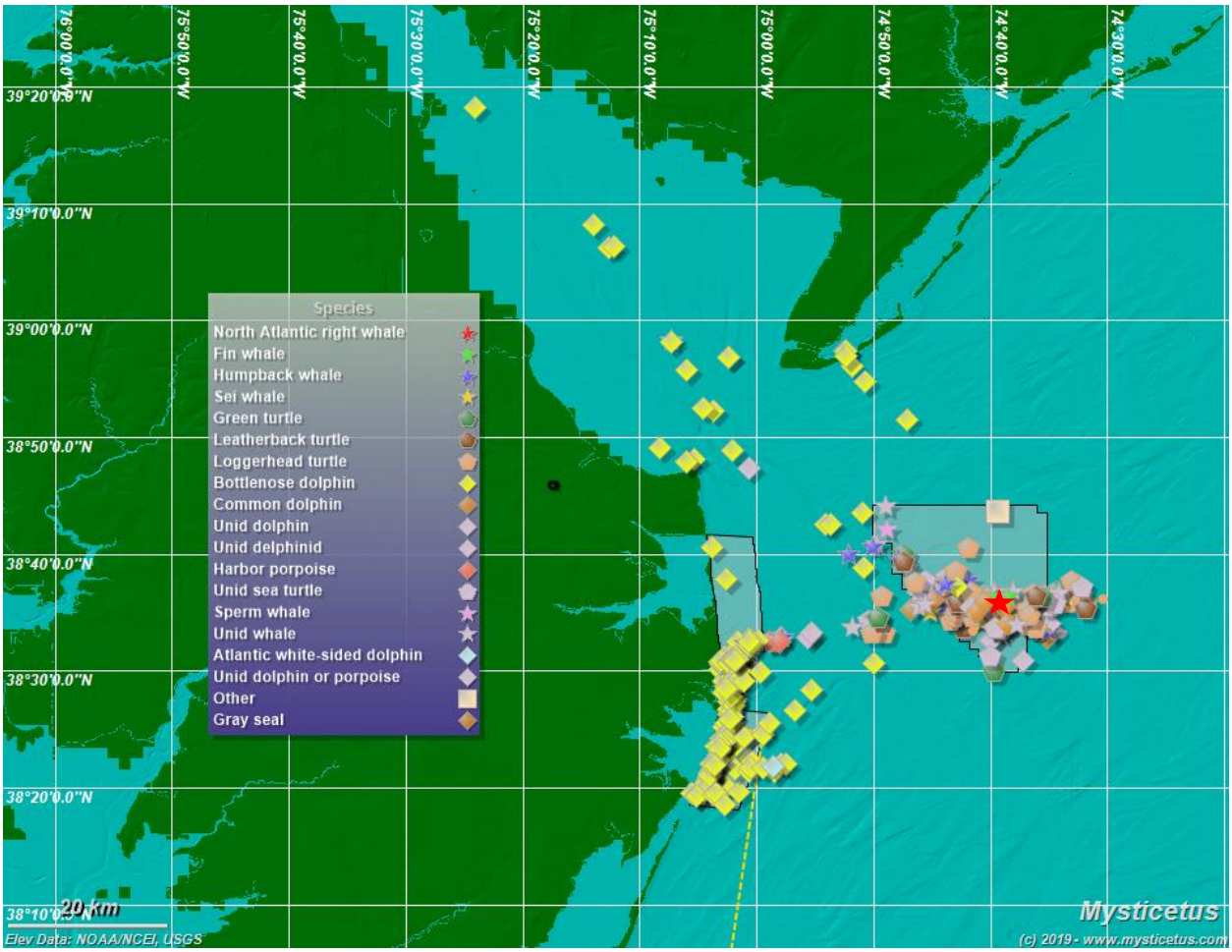

Figure 4. Locations of all protected species sightings made during all modes of operation (geophysical, geotechnical, and transit) inside and outside the Lease Area (offshore gray polygon) and the proposed cable shore routes (two nearshore gray polygons).

4.1 Geophysical Results

Geophysical monitoring effort, protected species distribution, and sighting data in the Survey Area based on various operating conditions (e.g., darkness vs. daylight; regulated sound source(s) on versus off) are presented in Figures 5-8, Table 8 10, and Appendix C. Results specific to requirements of the BOEM AMP, including detection rates, are provided in Appendix G. Results are summarized either as data pooled for the total Survey Area, or as data separated by the Lease Area and/or areas outside the Lease Area (i.e., the two proposed cable approaches and transits between these areas and/or the shoreline). Where relevant, data were filtered by vessel and monitoring method as well.

4.1.1 Geophysical Monitoring Effort

Monitoring by PSOs began aboard the *Samantha Miller* on 24 July 2018; geophysical operations were conducted from 26 July 2018 – 26 August 2018 and from the *Danielle Miller* 11 August 2018 – 19 January 2019. At least one regulated sound source was operating

(i.e., *on*) during approximately half (61%) of the total 2,139 h of geophysical survey monitoring effort from both vessels; these sound sources were off during the remaining 39% of the survey period (Table 8, Figure 5, Figure 6, Figure 7). Geophysical sound sources were on during more hours (1,211 h) from the *Danielle Miller* than the *Samantha Miller* (90 h) because the *Danielle Miller* survey period was longer (162 days) and surveyed 24-h-per-day compared to the *Samantha Miller* (30 days) which operated only during daylight.

A total of 2,138 h of per-person PSO and PAM monitoring effort occurred during the geophysical surveys (Table 8). During nighttime surveys, this effort overlapped, as PAM and nighttime visual (e.g., IR and/or NVD) monitoring occurred simultaneously (see Section 3.2 for how simultaneous effort was calculated). Of the 2,138 h of per-person visual (UE/RB, IR, NVD) and PAM effort, about 46% occurred during nighttime and 54% during daylight. Nearly all effort (>99%) from the *Samantha Miller* occurred during daylight, with <1% percent during darkness while transiting back and forth from port, because effort aboard the *Samantha Miller* was limited to daytime operations and the crew stayed on land each night.

Most (80%) of the 2,138 h of per-person PSO/PAM effort used visual methods (UE/RB, IR or NVD); the remaining 18% utilized PAM. Monitoring during darkness occurred with UE, NVD, IR and PAM. All 430 h of PAM effort occurred during darkness as no daylight periods during the geophysical survey required the use of PAM for mitigation (i.e., the EZ was not obscured by fog or other visual obstructions during daylight clearance and operations periods associated with regulated sound sources) (Table 9). Virtually all (>99%) of the 355 h of IR effort and 149 h of NVD effort occurred during darkness including twilight hours (Table 9). All PAM, IR and NVD monitoring effort was conducted in the Lease Area from the *Danielle Miller* during darkness; the *Samantha Miller* did not conduct any nighttime geophysical operations. Results used to compare the effectiveness of the applied detection methods are discussed in Appendix G.

Table 8. Monitoring effort for each vessel by geophysical (GP) sound source on and off in the Survey Area.

Sound Source Status	Hours
Samantha Miller	
On (operating)	90
Off (not operating)	181
***Samantha Miller* Total**	**271**
***Danielle Miller* (Geophysical Portion)**	
On (operating)	784
Off (not operating)	632
***Danielle Miller* GP total**	**1416**
Total GP	
On (GP total)	**847**
Off (GP Total)	**813**
Grand Total Monitoring Effort	**1687**

Table 9. Total per-person effort (hours:mins) by monitoring method from each vessel during night and day in the Survey Area during the geophysical survey period.[1/]

Period	UE/RB	NVD	IR	PAM	Total Effort All Methods
Samantha Miller					
Night	0:22	0:00	0:00	0:00	0:22
Day	271:37	0:00	0:00	0:00	271:37
***Samantha Miller* Total**	272:00	0:00	0:00	0:00	272:00
Danielle Miller					
Night	94:15	149:27	355:16	389:09	988:08
Day	878:22	0:00	0:09	0:00	878:32
***Danielle Miller* Total**	**972:37**	**149:27**	**355:26**	**430:21**	**1,866:40**
Total GP					
Night Total	94:37	149:27	355:16	430:21	988:31
Day Total	1,150:00	0:00	0:09	0:00	1,150:10
Total	**1,244:38**	**149:27**	**355:26**	**430:21**	**2,138:41**

[1/] Total calculated separately for each detection method; thus, overlapping effort (e.g., IR and PAM) are summed separately. UE = Unaided eye with occasional use of reticle binoculars (RB), IR = infra-red camera monitoring, NVD = night vision device, PAM = passive acoustic monitoring.

Table 10. Total per-person effort (hours:minutes) by monitoring method by vessel with sound source on and off in the Survey Area during the geophysical survey period. [1/]

Sound Source Status	UE/RB	NVD	IR	PAM	Total Effort All Methods
Samantha Miller					
On	90:31	0:00	0:00	0:00	90:31
Off	181:28	0:00	0:00	0:00	181:29
***Samantha Miller* Total**	**272:00**	**0:00**	**0:00**	**0:00**	**272:00**
Danielle Miller GP					
On	497:12:00	0:00	339:07	375:08	1,211:29
Off	475:25:00	149:27	16:18	13:59	655:10
***Danielle Miller* Total**	972:37	149:27	355:26	389:07	1,866:39
Geophysical Total	**1244:37**	**149:27**	**355:26**	**389:07**	**2,138:39**

[1/] Total calculated separately for each detection method; thus, overlapping effort (e.g., IR and PAM) are summed separately. UE = Unaided eye with occasional use of reticle binoculars, IR = infra-red camera monitoring, NVD = night vision device, PAM = passive acoustic monitoring.

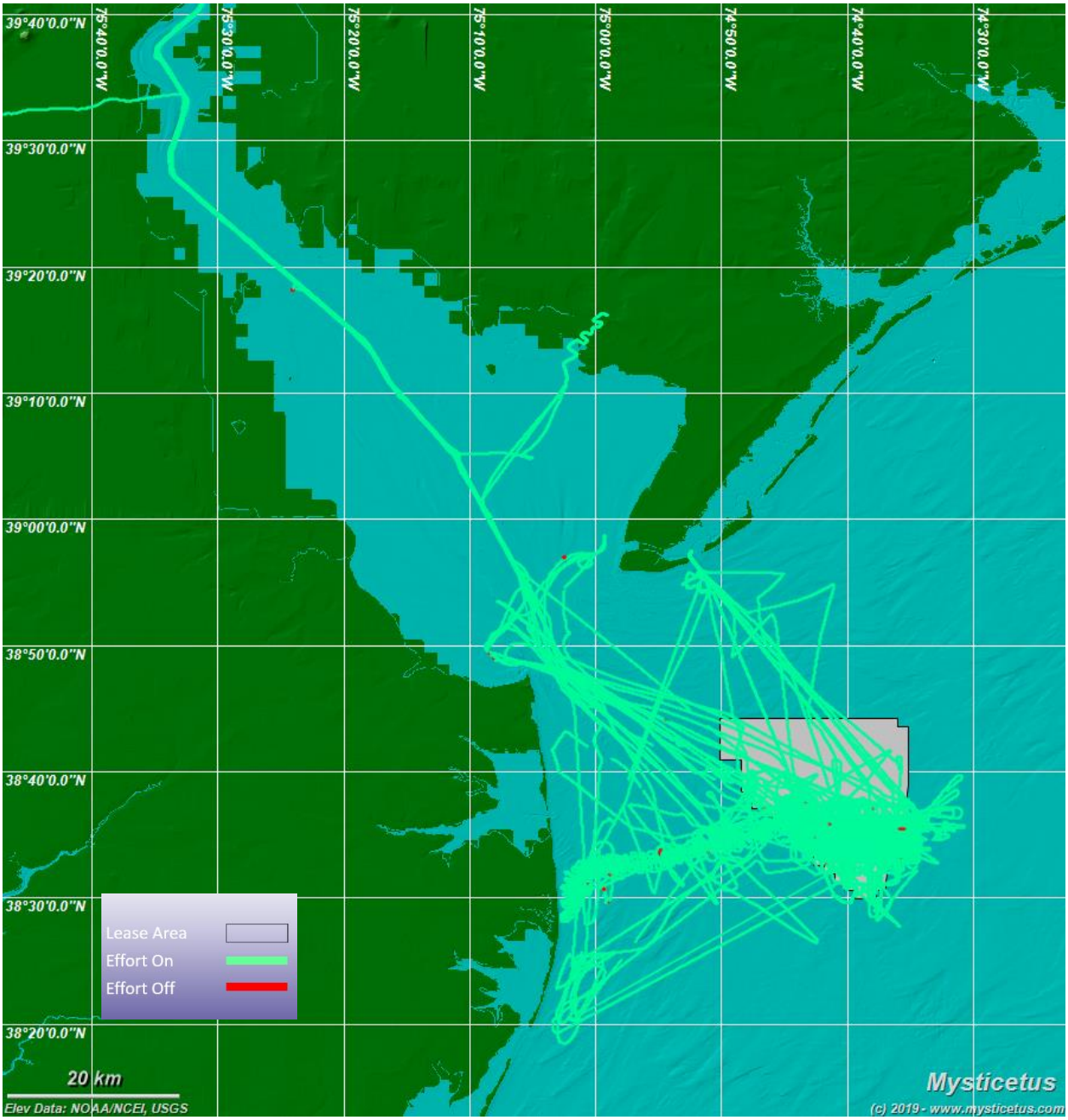

Figure 5. *Danielle Miller* geophysical vessel tracklines during all monitoring effort in the Survey Area.

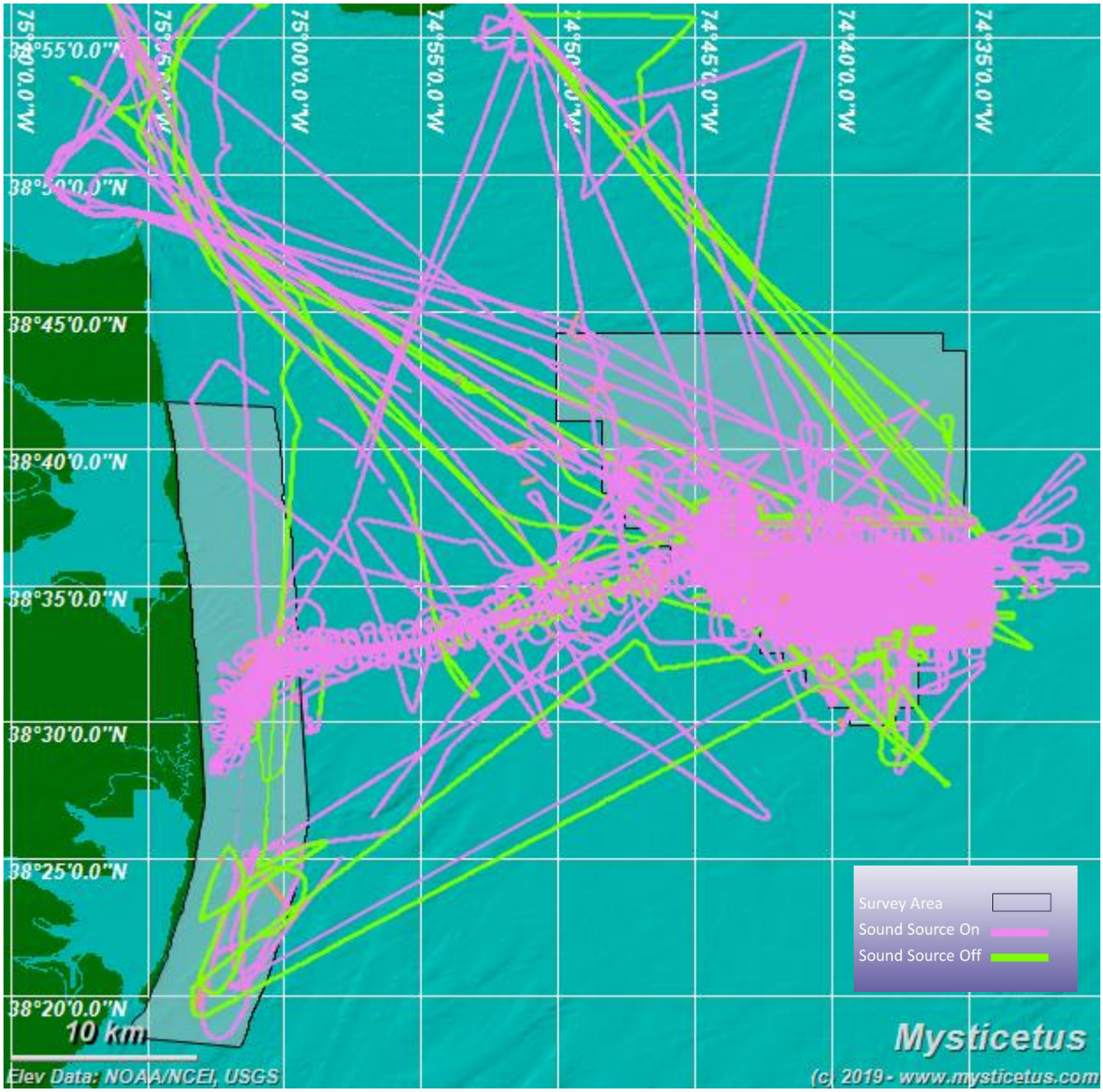

Figure 6. *Danielle Miller* geophysical vessel tracklines during all all sound source off and on periods.

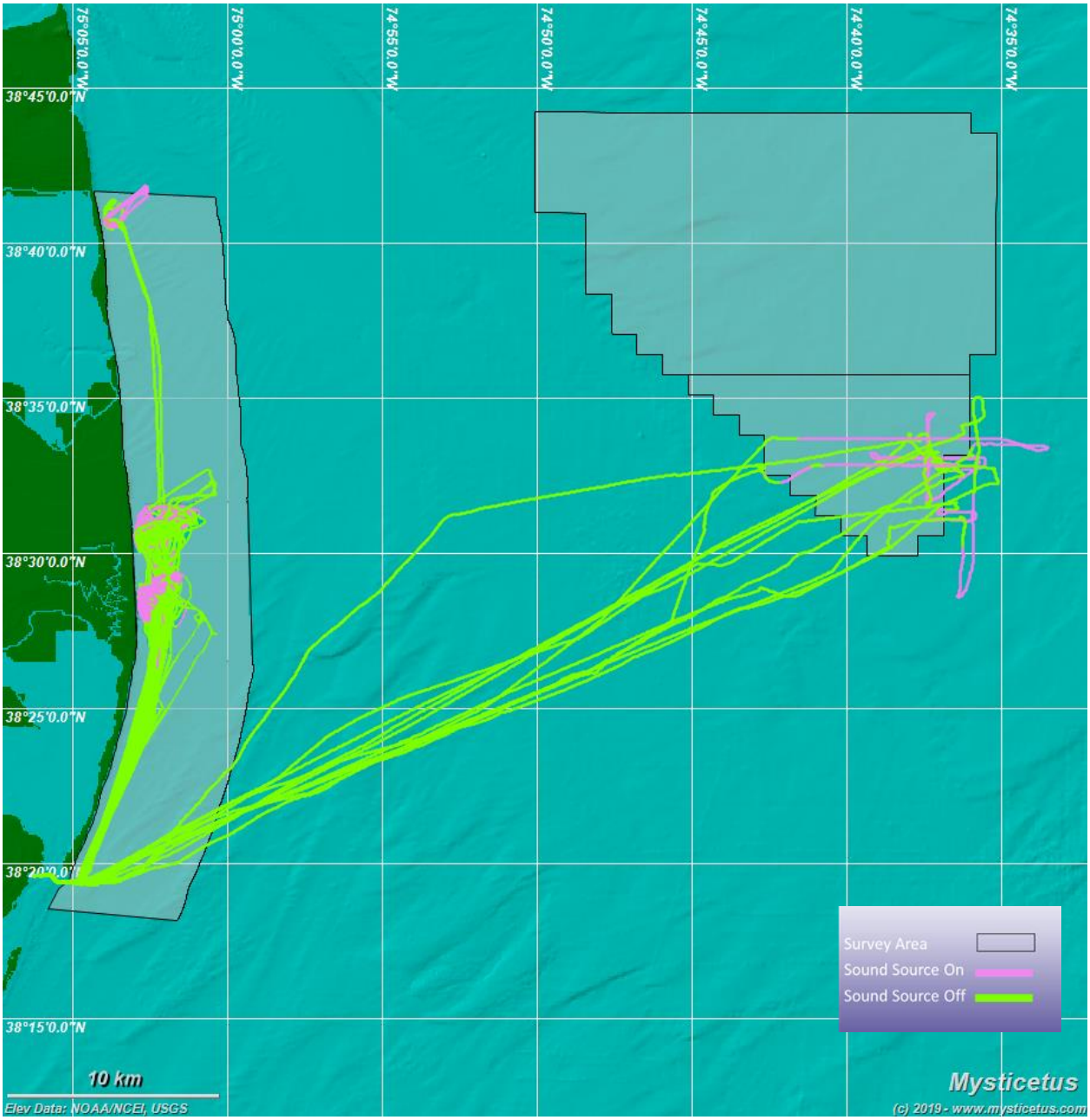

Figure 7. *Samantha Miller* geophysical vessel tracklines during all sound source off and on periods.

4.1.1.1 Geophysical Environmental Conditions

Overall, the environmental conditions were conducive to effectively monitor for protected species during survey operations using visual monitoring methods described in Section 3.2. The majority (81%; n = 1,740 h) of visual and PAM effort was conducted in Beaufort sea states of 3 or less (

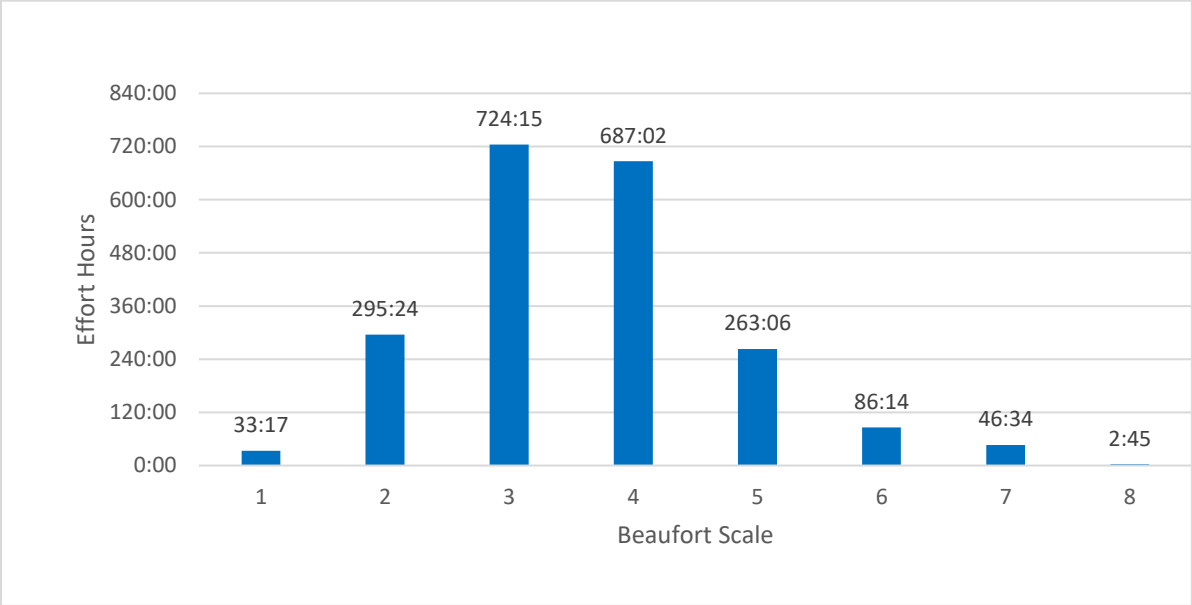

Figure 8).

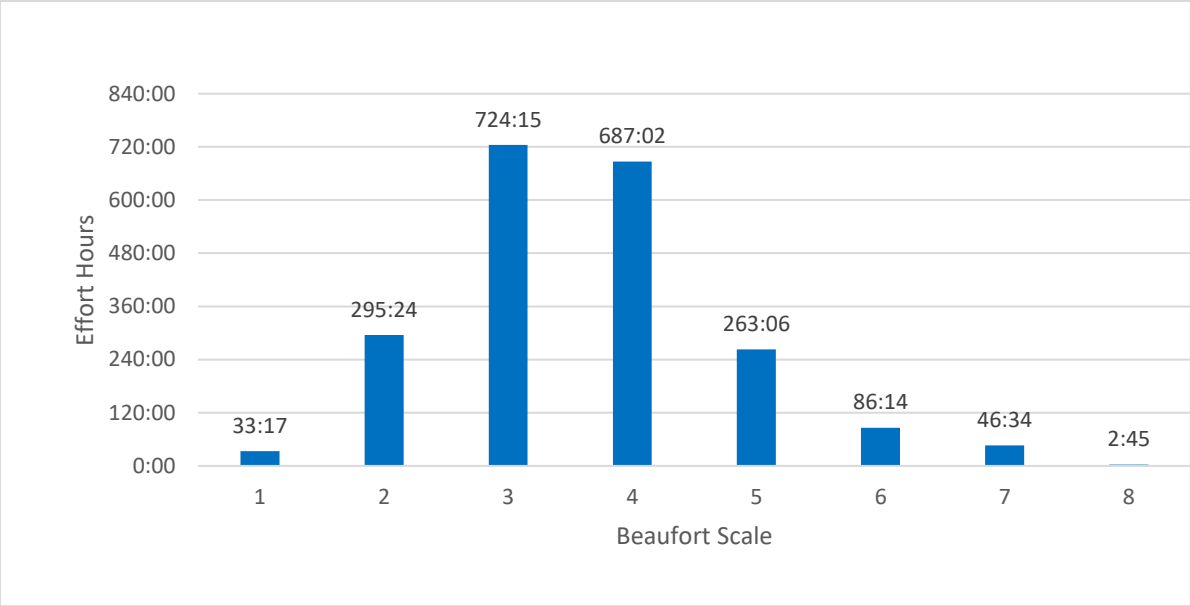

Figure 8. Beaufort sea state (Bft) by all monitoring effort hours during the geophysical survey period inside the Survey Area.

4.1.2 Geophysical Protected Species Detections

During the geophysical survey period, there were a total of 317 protected species detections in the Survey Area (both inside and outside the Lease Area and cable approaches) comprised of approximately 2,520 individuals (Table 11, Figure 9). No Atlantic sturgeon (*Acipenser oxyrinchus*) were sighted during surveys. Of the 317 detections, 89% were identified to species level, while the remaining 11% were identified only to taxonomic family level. The most commonly recorded species was the bottlenose dolphin (*Tursiops truncatus*; 209 detections of 2,377 individuals), followed by the loggerhead turtle (*Caretta*; 37 detections of 37 individuals), leatherback turtle (*Dermochelys coriacea*; 14 detections of 14 turtles), and the humpback whale (*Megaptera novaeangliae*; 12 detections of 17 individuals). A total of 22 visual detections of 27 large whales were observed, including 17 humpback whales, one sperm whale, and nine unidentified whales. No whale PAM detections were made. All acoustic detections were classified as unidentified delphinids or dolphins and were counted as a minimum of a single individual if PAM detections were not confirmed/matched with a simultaneous visual sighting.

Table 11. All protected species detections in the Survey Area during the geophysical survey period (inside and outside the Lease Area).

Species	Inside Lease Area				Potential Cable Shore Approach				Outside the Lease Area and Cable Shore Approach				Total		
	Sound Source Off		Sound Source On		Sound Source Off		Sound Source On		Sound Source Off		Sound Source On				
	No. Detections	No. Estim. Indiv.	No. Detections	No. Estim. Indiv.	No. Detections	No. Estim. Indiv.	No. Detections	No. Estim. Indiv.	No. Detections	No. Estim. Indiv.	No. Detections	No. Estim. Indiv.	Total No. Detections	Total No. Estim. Indiv.	Overall Mean Group Size
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	1	6	0	0	1	6	6.0
Bottlenose dolphin	1	2	0	0	64	445	1	13	117	1,488	26	429	209	2,377	11.4
Common dolphin	0	0	3	6	0	0	0	0	0	0	2	9	5	15	3.0
Green turtle	2	2	2	2	0	0	0	0	3	3	2	2	9	9	1.0
Humpback whale	1	2	4	5	0	0	0	0	6	9	1	1	12	17	1.4
Leatherback turtle	4	4	7	7	0	0	0	0	2	2	1	1	14	14	1.0
Loggerhead turtle	14	14	13	13	0	0	0	0	8	8	2	2	37	37	1.0
Other	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1.0
Sperm whale	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1.0
Unidentified delphinid	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1.0
Unidentified dolphin	4	18	2	3	0	0	0	0	0	0	1	1	7	22	3.1
Unidentified sea turtle	2	2	2	2	0	0	0	0	6	6	1	1	11	11	1.0
Unidentified whale	4	4	4	4	0	0	0	0	0	0	1	1	9	9	1.0
Grand Total	**34**	**50**	**38**	**43**	**64**	**445**	**1**	**13**	**143**	**1,522**	**37**	**447**	**317**	**2,520**	**7.9**

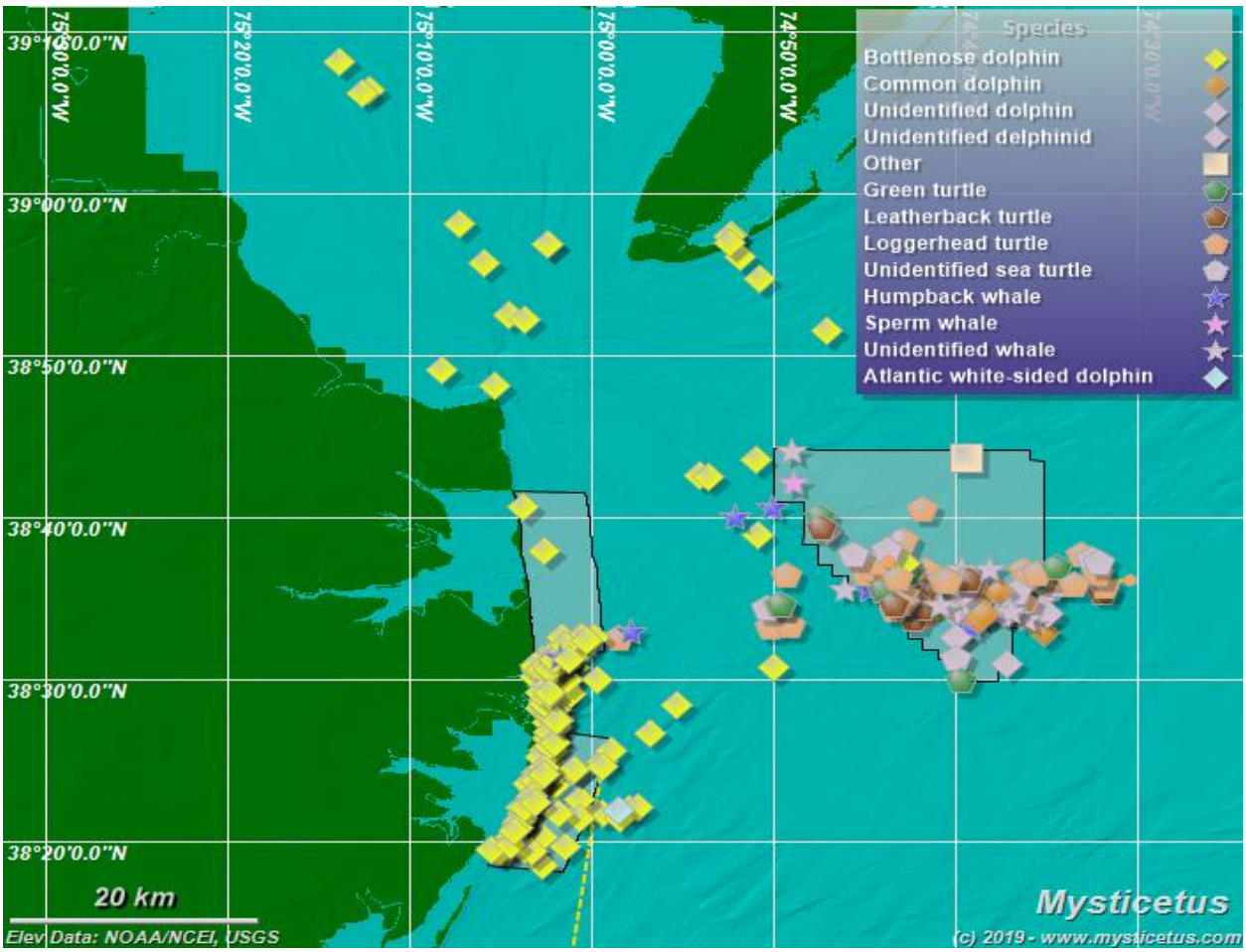

Figure 9. Locations of all detections of protected species in the Survey Area during the geophysical survey period. Lease Area and proposed nearshore cable approach areas are indicated by gray-shaded polygons.

A total of 245 detections (~ 2,437 individuals) of protected species were made outside vs. 72 detections (~93 individuals) inside the Lease Area during the geophysical survey period (Figure 9). The higher number of individuals outside the Lease Area was related to the relatively high number of bottlenose dolphins seen along the shoreline from the *Samantha Miller* predominantly in the cable approach areas. More individual large whales were seen inside (n = 16) vs. outside (n = 11) the Lease Area (Figure 10). Only the humpback whale (5 of 12 detections) was seen < 20 km from shore, largely in or near the proposed cable approach area (Figure 10).

The most commonly sighted sea turtle that was identified to species was the loggerhead turtle (*Caretta caretta*) followed by the leatherback turtle (*Dermochelys coriacea*) (n = 37 and 14, respectively). Over 99% of all sea turtles were seen > 20 km from shore, 65% of which were in the Lease Area polygon (Figure 9 and Table 11).

Mean group size was highest for bottlenose dolphin records followed by unidentified dolphins (Table 11). Mean group size for the humpback whale was 1.5 and 1.0 for all other whale sightings and sea turtles (Table 11). The average UE/RB detection rates were 1.7 records per 100 h of effort for whales, 1.5 for delphinids/porpoises, and 3.32 for sea turtles). Bottlenose dolphins represented the highest detection rate of 9.77 detections per 100 h of effort.

Table 33. Geophysical survey detection rates (number of initial1/ detections for per-person decimal hours of effort2/) in daylight vs. darkness for visual and PAM methods by species and groupings in the Survey Area by vessel during the geophysical survey. 6/

Species	Day 3/ 4/								Night 3/ 4/								Grand Total 3,807.1 h	
	NVD 5/ 0.0 h		PAM 49.5 h		UE 1,770.2 h		Day Total 1,872.0 h		IR 802.1 h		NVD 281.4 h		PAM 661.3 h		Night Total 1,935.1 h			
	Number of Detections 5/	Detection Rate (No. NVD Detections / 100 h NVD Effort	Number of Detections	Detection Rate (No. PAM Detections / 100 h PAM Effort	Number of Detections	Detection Rate (No. Visual Detections / 100 h Visual Effort	Total Daytime Detections	Total Detection Rate No. Detections / 100 h Effort)	Number of Detections	Detection Rate (No. IR Detections / 100 h IR Effort	Number of Detections \5	Detection Rate (No. NVD Detections / 100 h NVD Effort	Number of Detections	Detection Rate (No. PAM Detections / 100 h PAM Effort	Total Daytime Detections	Total Detection Rate No. Detections / 100 h Effort)	Total Number of Detections	GP Total Detection Rate (No. Detections / 100 h Effort)
Delphinid Total	1	--	2	4.0	228	12.9	231	12.3	7	1.0	1	0.4	14	2.1	23	1.2	254	6.7
Pinniped Total	0	0.0	0	0.0	1	0.1	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
Turtle Total	0	0.0	0	0.0	87	4.9	87	4.6	1	0.1	0	0.0	0	0.0	1	0.1	88	2.3
Whale Total	1	--	0	0.0	46	2.6	47	2.5	6	0.7	0	0.0	0	0.0	6	0.3	53	1.4
Grand Total	**2**	--	**2**	**4.0**	**362**	**20.5**	**366**	**19.6**	**14**	**1.9**	**1**	**0.4**	**14**	**2.1**	**30**	**1.6**	**396**	**10.4**

1/ Detections presented are initial detections from each monitoring method. UE = Unaided Eye (during daylight this included occasional use of 7 x 50 reticle binoculars primarily to confirm sightings, species, etc.), IR = Infrared binoculars, NVD = Night Vision Device (night vision binoculars).
2/ Effort includes simultaneously occurring effort, representing totals for each person on watch by method. See Methods section.
3/ The two NVD detections occurred outside of NVD watch hours.

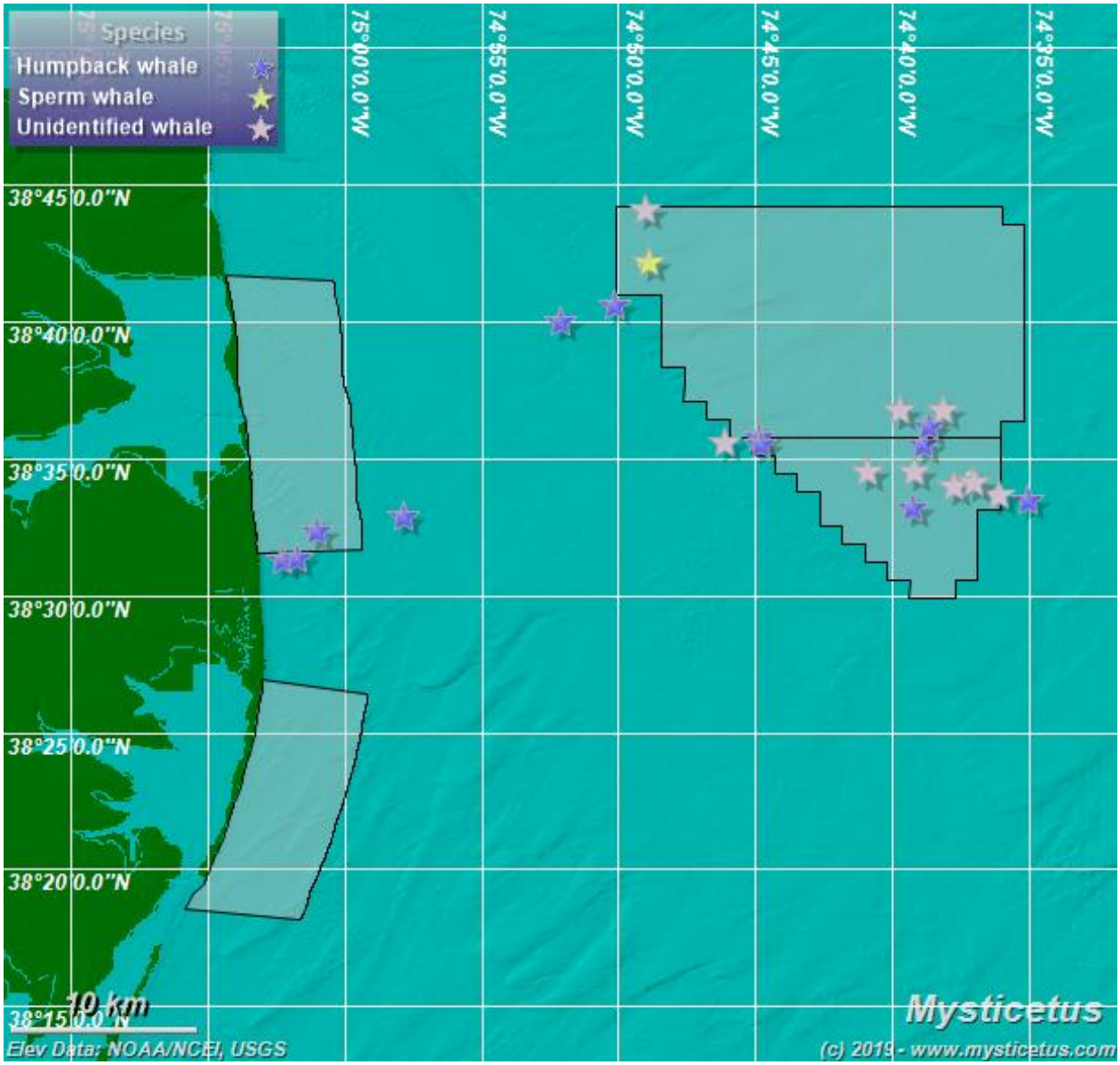

Figure 10. Geophysical sighting locations of all large whale species visual and PAM detections outside and inside the Lease Area. Lease Area and proposed nearshore cable approach areas are indicated by gray-shaded polygons.

4.1.2.1 Geophysical North Atlantic Right Whale Sighting

No confirmed or possible NARW detections were made inside or outside of the Lease Area or Survey Area during geophysical survey efforts from either the *Danielle Miller or Samantha Miller.*

4.1.2.2 Geophysical Protected Species Behavior

To maximize sample size, behavior data were pooled for all detections in the entire Survey Area by whales, delphinids and sea turtles. Overall, behavior state was recorded for 96 % (n = 305) of the total 317 detections (Figure 11 through Figure 13). Behavior

could not be determined for the remaining detections because they were only detected with PAM, the animal was too far away, or the observation was too short to determine behavior state.

For the detections of large whales, medium travel was the most commonly (40.9%) observed behavior state (Figure 11). Behavior among delphinids was recorded most often for bottlenose dolphins (209 detections), with 59% exhibiting travel behavior followed by mill (33%) (Figure 12). Among sea turtles, the most commonly recorded behavior states were rest/slow travel and travel (Figure 13).

Most detections were recorded when sound sources were off (76%) vs. on (24%) (Table 11). There was no apparent difference between the behavior states observed when sources were on vs. off for any of the protected species groups compared to typical behaviors demonstrated by those species. Travel (pooled across types of travel) was the most commonly observed behavior state when geophysical sources were both on and off (Figure 11 through Figure 13), while mill behavior was seen more frequently when sources were off.

No change in behavior was noted for most (75% or 1890) of the 2,520 individuals where behavior was recorded. Among 48 individuals, a clearly defined change in behavior or activity could be determined between the first detection and subsequent detections. Most observed changes in behavior consisted of diving but also change in heading (Figure 14 through Figure 16). More changes in behavior were recorded while the geophysical sound sources were off versus on.

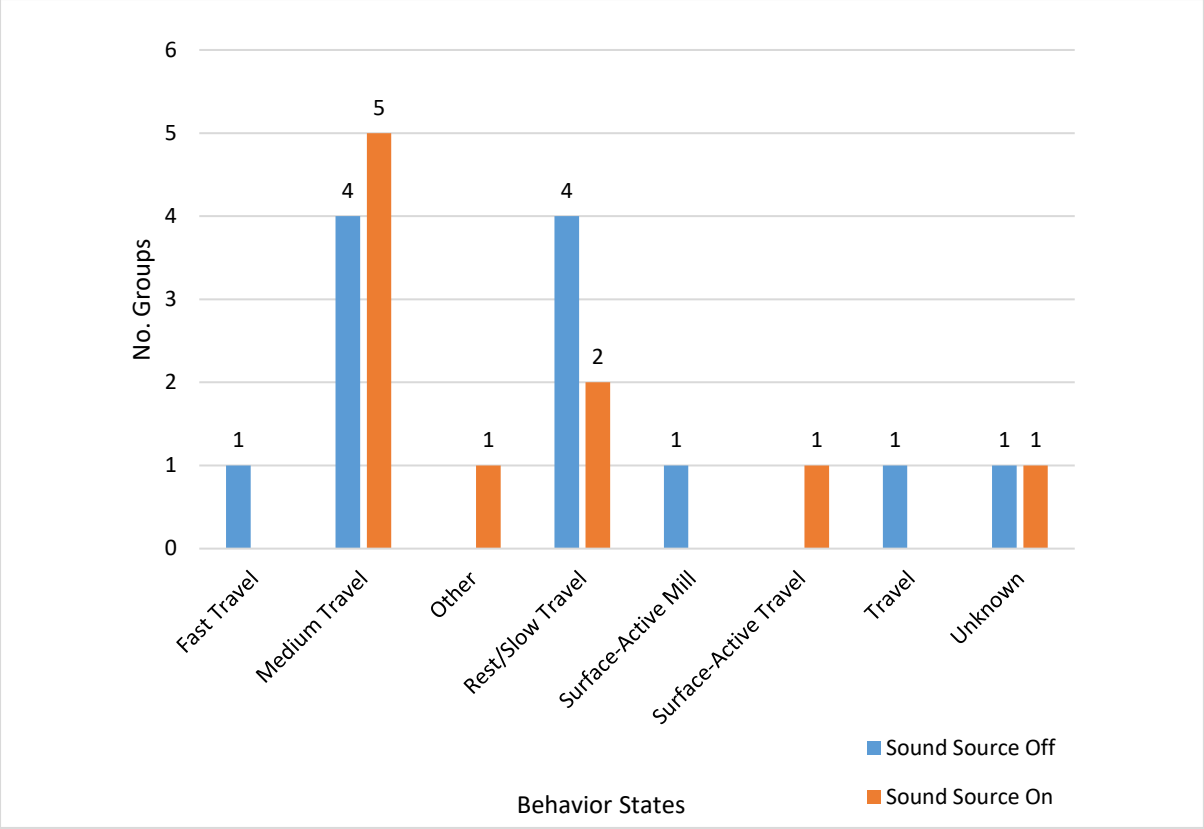

Figure 11. Behavior states for all whale visual detections with geophysical sound source *on* vs. *off* in the Survey Area. No whale PAM detections were made.

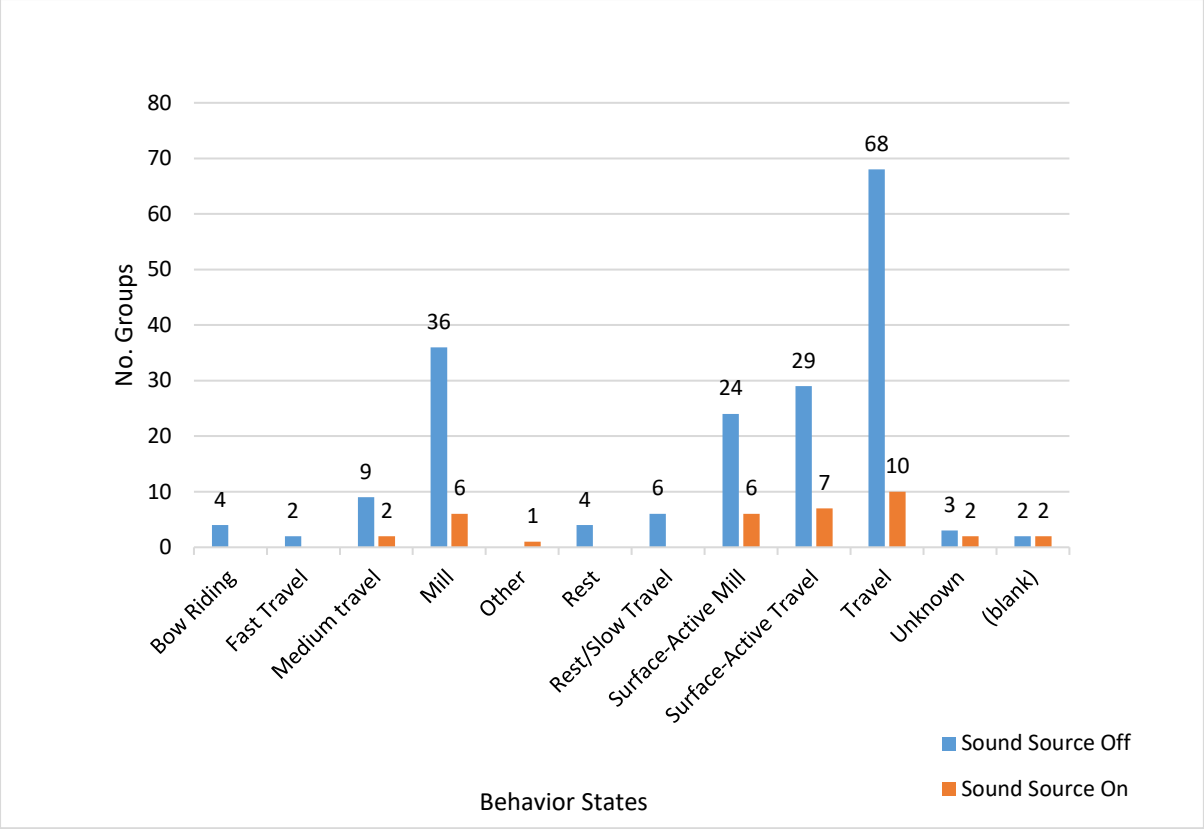

Figure 12. Behavior states for all delphinid/dolphin visual detections with geophysical sound source *on* vs. *off* in the Survey Area. Excludes PAM detections as behavior state could not be determined. No porpoises were identified.

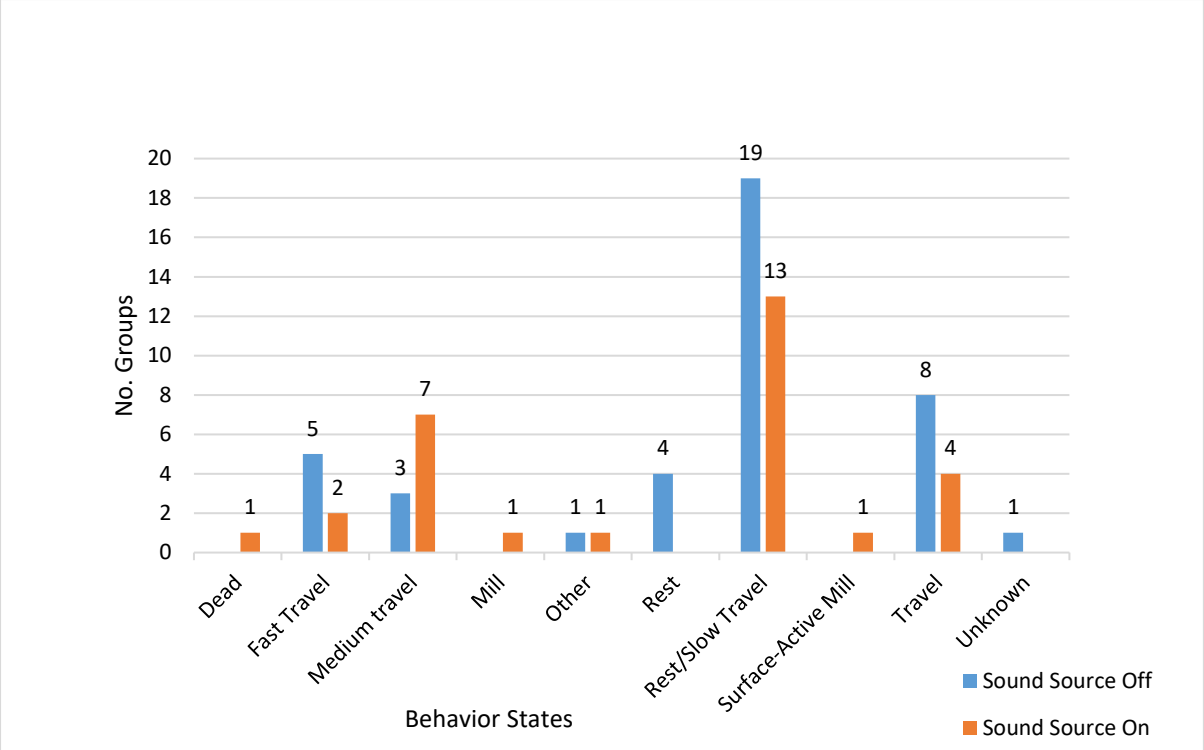

Figure 13. Behavior states for all sea turtle detections with geophysical sound source *on* vs. *off* in the Survey Area.

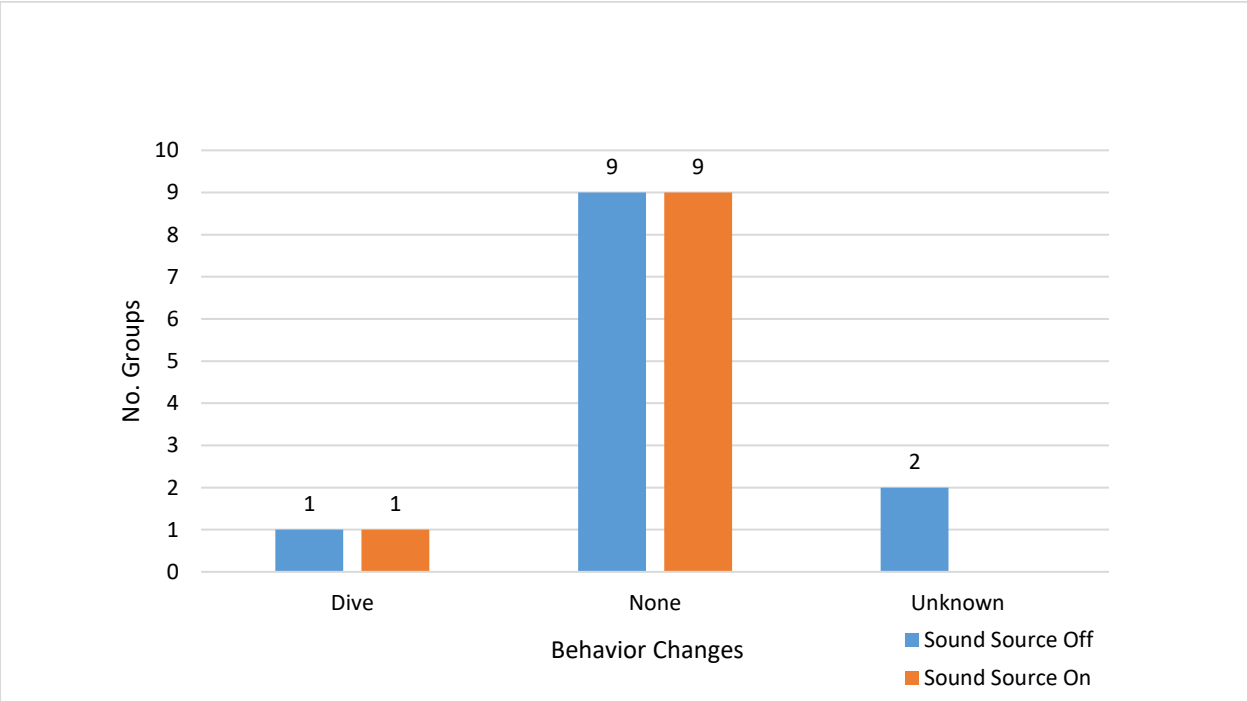

Chart does not include PAM detections as behavior could not be determined.

Figure 14. Observed changes in behavior (or lack thereof, i.e, none) for all whale detections with geophysical sound source *on* vs. *off* in the Survey Area.

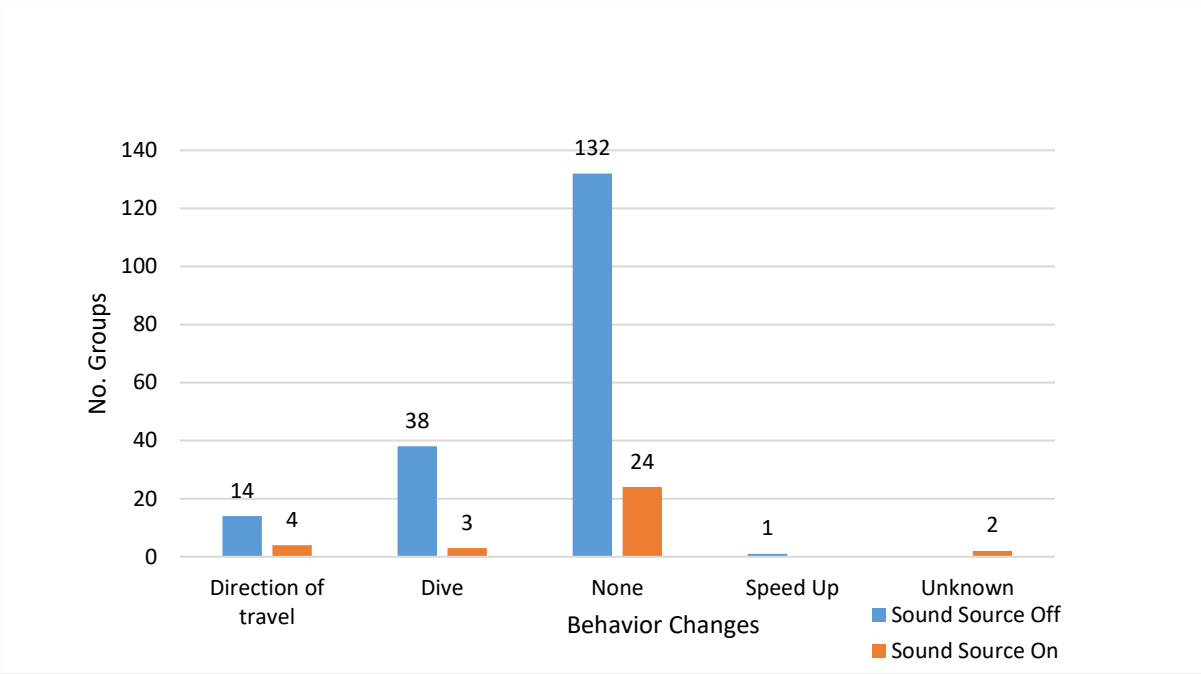

Figure 15. Behavior changes (or lack thereof) for all delphinid/dolphin detections with geophysical sound source *on* vs. *off* in the Survey Area.

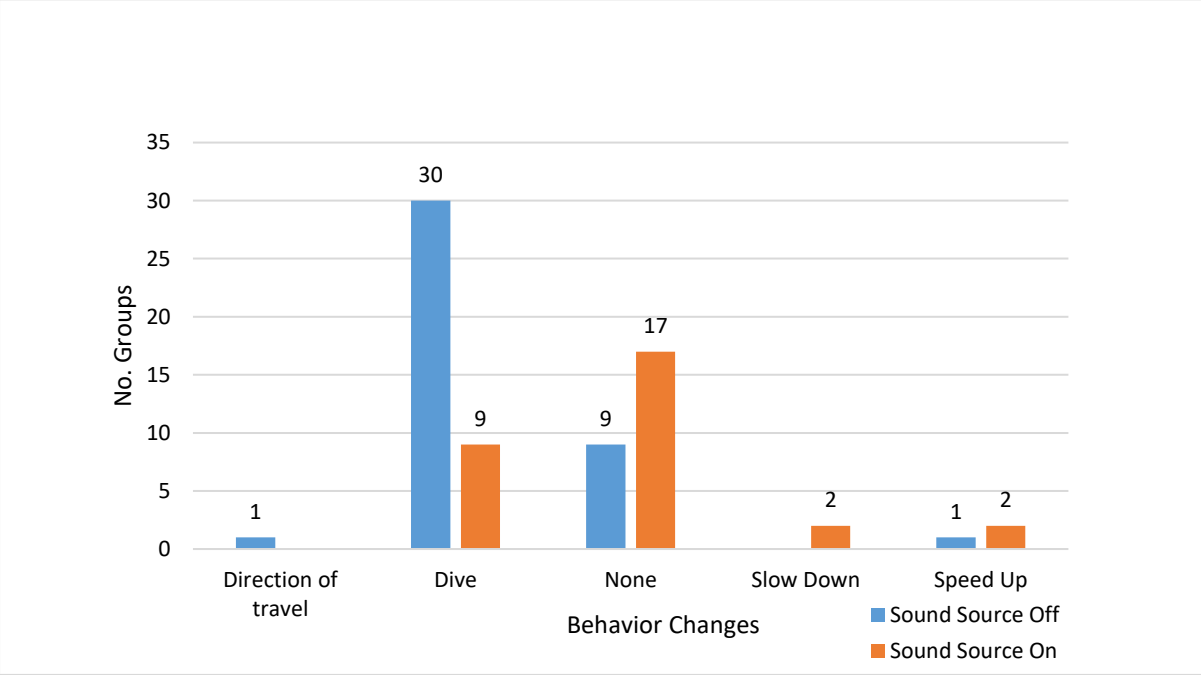

Figure 16. Behavioral changes (or lack thereof) of sea turtles while the geophysical sound source was *off* or *on* in the Survey Area.

4.1.2.3 Geophysical Closest Point of Observed Approach (CPA)

The closest Point of Observed Approach (CPA) and the frequency of sightings within three distance categories (< 500 m [EZ], 500-1,000 m, and > 1,000 m) were used as a metric to compare how close to the source protected species were observed during sound *on* and *off* periods (Table 12 and Figure 17 through Figure 22). On average, CPA of whales tended to be observed closer to the location of the source while the source was *off* vs. when it was *on*. In contrast, the mean CPA of delphinids/dolphins was often closer while the sound source was *on* vs. *off*. Little difference in CPA distance was observed among sea turtles during *on* and *off* periods. Of the total 22 whale detections for which distance could be estimated, half were seen < 500 m from the sound source location (Figure 17). Dolphins and porpoises (n = 218 detections with distance data) were seen predominantly (86%, n = 188) at distances < 500 m from the sound source (Figure 19). Ninety-seven percent (n =69) of sea turtle detections occurred < 500 m from the sound source (Figure 21).

Table 12. Mean, minimum and maximum observed Closest Point of Approach (CPA) distance (m) of protected species sightings while the sound source was off and on during the geophysical survey period.

Species	CPA Sound Source Off (m)				CPA Sound Source On (m)			
	Min.	Max.	Mean	Std Dev.	Min.	Max.	Mean	Std Dev.
***Danielle Miller* (Geophysical Portion)**								
Whale Totals	**20.00**	**923.94**	**382.11**	**239.83**	**150.00**	**1,500.00**	**618.82**	**396.45**
Humpback whale	20.00	923.94	363.89	317.17	150.00	1,500.00	609.15	478.74
Sperm whale	501.26	501.26	501.26	0.00	0.00	0.00	0.00	0.00
Unidentified whale	250.00	513.41	375.09	118.48	265.30	1,157.19	628.50	291.49
Turtle Totals	**3.00**	**604.07**	**121.49**	**119.25**	**2.00**	**923.94**	**98.42**	**172.80**
Green turtle	5.00	201.52	55.30	73.54	5.00	20.00	11.25	6.50
Leatherback turtle	3.00	285.82	182.58	100.75	10.00	923.94	169.24	291.21
Loggerhead turtle	5.00	255.82	95.49	84.47	2.00	308.60	98.58	92.93
Unidentified sea turtle	25.00	604.07	198.09	178.75	10.00	50.00	25.00	17.80
Delphinid Totals	**0.00**	**923.94**	**141.02**	**180.85**	**0.00**	**923.94**	**137.26**	**299.54**
Bottlenose dolphin	0.00	688.97	121.07	141.42	923.94	923.94	923.94	0.00
Common dolphin	0.00	0.00	0.00	0.00	0.00	114.15	38.54	46.61
Unidentified dolphin	150.00	923.94	420.33	356.42	0.00	10.00	6.67	4.71
***Danielle Miller* Totals**	**0.00**	**923.94**	**158.17**	**183.08**	**0.00**	**1,500.00**	**213.31**	**331.41**
Samantha Miller								
Whale Totals	**377.17**	**550.00**	**463.59**	**86.41**	**0.00**	**0.00**	**0.00**	**0.00**
Humpback whale	377.17	550.00	463.59	86.41	0.00	0.00	0.00	0.00
Turtle Totals	**30.00**	**30.00**	**30.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Unidentified sea turtle	30.00	30.00	30.00	0.00	0.00	0.00	0.00	0.00
Delphinid Totals	**1.00**	**1,882.17**	**280.15**	**329.36**	**10.00**	**1,176.71**	**295.90**	329.90
Atlantic white-sided dolphin	100.00	100.00	100.00	0.00	0.00	0.00	0.00	0.00
Bottlenose dolphin	1.00	1,882.17	278.82	329.92	10.00	1,176.71	295.90	329.90
Unidentified dolphin	644.32	644.32	644.32	0.00	0.00	0.00	0.00	0.00
***Samantha Miller* Totals**	**1.00**	**1,882.17**	**280.97**	**327.43**	**10.00**	**1,176.71**	**295.90**	**329.90**
Geophysical Total	**0.00**	**1,882.17**	**231.95**	**285.33**	**0.00**	**1,500.00**	**242.33**	**333.22**

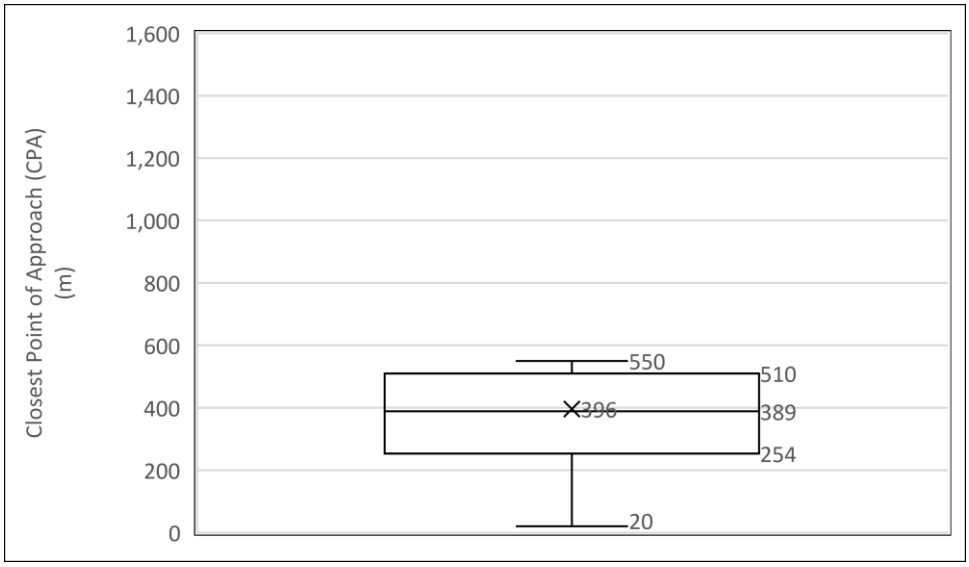

Figure 17. Closest Observed Approach (CPA) for all whale detections with geophysical sound source off in the Survey Area.

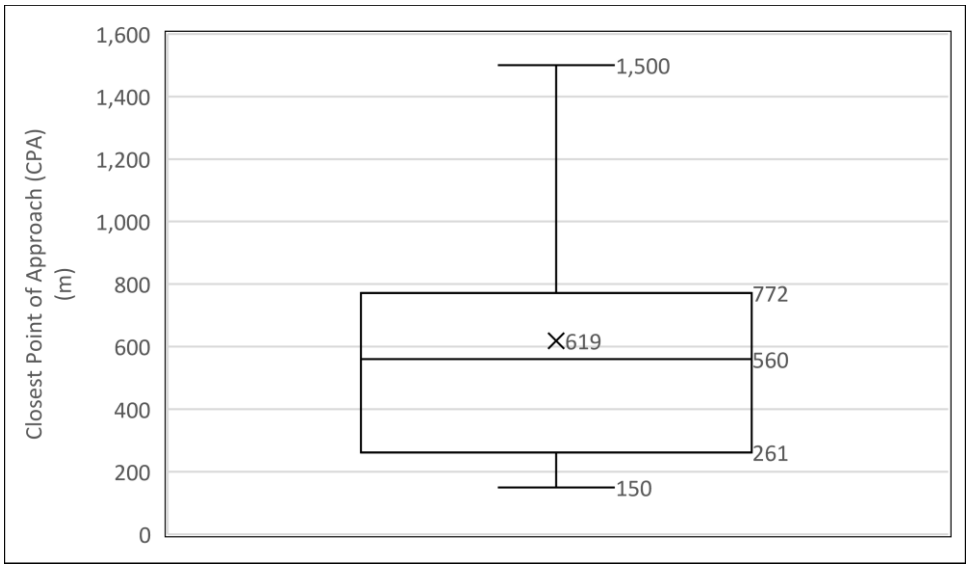

Figure 18. Closest Observed Approach (CPA) for all whale detections with geophysical sound source on in the Survey Area.

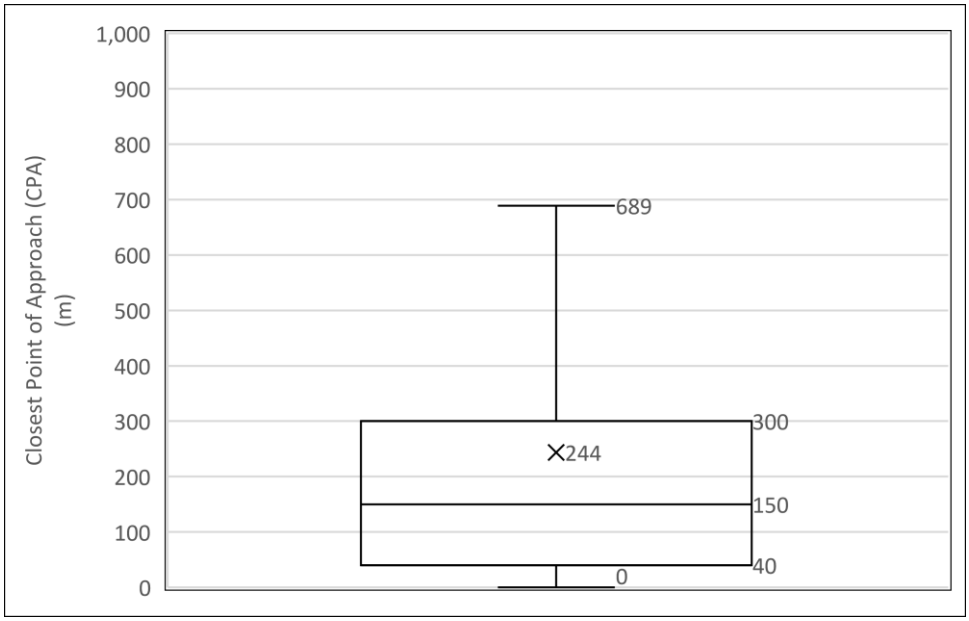

Figure 19. Closest Observed Approach (CPA) for all delphinid/dolphin detections with geophysical sound source off in the Survey Area. No porpoises were identified.

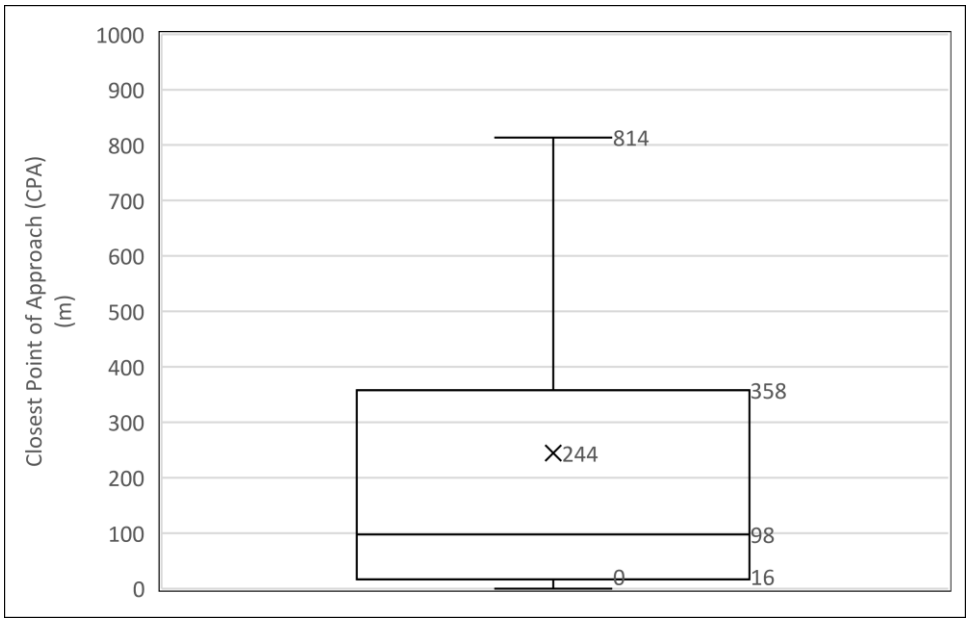

Figure 20. Closest Observed Approach (CPA) for all delphinid/dolphin detections with geophysical sound source on in the Survey Area. No porpoises were identified.

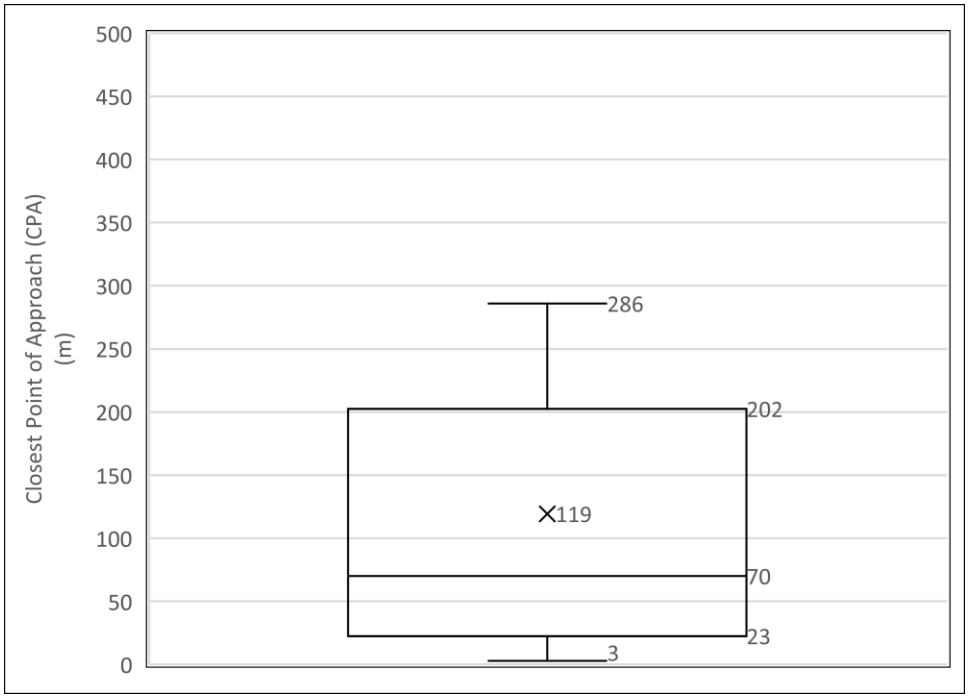

Figure 21. Closest Observed Approach (CPA) for all sea turtle detections with geophysical sound source off in the Survey Area.

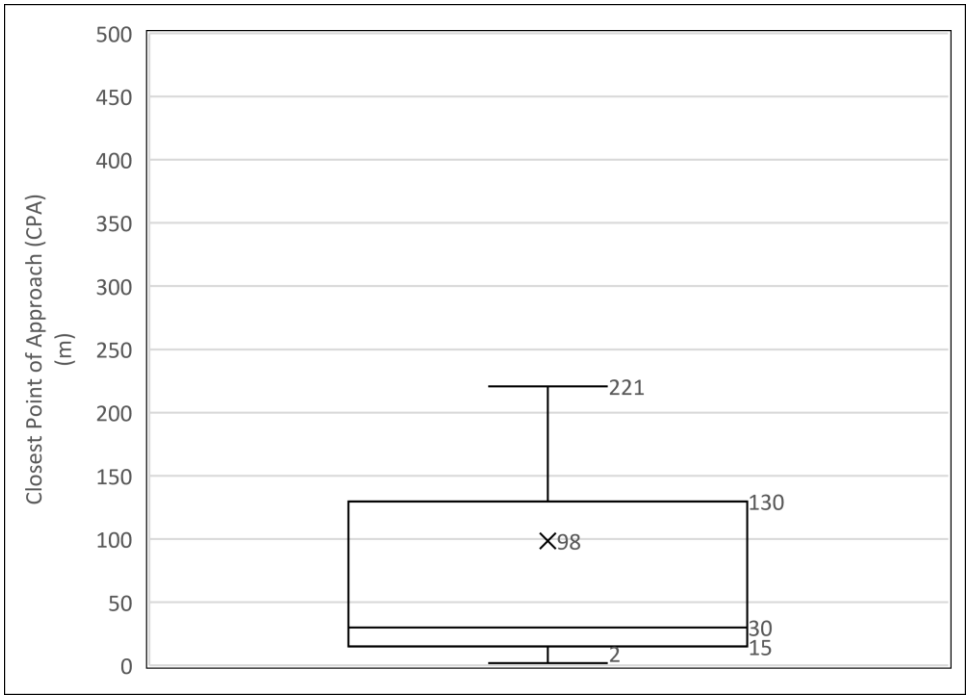

Figure 22. Closest Observed Approach (CPA) for all sea turtle detections with geophysical sound source on in the Survey Area.

4.1.3 Photographs and IR Video

HD still photographs of protected species detections were taken opportunistically during the geophysical survey period from both vessels. The best photos (in terms of focus, clarity, etc.) are presented in Appendix I. No video was taken during the geophysical survey period.

4.1.4 Geophysical Protected Species Incident Reports

There were no marine mammal deaths, carcasses, or strandings recorded during geophysical surveys conducted from the *Samantha Miller.* However, one badly decomposed unidentified animal carcass was seen from the *Danielle Miller* during the survey period. Photographs were taken as it floated by the vessel, but species could not be confirmed due to the state of the decomposition. Protocol according to the BOEM Lease (Appendix A) was followed and the incident was reported to the necessary authorities.

All incident reports were reported within the timelines identified in the BOEM Lease and AMP and the NMFS-issued IHA. In addition, a daily summary report of numbers and species of sightings and number of detections within the EZs was provided daily to the vessel POC by the Lead PSO.

4.1.5 Geophysical Mitigation Measures

Mitigation measures requested and implemented during the geophysical survey are summarized in Table 13. No mitigation was needed for over half (n=190) of the total 317 detections made in the Survey Area. All mitigation measures requested by PSOs were implemented by the vessel crew. The most frequently implemented mitigation measure was a delay in starting or re-starting operations due to a detection during clearance periods (*n* = 94 total delays). A total of 31 shutdowns were implemented when protected species were observed closely approaching, near, or within the EZ. The vessel operator implemented one course alteration to avoid potential collision with a whale.

The taxonomic grouping most frequently associated with a mitigation action was sea turtles consisting primarily of operational delays (*n* = 26) and shutdowns (*n* = 24). Overall, 71% of all sea turtle detections resulted in a mitigation measure being implemented.

Among cetaceans identified to species, shutdowns (*n* = 6) were more common than delays (*n* = 3) and course alternation (*n* = 1). A confirmed Endangered Species Act (ESA)-listed (including Protected status) whale species was involved in five mitigation measures: two shutdowns and three delays for humpback whales and one course alteration for a sperm whale. In addition, four shutdowns occurred for unidentified whales. Overall, most (52%) of the total 126 mitigation measure actions (shut down, delay, or course alternation) were associated with delphinids, the majority (98%) of which were bottlenose dolphin detections (*n* = 65 of 66 delphinid mitigation actions).

The number of implemented mitigation measures was similar between the *Samantha Miller* (*n* = 62) and the *Danielle Miller* (*n* = 64). However, nearly all (98%) of the *Samantha Miller* mitigation measures were delays in operations associated with bottlenose dolphins; only one shutdown occurred following a bottlenose dolphin sighting.

In contrast, aboard the Danielle Miller, nearly equal number of mitigation events consisted of shutdowns (*n* = 30) and operational delays (*n* = 33).

Table 13. Summary table of mitigation measures implemented[1].

Species	Mitigation Response			Detections without Mitigation Required[2]
	Delay	Shutdown	Total Mitigation Events	
Danielle Miller				
Bottlenose dolphin	4	0	4	1
Common dolphin	0	0	0	5
Green turtle	3	3	6	3
Humpback whale	2	2	4	3
Leatherback turtle	3	6	9	5
Loggerhead turtle	15	13	28	6
Unidentified delphinid	0	0	0	1
Unidentified dolphin	1	0	1	3
Unidentified sea turtle	5	2	7	1
Unidentified whale	0	4	4	4
Danielle Miller Total	33	30	63	32
Samantha Miller				
Bottlenose dolphin	60	1	61	25
Humpback whale	1	0	1	0
Samantha Miller Total	61	1	62	25
Geophysical Total	**94**	**31**	**125**	**57**

[1]Table includes all delays and shutdowns during sound source on and off periods.

[2] Detections that occurred while the sound source was on but did not require a mitigation measure.

4.1.6 Estimated Lost Production Time

The total loss of production associated with mitigation was approximately 75 h over the 177-day geophysical survey period for both the *Samantha Miller* and *Danielle Miller*. The mean down time per detection was 41 min due to delays in starting operations. The mean down time was 18 min associated operation shutdowns (Table 14).

Table 14. Estimated Loss of Operational Production Time and Events Associated with Protected Species Mitigation during the Geophysical Survey in the Survey Area.[1/]

Mitigation Event	Delphinid	Turtle	Whale	Total
Number of delays	65	26	3	94
Number of shutdowns	1	24	6	31
Total number of mitigation events	**66**	**50**	**10**	**126**
Loss of production HH:MM	**Total**	**Mean**		
Loss due to delays	65:15	0:41		
Loss due to shutdowns	9:43	0:18		
Total	74:58	0:35		

[1/] Totals exclude speed reductions associated with protected species vessel strike avoidance mitigation measures as such mitigation did not result in notable loss of operational production time.

4.2 Geotechnical Results

Geotechnical monitoring effort, protected species distribution, and sighting data in the Survey Area based on various conditions (e.g., darkness vs. daylight; regulated sound source(s) on versus off) are presented in Figure 23 through Figure 26 and Table 15 through Table 17. Results specific to requirements of the BOEM AMP, including detection rates, are presented in Appendix G.

4.2.1 Geotechnical Monitoring Effort

Geotechnical surveys were conducted from the *Seacor Supporter* 23 September 2018 – 19 October 2018 and from the *Danielle Miller* 28 November 2018 – 19 January 2019. At least one sound source was operating (i.e., on) during 98 h (8%) of the total 1,144 h of combined monitoring effort from both vessels. Sound sources were off during the remaining 92% of monitoring effort (Figure 24 and Figure 25). Geotechnical sound sources were on during more hours (106 h) from the *Seacor Supporter* than the *Danielle Miller* (35 h).

A total of 1,668 h of per-person visual and PAM monitoring effort occurred during the geotechnical survey (

Table 16). During darkness (57%), this time was overlapping/simultaneous, i.e., when PAM and nighttime visuals (e.g., IR and/or NVD) were concurrent. The remaining monitoring effort (43%) occurred during daylight. Most (80%) of the 1,668 h of per-person effort occurred using visual methods (UE/RB, IR or NVD); the remaining 20% occurred with PAM. All 321 h of PAM monitoring effort occurred during darkness as no daylight periods during the geotechnical survey required the use of PAM (i.e., the EZ was not obscured during daylight by fog, etc., during daylight clearance and operations periods associated with sound sources). Virtually all (>99%) of the 499 hr of IR effort occurred during nighttime. All PAM, IR and NVD monitoring effort was conducted in the Lease Area during nighttime. Results used to compare the effectiveness of the applied detection methods are discussed in Appendix I.

Table 15. Monitoring effort for each vessel by geotechnical (GT) sound source on and off in the Survey Area.

Sound Source	Hours
Seacor Supporter	
On (operating)	78
Off (not operating)	378
***Seacor Supporter* Total**	**456**
***Danielle Miller* GT**	
On (operating)	20
Off (not operating)	668
***Danielle Miller* GT Total**	**688**
Geotechnical Total	**1,144**

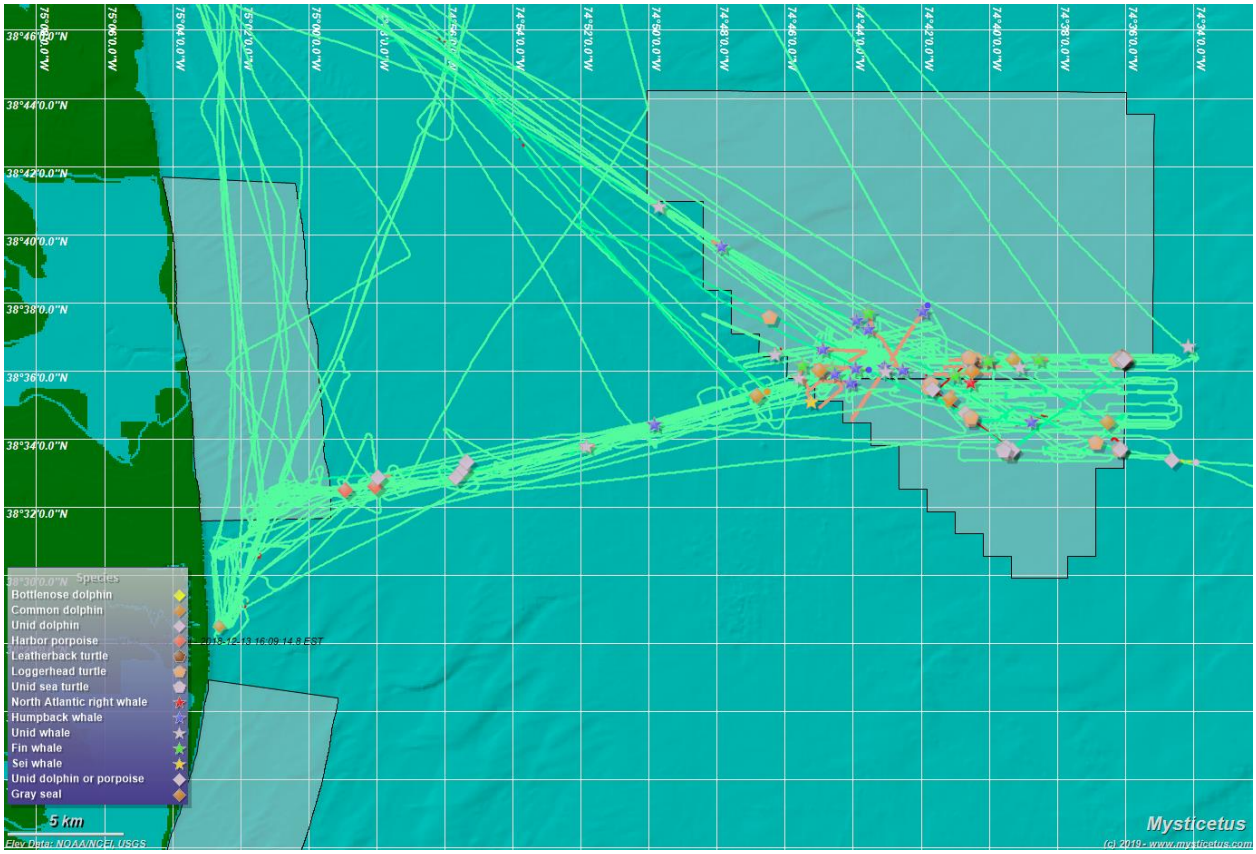

Figure 23. Geotechnical monitoring effort (visual and PAM) and protected species detections while sound source on and off in the Survey Area.

Figure 24. Danielle Miller geotechnical vessel tracklines during all sound source off and on periods.

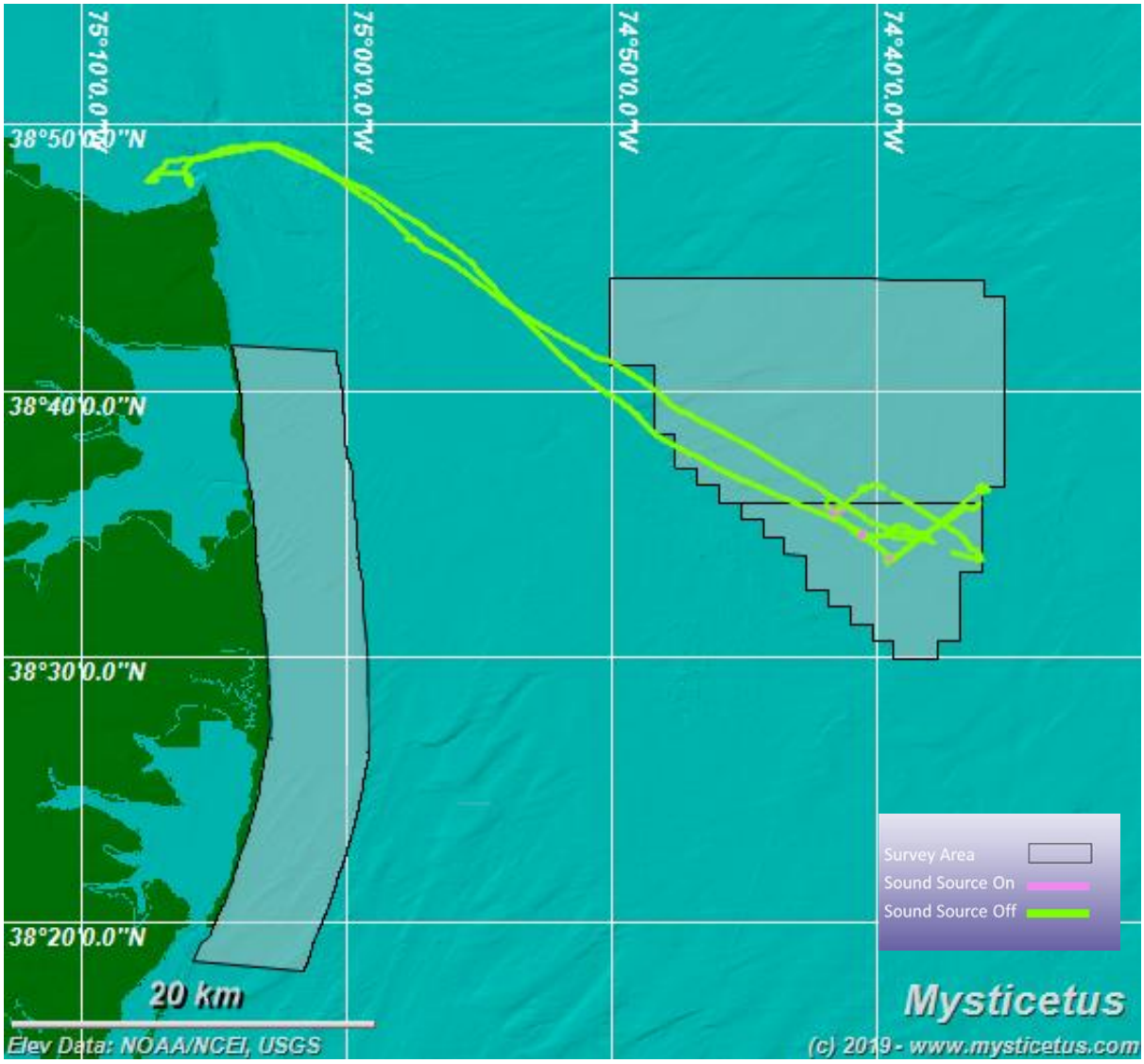

Figure 25. Seacor Supporter geotechnical vessel tracklines during all sound source off and on periods.

Table 16. Total per-person effort (hours) by monitoring method during night (darkness) and day in the Survey Area during the geotechnical (GT) survey period.[1]

Period	IR	NVD	UE/RB	PAM	Total Effort All Methods
Seacor Supporter					
Night	186:30	1:07	9:10	166:30	363:18
Day	32:09	0:00	232:57	42:43	307:50
Seacor Supporter Total	218:40	1:07	242:08	209:13	671:08
Danielle Miller GT					
Night	260:21	130:49	86:28	105:41	583:21
Day	20:02	0:00	387:10	6:44	413:56
Danielle Miller GT Total	280:23	130:49	473:39	112:25	997:18
GT Night	446:52	131:57	95:38	272:11	946:39
GT Day	52:11	0:00	620:08	49:27	721:47
Geotechnical Total	**499:03**	**131:57**	**715:47**	**321:38**	**1,668:26**

Table 17. Total per-person effort (hours) by monitoring method by vessel with sound source on and off in the Survey Area during the geotechnical (GT) survey period.[1/]

Sound Source	IR	NVD	UE/RB	PAM	Total Effort All Methods
Seacor Supporter					
On (operating)	28	0	51	27	106
Off (not operating)	191	1	191	182	565
***Seacor Supporter* Total**	**219**	**1**	**242**	**209**	**671**
Danielle Miller GT					
On (operating)	10	1	11	13	35
Off (not operating)	270	130	462	100	962
***Danielle Miller* GT Total**	**280**	**131**	**474**	**112**	**997**
GT On	38	1	62	40	141
GT Off	461	131	653	282	1527
Geotechnical Total	**499**	**132**	**715**	**322**	**1668**

[1/] Total calculated separately for each detection method; thus, overlapping effort (e.g., IR and PAM) are summed separately. UE/RB = Unaided eye with occasional use of reticle binoculars (RB), IR = infra-red camera monitoring, NVD = night vision device, PAM = passive acoustic monitoring.

4.2.1.1 Geotechnical Environmental Conditions

Overall, the environmental conditions were conducive to effectively monitor for protected species during survey operations using visual monitoring methods described in Section 3.2 The majority (67%) of visual and PAM effort was conducted in Beaufort sea states of 3 or less (Figure 26).

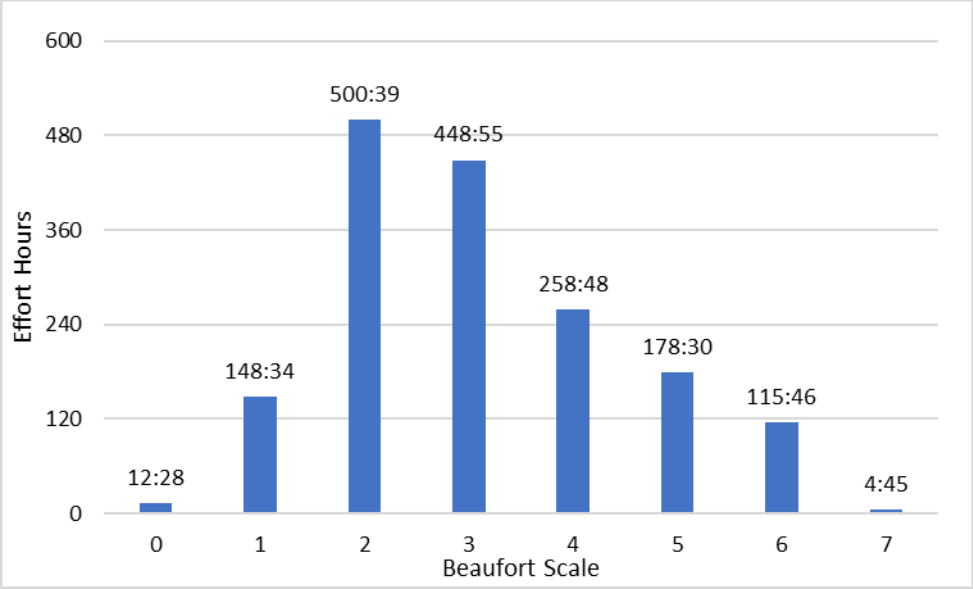

Figure 26. Beaufort states by PSO/PAM monitoring effort during the geotechnical survey period inside the Lease Area.

4.2.2 Geotechnical Protected Species Detections

During the geotechnical survey period, there were a total of 80 protected species detections in the Survey Area (both inside and outside the Lease Area) comprised of approximately 217 individuals (Table 18, Figure 27). No Atlantic sturgeon were sighted during the survey. Of the 80 detections, 60% were identified to 10 species while the remaining 40% were identified only to taxonomic family level. The most commonly recorded species was the humpback whale followed by the loggerhead sea turtle. Thirty sightings of 37 individual whales (five identified to species) were observed, including one confirmed and one probable NARW (based on the observed v-shaped blow distinctive of this species; Appendix H). Acoustic detections were classified as unidentified delphinids or dolphins and were counted as a minimum of a single individual if PAM detections were not confirmed/matched with a simultaneous visual sighting.

The most commonly sighted sea turtle species was the loggerhead (12 turtles) followed by the leatherback (1 turtle). All sea turtles were seen >20 km from shore, most (16 out of 17) in the Lease Area polygon (Figure 27). The leatherback sea turtle was seen offshore in the Lease Area.

Mean group size was 3.3 for bottlenose dolphins, 1.5 for humpback whales and 1.0 for sea turtles (Table 18). See Appendix G for geophysical and geotechnical pooled detection rates.

Table 18. Total number of protected species detections in the Survey Area during geotechnical sound source off and on periods.

Species	Inside the Lease Area [1] [2]				Outside the Lease Area				Total		
	Sound Source Off		Sound Source On		Sound Source Off		Sound Source On[3]				
	No. Detections	No. Estim. Indiv.	No. Detections	No. Estim. Indiv.	No. Detections	No. Estim. Indiv.	No. Detections	No. Estim. Indiv.	Total No. Detections	Total No. Estim. Indiv.	Overall Mean Group Size
Bottlenose dolphin	0	0	0	0	3	10	0	0	3	10	3.3
Common dolphin	6	65	0	0	1	15	0	0	7	80	11.4
Fin whale	7	7	0	0	1	1	0	0	8	8	1.0
Gray seal	0	0	0	0	1	1	0	0	1	1	1.0
Harbor porpoise	0	0	0	0	2	2	0	0	2	2	1.0
Humpback whale	10	16	1	1	1	1	0	0	12	18	1.5
Leatherback turtle	1	1	0	0	0	0	0	0	1	1	1.0
Loggerhead turtle	9	9	2	2	1	1	0	0	12	12	1.0
North Atlantic right whale	1	1	0	0	0	0	0	0	1	1	1.0
Sei whale	0	0	0	0	1	1	0	0	1	1	1.0
Unid dolphin	13	24	0	0	5	45	0	0	18	69	3.8
Unid dolphin or porpoise	0	0	0	0	1	1	0	0	1	1	1.0
Unid sea turtle	3	3	1	1	0	0	0	0	4	4	1.0
Unid whale	4	4	0	0	5	5	0	0	9	9	1.0
Grand Total	**54**	**130**	**4**	**4**	**22**	**83**	**0**	**0**	**80**	**217**	**2.7**

[1] Lease area includes 0482 and 0519.
[2] No sightings occurred in the Cable approach area.
[3] No sightings occurred outside the lease area while the sound source was on.

Table 19. Total number of protected species detections detected inside and outside the Lease Area during the geotechnical survey period.

Species Common Name	Inside Lease Area		Outside Lease Area		Total		
	No. Detections	No. Estimated Individuals	No. Detections	No. Estimated Individuals	No. Detections	No. Estimated Individuals	Overall Mean Group Size
Seacor Supporter							
Bottlenose dolphin	0	0	3	10	3	10	3.3
Fin whale	1	1	0	0	1	1	1.0
Humpback whale	2	2	0	0	2	2	1.0
Leatherback turtle	1	1	0	0	1	1	1.0
Loggerhead turtle	10	10	1	1	11	11	1.0
North Atlantic right whale	1	1	0	0	1	1	1.0
Unidentified dolphin	12	22	1	10	13	32	2.5
Unidentified sea turtle	4	4	0	0	4	4	1.0
***Seacor Supporter* Total**	**31**	**41**	**5**	**21**	36	62	1.7
***Danielle Miller* (Geotechnical Portion)**							
Common dolphin	6	65	1	15	7	80	11.4
Fin whale	6	6	1	1	7	7	1.0
Gray seal			1	1	1	1	1.0
Harbor porpoise			2	2	2	2	1.0
Humpback whale	9	15	1	1	10	16	1.6
Sei whale			1	1	1	1	1.0
Unidentified dolphin	1	2	4	35	5	37	7.4
Unidentified dolphin or porpoise			1	1	1	1	1.0
Unidentified whale	4	4	5	5	9	9	1.0
***Danielle Miller* GT Total**	**27**	**93**	**17**	**62**	**44**	**155**	**3.5**
Geotechnical Total	**58**	**134**	**22**	**83**	**80**	**217**	**2.7**

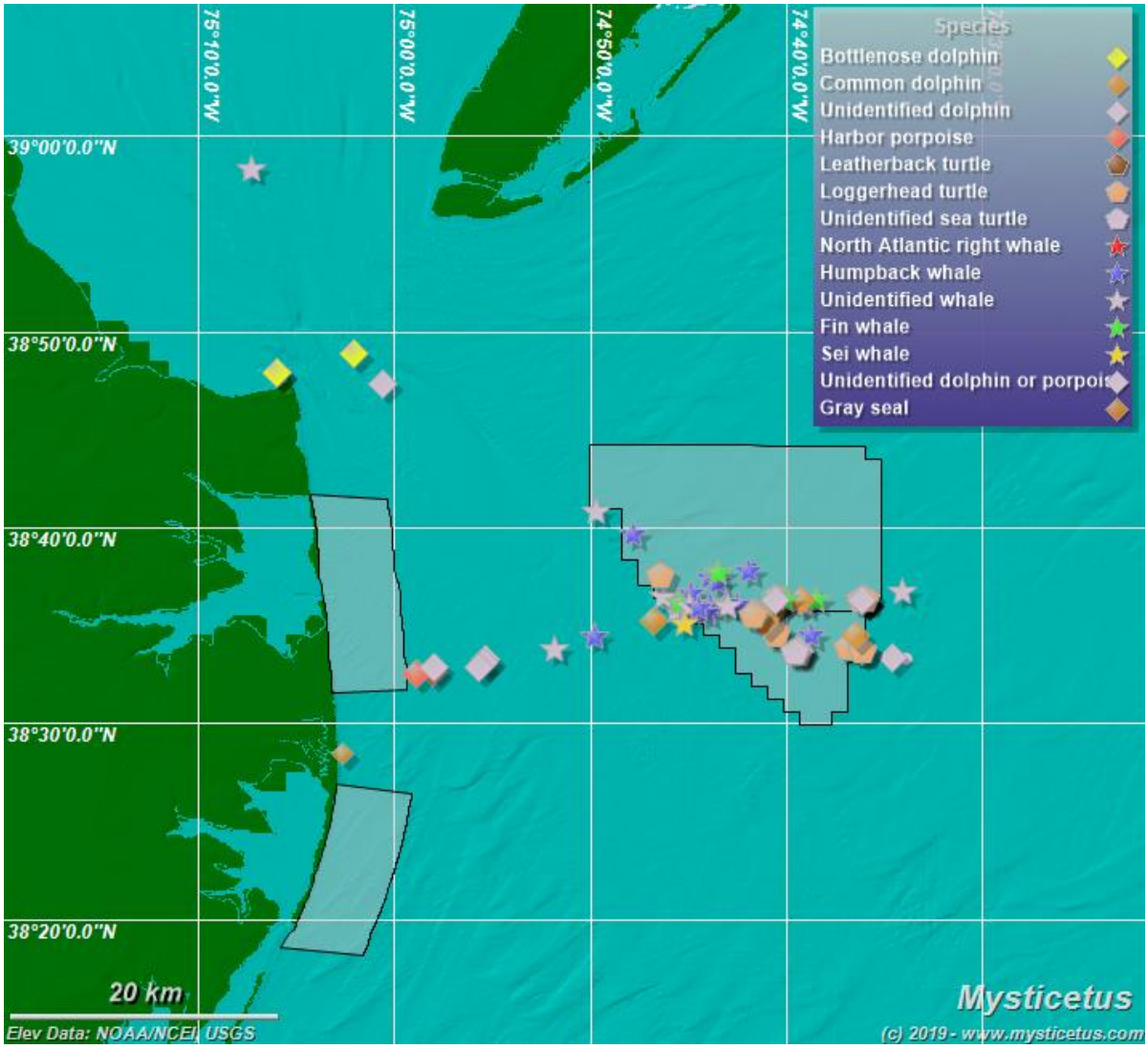

Figure 27. Locations of all detections of protected species in the Survey Area during the geotechnical survey period. Lease Area and proposed nearshore cable approach areas are indicated by gray-shaded polygons.

4.2.2.1 Geotechnical North Atlantic Right Whale Sighting

One confirmed NARW visual detection and one probable NARW detection occurred during the geotechnical survey period. Both were detected with the IR cameras. Sighting reports were provided to NMFS, along with IR camera video stills (Appendix H).

All reports of NARW sightings were reported within the timelines identified in the BOEM Lease and AMP and the NMFS-issued IHA. In addition, a daily summary report of numbers and species of sightings and number of detections within the EZs was provided daily to the vessel POC by the Lead PSO.

Figure 28. Location of the confirmed North Atlantic right whale (*Eubalaena glacialis*) seen 1,251 m from the *GZA Seacor Supporter* on 05 October 2018 and the probable NARW 800 m from the *M/V Danielle Miller*, both detected with infrared cameras during darkness.

4.2.2.1 Geotechnical Protected Species Behavior

To maximize sample size, behavior data were pooled for all visual detections in the Survey Area by whales, delphinids and sea turtles. Behavior state was recorded for 68 of the total 80 detections (Figure 29 through Figure 31). Behavior state was unknown for 18 detections because they were only acoustically detected (n = 11; no visual confirmation of behavior), were too far away, or observation was too short to determine behavior.

For the 31 detections of large whales, rest/slow travel was the most commonly (26%) observed behavior state (Figure 29). Three of 18 humpback whales observed milling, a behavior state commonly associated with foraging and feeding, although no prey was observed. Most (65%) delphinids were observed traveling or surface-active traveling (Figure 30). Among sea turtles, the most commonly recorded behavior state was rest/slow travel (Figure 31). Most humpback whale records for the mid-Atlantic are for the January to April period, although occasional sightings are made in the summer (Swingle et al. 1993; Barco et al. 2002; Barco et al. 2015; Williams et al. 2015). Humpback whales have been sighted in the mid-Atlantic regularly in the winter months since the early 1900s (Barco et al. 2015). Barco et al. (2002) suggested that the mid-Atlantic region primarily represents a supplemental winter feeding ground used by humpbacks.

Since relatively few protected species were seen while the geotechnical sound source was on, it was not possible to validly compare behavior while the source was on vs. off (Figure 29 through Figure 31).

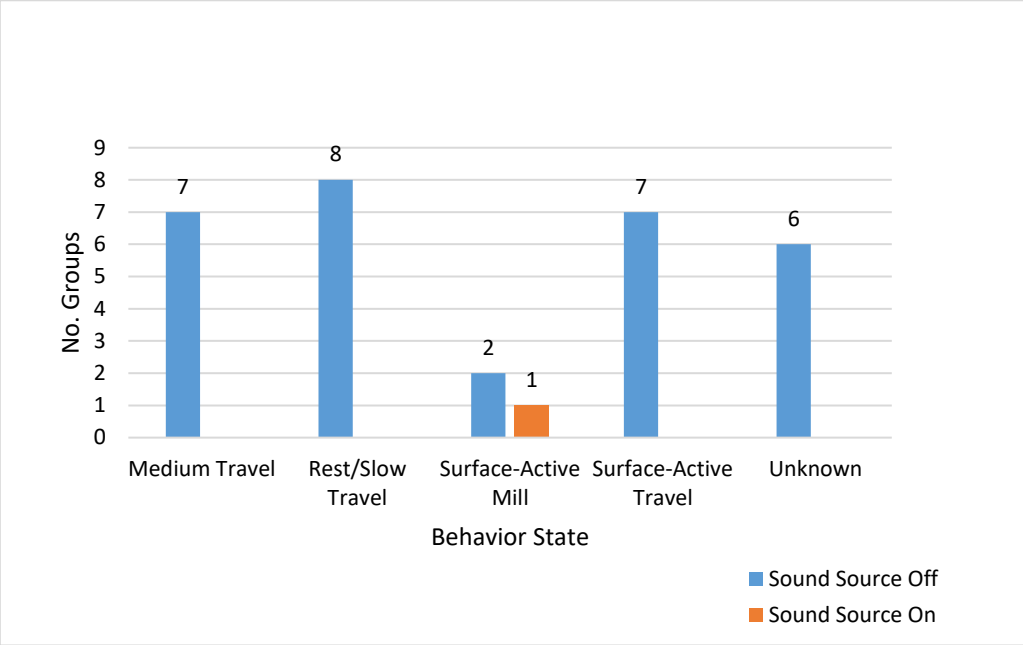

Figure 29. Behavior state observed for all large whale detections in the Lease Area when sound sources were *on* vs. *off* during the geotechnical survey period.

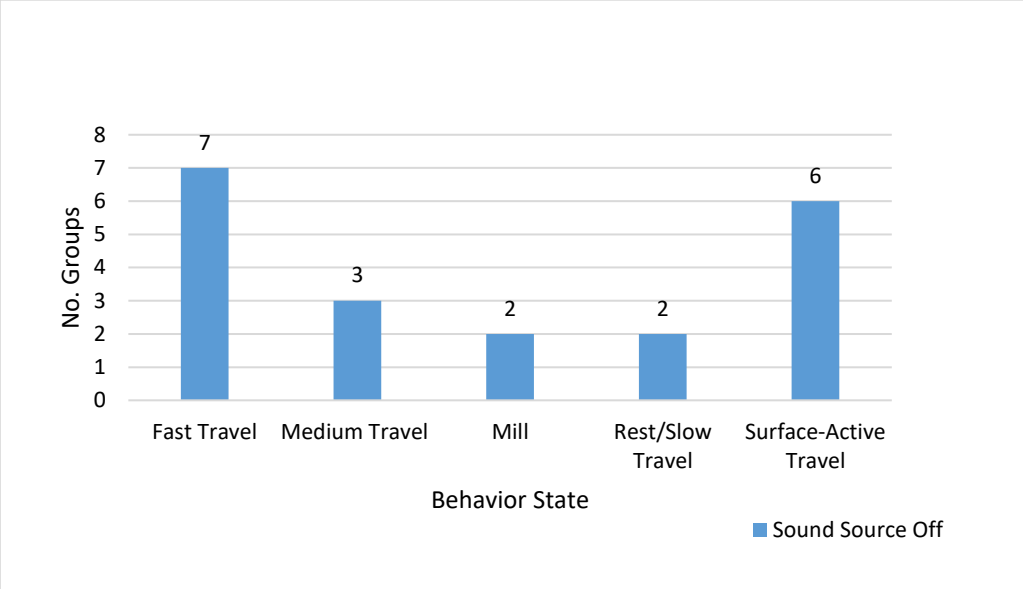

*Chart does not include PAM detections as behavior state could not be determined. No dolphins or porpoises were detected while the sound source was on. There were two detections of harbor porpoises.

Figure 30. Behavior state observed for all delphinid and porpoise detections in the Lease Area when sound sources were *off* during the geotechnical survey (no visual detections occurred during sound source on periods).

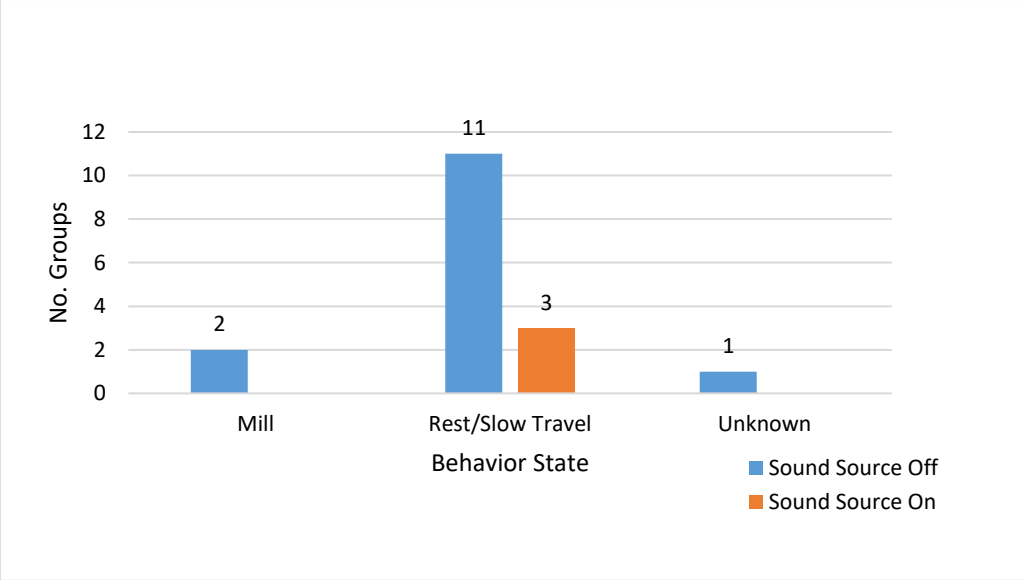

Figure 31. Behavior state observed for all sea turtle detections in the Lease Area when sound sources were *on* vs. *off* during the geotechnical survey.

Changes in behaviors were rarely recorded for all visual detections of whales, delphinids or porpoises, and sea turtles during the geophysical survey (Figure 32 through Figure 34). Changes were not recorded for some sightings because they were observed too briefly to adequately asses a change or behavior. Too few sightings occurred during sound source off periods to evaluate this variable.

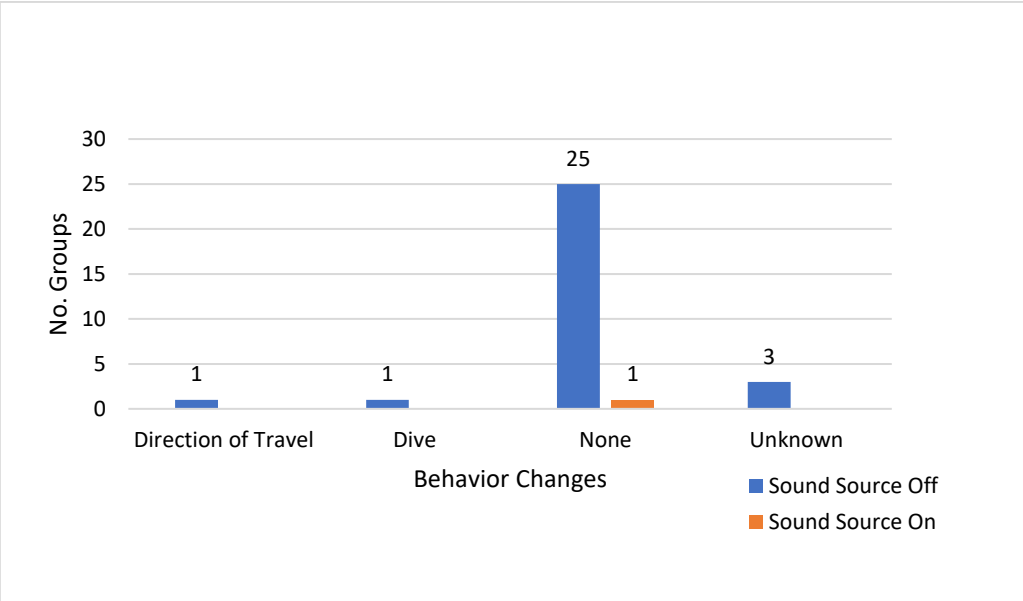

Chart does not include PAM detections as behavior state could not be determined.

Figure 32. Behavioral changes of whale species while the regulated geophysical sound source was *off* vs. *on* in the Survey Area.

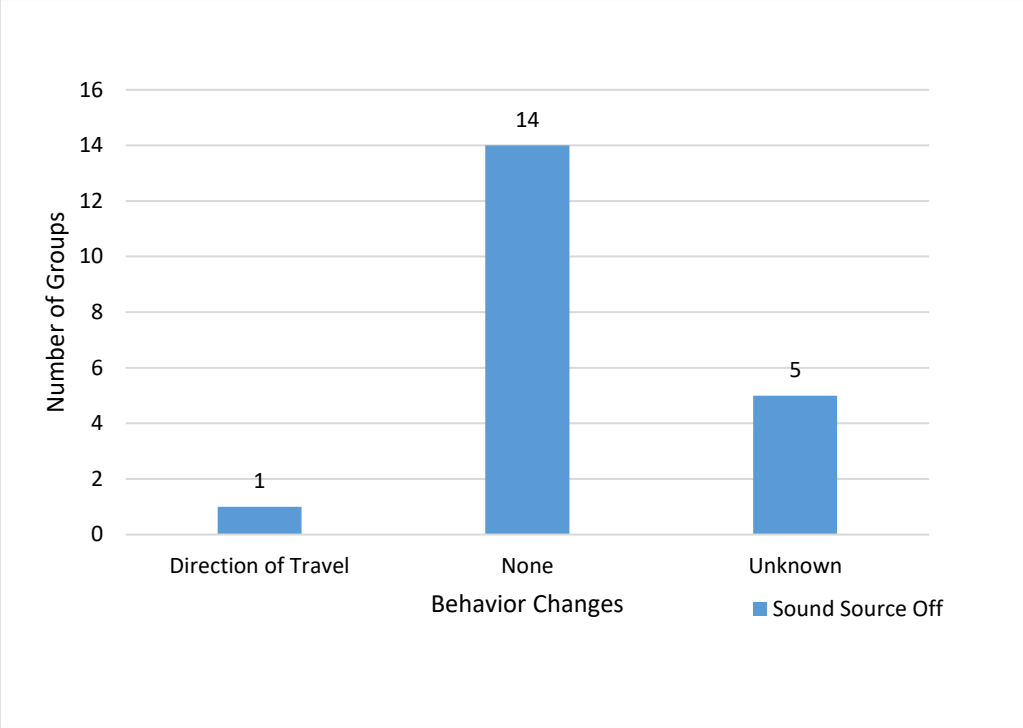

Figure 33. Behavioral changes of dolphin species while the regulated geophysical sound source was *off* in the Survey Area (no sightings while sound source on).

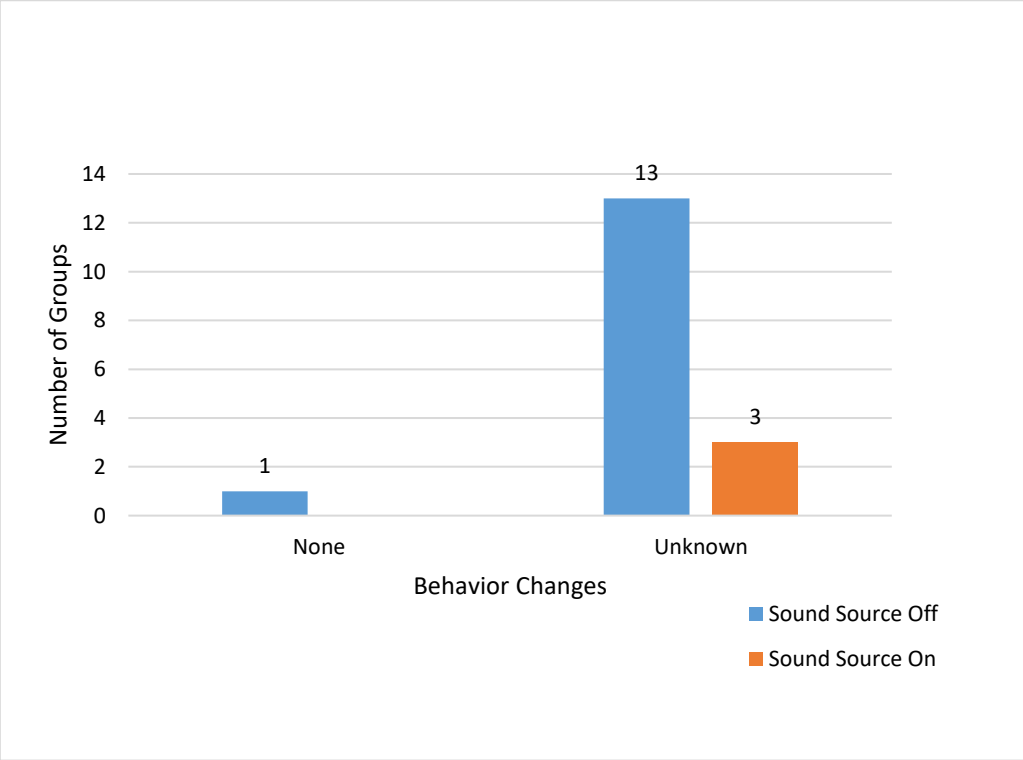

Figure 34. Behavioral changes of turtle species while the geophysical sound source was *off* vs. *on* in the Survey Area.

4.2.2.2 Geotechnical Closest Point of Observed Approach (CPA)

To maximize sample size, CPA data were pooled by two distance categories, within and beyond the default 200-m EZ for geotechnical operations (BOEM LEASE OCS-A 0482, and by whales, delphinids, and sea turtles (Figure 35 though Figure 40). A total of 69 detections (mostly bottlenose dolphins) and an estimated minimum total of ~146 individual marine mammals were visually observed during geotechnical source on and off periods. Too few sightings occurred during geotechnical sound source *off* periods to make a valid comparison with sound *on* periods. Mean CPA of whales was farther than that of delphinids and sea turtles. Most whale sighting CPAs occurred >200 m while most dolphin and sea turtle sightings occurred <200 m. No dolphins or porpoises were detected while the source was *on*. The two detections of harbor porpoise occurred while the sound source was *off* (Table 20).

Table 20. Mean observed Closest Point of Approach (CPA) distance (m) of protected species detections to the geotechnical sound source off and on periods in the Survey Area .[1/]

Species	CPA Distance (m) Sound Source Off				CPA Distance (m) Sound Source On			
	Min.	Max.	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.
Danielle Miller								
Delphinid Total	2	800	141.5	226.03	0	0	0.0	0.00
Common dolphin	2	250	47.0	84.32	0	0	0.0	0.00
Harbor porpoise	5	10	7.5	2.50	0	0	0.0	0.00
Unidentified dolphin	80	800	346.0	282.96	0	0	0.0	0.00
Unidentified dolphin or porpoise	48	48	48.0	0.00	0	0	0.0	0.00
Seal Total	161	161	161.3	0.00	0	0	0.0	0.00
Gray seal	161	161	161.3	0.00	0	0	0.0	0.00
Turtle Total	93	93	93.1	0.00	0	0	0.0	0.00
Loggerhead turtle	93	93	93.1	0.00	0	0	0.0	0.00
Whale Total	50	3656	847.5	719.05	350	350	349.8	0.00
Fin whale	195	1280	805.9	431.86	0	0	0.0	0.00
Humpback whale	50	3656	907.8	1,010.25	350	350	349.8	0.00
Sei whale	600	600	600.0	0.00	0	0	0.0	0.00
Unidentified whale	376	2127	847.1	562.31	0	0	0.0	0.00
Danielle Miller Total	**2**	**3656**	**567.7**	**671.01**	**350**	**350**	**349.8**	**0.00**
Seacor Supporter								
Delphinid Total	10	840	265.9	300.97	0	0	0.0	0.00
Bottlenose dolphin	10	252	100.6	107.67	0	0	0.0	0.00
Unidentified dolphin	187	840	513.7	326.67	0	0	0.0	0.00
Turtle Total	6	846	206.0	210.50	10	90	50.0	32.66
Leatherback turtle	180	180	180.0	0.00	0	0	0.0	0.00
Loggerhead turtle	10	846	237.8	236.36	10	50	30.0	20.00
Unidentified sea turtle	6	280	119.3	116.83	90	90	90.0	0.00
Whale Total	169	1251	514.7	430.21	0	0	0.0	0.00
Fin whale	169	169	169.0	0.00	0	0	0.0	0.00
Humpback whale	285	354	319.4	34.72	0	0	0.0	0.00
North Atlantic right whale	1251	1251	1,251.0	0.00	0	0	0.0	0.00
Seacor Supporter Total	**6**	**1251**	**275.8**	**306.10**	**10**	**90**	**50.0**	**32.66**
Geotechnical Total	**2**	**3656**	**468.9**	**590.48**	**10**	**350**	**124.9**	**132.85**

[1/]Does not include PAM detections without a confirmed sighting distance. Includes the entire survey area.

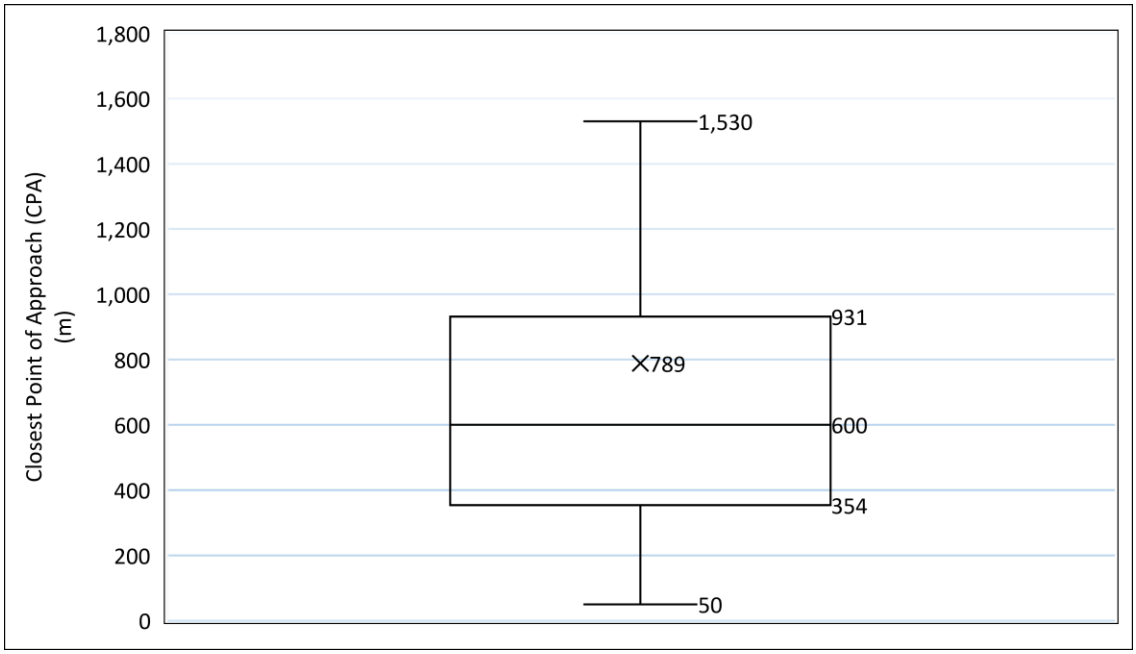

Figure 35. CPA categories for all whale groups with geotechnical sound source off in the Survey Area. Excludes PAM detections as behavior state could not be determined.

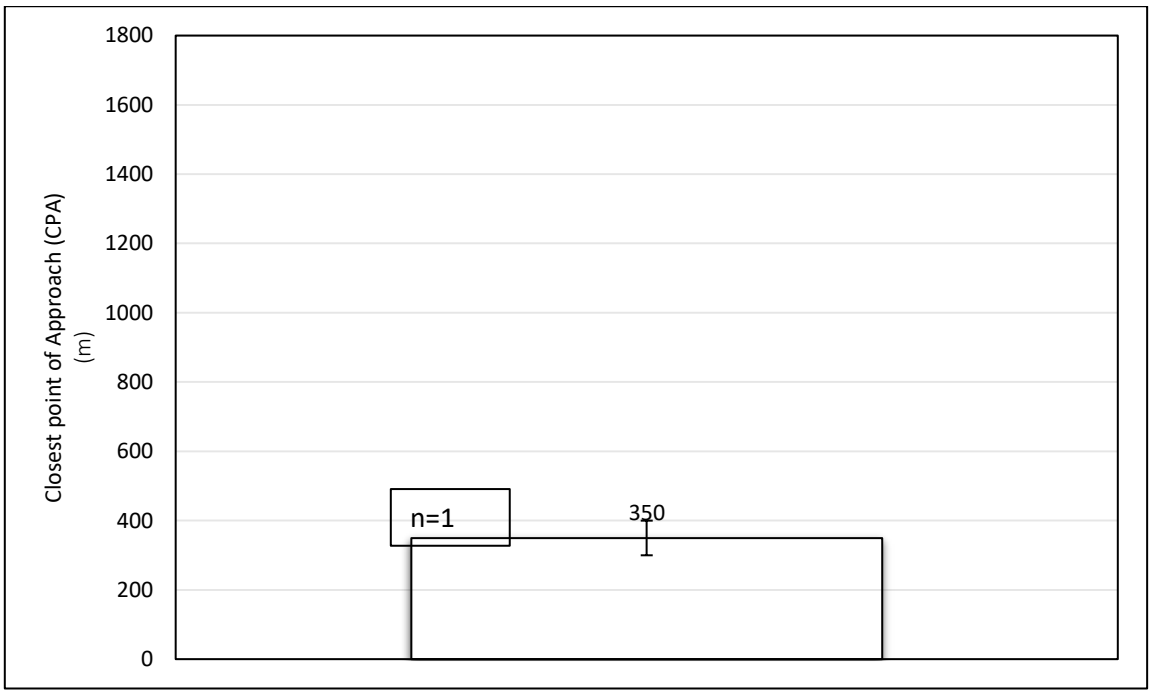

Figure 36. CPA categories for all whale groups with geotechnical sound source on in the Survey Area.

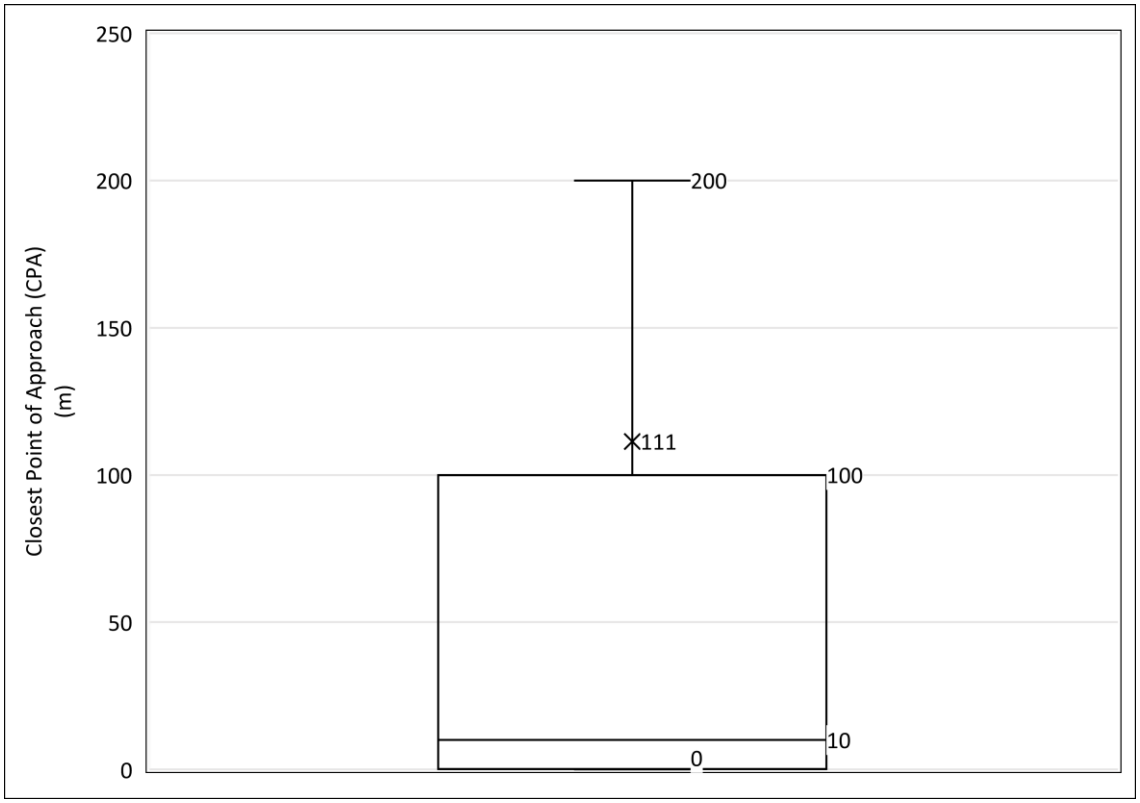

Figure 37. CPA categories for all dolphin and porpoise groups with geotechnical sound source off in the Survey Area. Excludes PAM detections as behavior state could not be determined. Note: No mean closest point of approach for pooled dolphins and porpoises with sound source on.

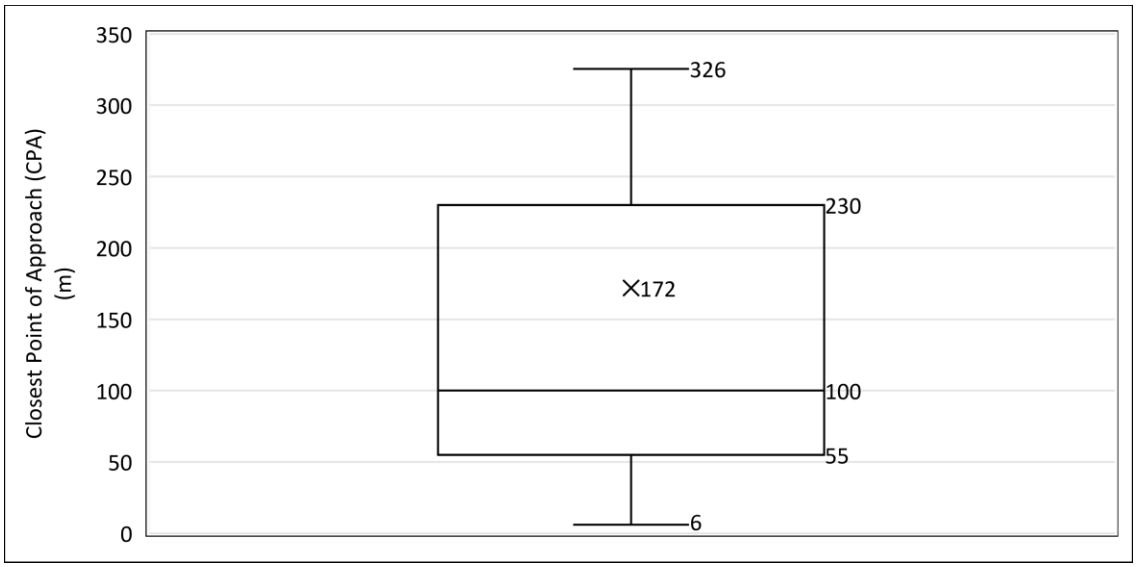

Figure 38. CPA categories for all sea turtle groups with geotechnical sound source off in the Survey Area.

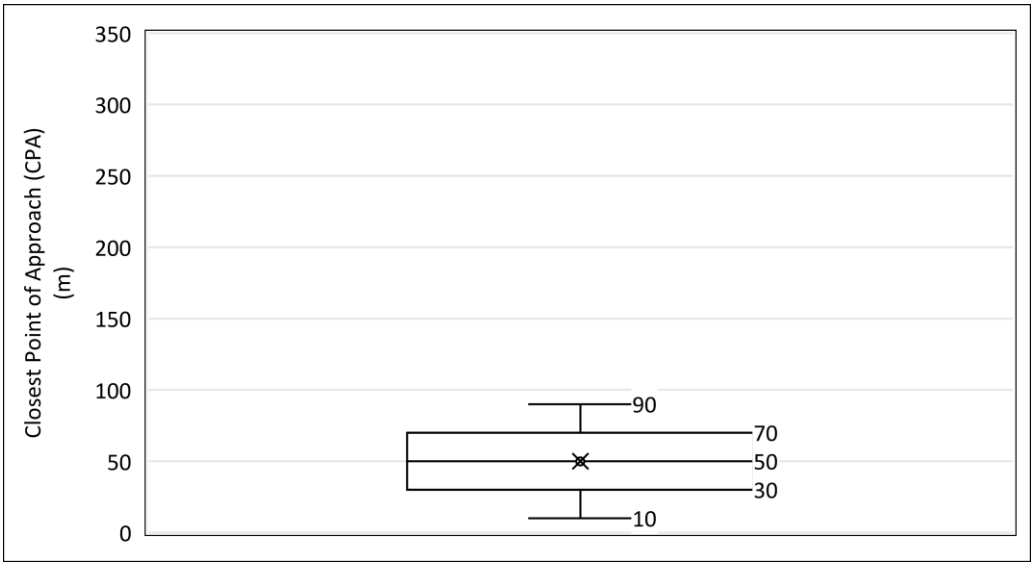

Figure 39. CPA categories for all sea turtle groups with geotechnical sound source on in the Survey Area.

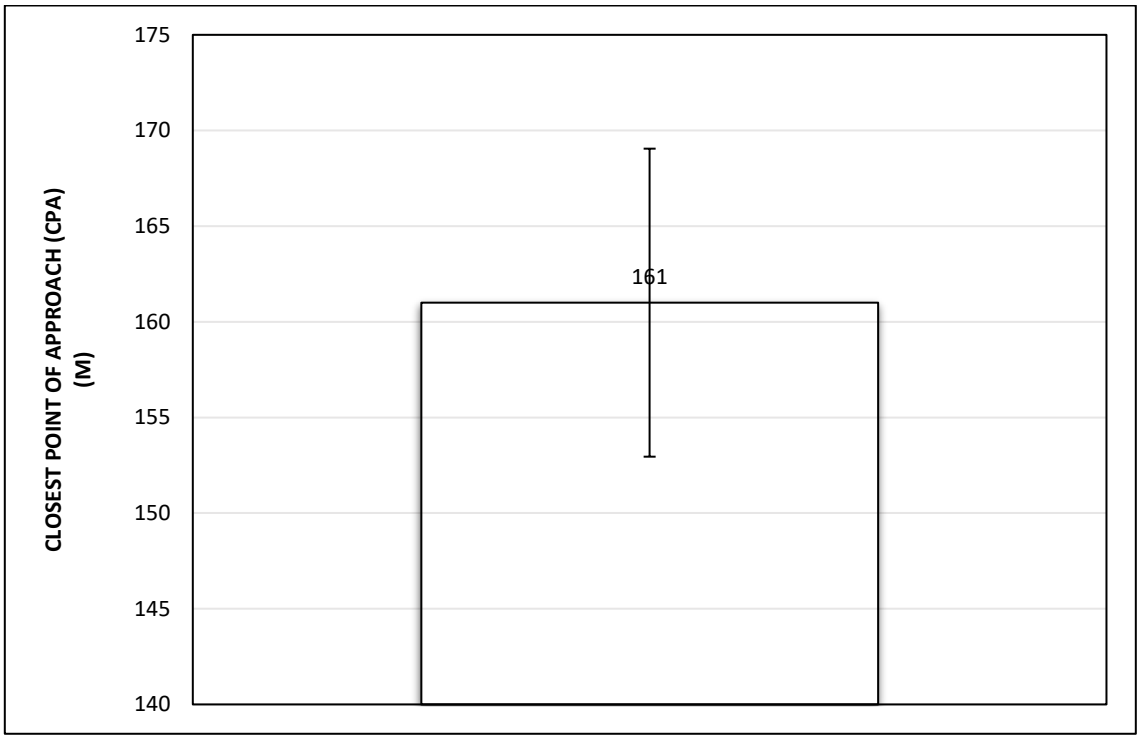

Figure 40. CPA categories for all seal groups with geotechnical sound source off in the Survey Area. Excludes PAM detections as behavior state could not be determined. Note: No mean closest point of approach for pooled dolphins and porpoises with sound source on.

4.2.3 Photographs and IR Video

Still photographs of protected species detections were taken opportunistically during the geotechnical survey from both vessels. The best photos (in terms of focus, clarity, etc.) are presented in Appendix I. Video and photos were captured from the IR video camera for detections of protected species as possible. This included the probable NARW mentioned earlier in this report. The best photos from this encounter are presented in Appendix H.

4.2.4 Geotechnical Protected Species Exposures

Protected species exposures are not summarized for geotechnical operations because exposure to associated sound sources are not considered exposures per recent agency evaluations (e.g., BOEM 2014). Nearly all protected species detections occurred while the sound source(s) was *off* (Table 18). Too few sightings occurred while the geotechnical sound source was *on* (n=4) to evaluate potential differences in numbers, behavior, CPA, or detection rates for *on* vs. off periods. All detections were made visually (i.e. no PAM detections) therefore all detections had an associated estimated distance (Table 20). Most whales were seen > 200 m and most dolphins and sea turtles < 200 m from the sound source location (Figure 35 through Figure 40).

Table 21. Number of visual detections of protected species by distance category in the Survey Area during the geotechnical (GT) survey period.

	< 200 m		> 200 m		Total	
Species	**No. Groups**	**Estimated No. Individual**	**No. Group**	**Estimated No. Individual**	**No. Group**	**Estimated No. Individual**
Seacor Supporter						
Bottlenose dolphin	2	9	1	1	3	10
Fin whale	1	1	0	0	1	1
Humpback whale	0	0	2	2	2	2
Leatherback turtle	1	1			1	1
Loggerhead turtle	8	8	3	3	11	11
North Atlantic right whale	0	0	1	1	1	1
Unidentified dolphin	1	6	1	10	2	16
Unidentified sea turtle	3	3	1	1	4	4
***Seacor Supporter* Total**	**16**	**28**	**9**	**18**	**25**	**46**
***Danielle Miller* (Geotechnical Portion)**						
Common dolphin	6	55	1	25	7	80
Fin whale	1	1	6	6	7	7
Gray seal	1	1	0	0	1	1
Harbor porpoise	2	2	0	0	2	2
Humpback whale	2	3	8	13	10	16
Loggerhead turtle	1	1			1	1
Sei whale	0	0	1	1	1	1
Unidentified dolphin	3	33	2	4	5	37

Species	< 200 m		> 200 m		Total	
	No. Groups	Estimated No. Individual	No. Group	Estimated No. Individual	No. Group	Estimated No. Individual
Unidentified dolphin or porpoise	1	1	0	0	1	1
Unidentified whale	0	0	9	9	9	9
***Danielle Miller* GT Total**	**17**	**97**	**27**	**58**	**44**	**155**
Geotechncial Total	**33**	**125**	**36**	**76**	**69**	**201**

* *Seacor Supporter* detections do not include PAM detections as distance could not be determined. There were no PAM detections for the Danielle Miller GT

4.2.5 Geotechnical Protected Species Incident Reports

There were no confirmed marine mammal deaths, carcasses or strandings recorded during the Skipjack Wind Project. Thus, no Protected Species Injury or Mortality reports were necessary/completed during the survey (as described in the BOEM Lease).

4.2.6 Geotechnical Mitigation Measures

Most (85%) of the detections of protected species did not require a mitigation measure to be implemented (Table 22). Most of the 10 measures requested and implemented involved 6 vessel speed reductions; two shutdowns and two delays were associated with mitigation. A shutdown for geotechnical operations involved delaying engagement of the drill bit.

Table 22. Summary table of mitigation measures implemented in the Survey Area during the geotechnical (GT) survey while the source source was on and off.

Species	Mitigation Response			Detections without Mitigation Required[1]
	Delay	Shutdown	Total Mitigation Events	
Humpback whale	0	0	0	1
Loggerhead turtle	2	2	4	0
Unid sea turtle	0	0	0	1
Grand Total	**2**	**2**	**4**	**2**

[1] Detections that occurred while the sound source was on but did not require a mitigation measure.

Table 23. Summary of mitigations measures taken during geotechnical survey only when sound source was on.

	Mitigation Response		
Species	**Shutdown**	**None**	**Grand Total**
Humpback whale	0	1	1
Loggerhead turtle	2	0	2
Unid sea turtle	0	1	1
Grand Total	2	2	4

4.2.7 Estimated Lost Production Time

The mean down time (loss of production) per sighting was 21 min and the total down time associated with mitigation measures was 85 min (Table 24). Down times were associated with two delays in equipment start up due to detections within the EZ and two shutdowns resulting from animals entering the EZ while equipment was operating. Time involved with vessel speed reduction was typically brief and not summarized. The total loss of production due to mitigation was approximately 85 min over the 119 days of the geotechnical survey period.

Table 24. Estimated Loss of Operational Production Time and Events Associated with Protected Species Mitigation during the Geotechnical Survey in the Survey Area.[1/]

Mitigation Event	Delphinid	Seal	Turtle	Whale	Geotechnical Total
Delay	0	0	2	0	2
Shutdown	0	0	2	0	2
Total No. Mitigation Events	**0**	**0**	**4**	**0**	**4**
Loss of Production HH:MM	**Visual**	**PAM**	**Total**	**Mean**	
Delay due to sighting	1:02	0:00	1:02	0:31	
Shutdown	0:23	0:00	0:23	0:11	
Total	**1:25**	**0:00**	**1:25**	**0:21**	

1/ No loss of production due to acoustic detections. Totals exclude speed reductions associated with protected species vessel strike avoidance measures as such mitigation did not result in notable loss of operational production time.

5 Sound Exposure Assessment

Exposure assessment discussion herein focuses on the number of individual marine mammal species exposed (i.e., "exposures") only to geophysical equipment sounds estimated to exceed NMFS Level A or Level B sound thresholds as identified in Section 3.6 (NMFS 2018). No exposures were anticipated to occur during the operation of geotechnical equipment including DP thrusters; thus, geotechnical operations are not discussed further in this section. Observed exposures of marine mammals to geophysical sound sources operating at frequencies < 200 kHz represented only potential Level B exposure per the project NMFS IHA.

There were no expected Level A exposures of marine mammals to any of the sources analyzed in the IHA (see Table 25), and no such exposures were authorized under the IHA.

Only those individuals detected within the equipment-specific EZs were considered potential exposures based on estimated received sound level isopleths of that equipment (see Table 6 in Section 3.7, "*Estimating Potential Exposures"*). A total of 116 individual protected species (including unidentified marine mammals and sea turtles) were observed within four different Level B EZs associated with the four different types of operating geophysical equipment (i.e., considered potential exposures; Table 26). Distance to the sound source was recorded for all these detections. Potential exposures were as follows: (1) 78 (67% of 116) individual exposures to chirp equipment, (2) 33 (28%) individual exposures to S-boom equipment, (3) 2 (2%) individual exposures to USBL equipment, and (4) 3 (3%) individual exposures to unspecified geophysical equipment (Table 26).

Potential exposures were recorded for three confirmed species among the total 14 species for which NMFS authorized Level B exposure in the IHA. One whale was associated with unclear/unknown operating equipment; this detection was thus given a conservative potential exposure threshold distance of 447 m (the whale's CPA was 150 m) (Table 26).

The number of observed exposures documented during the project was well below the number of takes authorized by the IHA. The highest number (n = 67) of individual exposures identified to species was associated with the bottlenose dolphin, representing 0.6% of the total 1,148 exposures permitted for this species by the IHA (Table 25). The highest percentage of exposures relative to number of exposures permitted by the IHA was for the single humpback whale exposure, representing 17% of the six IHA-authorized exposures for this species, and 0.001% of the regional Gulf of Maine population estimate.

There were three PAM detections made while the geophysical equipment was operating at frequencies <200 kHz that may have represented a minimum of three individual potential exposures. PAM detections consisted of unidentified delphinids based on call characteristics noted by the PAM operator or visual confirmation. One of these PAM detections was not visually confirmed. The other two PAM detections had distances verified by IR or UE/RB as within the EZ. Given that the mid- to high-frequency vocalizations produced by delphinids attenuate rather quickly with increasing distance (e.g., Berta et al. 2005), it is possible that the one PAM detection with unknown distance represents potential exposure to the Level B threshold. However, because distance was

unknown, PAM detections made while geophysical equipment operating at frequencies <200 kHz were not counted in the number of potential exposures reported herein.

Table 25. Estimated number of Level B exposures of visually-observed individual protected species to operating geophysical equipment relative to number of incidental exposure of marine mammals authorized in NMFS-issued IHA.

Common Name	*Scientific Name*	Stock	Federal ESA/ MMPA Status[1/]	Best Abundance Estimate (N_{best})[2/]	No. Authorized Exposure (Level B)	*Estimated No. Potential Exposures*	*% Population Potentially Exposed to Level B Acoustic Thresholds*
North Atlantic right whale	*Eubalaena glacialis*	W North Atlantic	Endangered/ Depleted and Strategic	440	1	0	0
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	Protected	823	6	1	0.001
Fin whale	*Balaenoptera physalus*	W North Atlantic	Endangered/ Depleted and Strategic	1,618	18	0	0
Sei whale	*B. borealis*	Nova Scotia	Endangered/ Depleted and Strategic	357	2	0	0
Minke whale	*B. acutorostrata*	Canadian East Coast	Protected	2,591	4	0	0
Sperm whale	*Physeter macrocephalus*	North Atlantic	Endangered/ Depleted and Strategic	440	1	0	0
Long-finned pilot whale	*Globicephala melas*	W North Atlantic	Strategic	5,636	32	0	0
Bottlenose dolphin	*Tursiops truncatus*[2/]	W North Atlantic Northern Migratory Coastal	Depleted and Strategic	11,548	1,148	67	0.006
Atlantic spotted dolphin	*Stenella frontalis*	W North Atlantic	Protected	440	24	0	0
Common dolphin	*Delphinus delphis*	W North Atlantic	Protected	70,184	535	15	<0.001
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	W North Atlantic	Protected	48,819	79	0	0
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/ Bay of Bay of Fundy	Protected	79,833	102	0	0
Harbor seal	*Phoca vitulina*	W North Atlantic	Protected	75,834	1,175	0	0
Gray seal	*Halichoerus grypus*	W North Atlantic	Protected	Unknown	1,175	0	0

[1/] Number of exposures based on number of individual marine mammals observed within EZs associated with all four types of geophysical equipment during geophysical operations (sound source < 200 kHz on periods).

[2/] Table excludes potential Level B exposures of 4 unidentified dolphins/delphinids for which distance and species could not be determined.

The maximum Level B exposure distance for any equipment category is 447 m (CSA, 2017). Therefore, a comparison was made between detections recorded within the maximum exposure distance and those detected within the equipment-specific Level B exposure. This comparison illustrates that the sources used rarely exposed marine mammals to Level B acoustic thresholds even though there may have been multiple detections within the maximum isopleth boundary.

Table 26. Estimated number of individual unidentified protected species observed by type of HRG equipment operating during the geophysical (GP) survey.

Type of Equipment & Species Group	Total Recorded During HRG Equipment Operations	No. Individuals Where Distance was Undeterminable	Total Recorded within Level Equipment Isopleth	Total Recorded Between Equipment Isopleth and 447 m	Total Recorded > 447 m	Total Estimated Exposures of Individual Animals[1/]
Chirp (Level B Isopleth = 7 m)	0	0	0	0	0	0
S-Boom (Level B Isopleth = 142 m)						
Unidentified dolphin	3	0	3	0	0	4
Unidentified delphinid [2/]	1	1	0	0	0	0
USBL (Level B Isopleth = 71 m)	0	0	0	0	0	0
Unspecified Equipment (Level B Isopleth = 447 m)	0	0	0	0	0	0
	Total Unidentified Species					
Unidentified dolphin/delphinid	*4[3/]*	*1[3/]*	*3[3/]*	*0[3/]*	*0[3/]*	*3[3/]*
Unidentified sea turtle	*2*	*0*	*2*	*0*	*0*	*2*
Total	***6***	***1[3/]***	***5***	***0***	***0***	***5***

[1/]Total estimated exposures of individual animals (column 6) = total recorded within the equipment-specific EZ boundary (column 3). Unidentified species were excluded from the estimated number of exposures tables because it was not possible to attribute potential exposure to a specific species relative to IHA-authorized exposures by species. However, these detections represent potential exposures.

[2/] Distance, group size, and species could not be determined for 1 unidentified delphinid PAM detection that was not visually verified. Minimum group size was thus considered 1 individual.

[3/]Distance could not be determined for 1 unidentified delphinid PAM detection.

6 Discussion

6.1 Species Occurrence and Distribution

Protected species were commonly observed during G&G surveys in the Survey Area. There were distinct differences in the patterns of distribution and composition of species in the nearshore waters of the proposed cable shore approach and the deeper offshore waters within the Lease Area. These general distribution and occurrence patterns followed those reported by Roberts et al (2015). Whales and sea turtles were detected predominantly within the Lease Area and >10 km from shore (and thus outside of the proposed cable shore approach). One confirmed and one probable NARW were observed offshore: one within the Lease Area and one between the Lease area and cable approaches. Both these sightings were detected at distances outside the EZ; the confirmed NARW occurred before 1 November 2018 when enhanced mitigation was implemented for NARW and the probable NARW sighting was made during geotechnical operations to which the enhanced mitigation did not apply. The humpback whale was the most commonly identified large whale species; several individuals were seen milling, a behavior attributed to potential feeding behavior among baleen whales (Mate et al. 2015), though no prey were seen. A single sperm whale was seen between the Lease Area and the proposed cable shore approach, a relatively uncommon sighting in such relatively shallow waters. Generally, whale sightings peaked during late summer/fall, coinciding with the peak migration periods of most large whales in the region.

In nearshore waters of the proposed cable approach, bottlenose dolphins were frequently seen, oftentimes bowriding, whether the geophysical sound source was operating or not. On several occasions, this species was seen engaged in apparent foraging/feeding, resulting in implementation of mitigation measures (Section 3.5). However, many sightings of bottlenose dolphins involved bowriding dolphins that voluntarily approached the survey vessels, particularly while vessels were underway. Mitigation was not required for dolphins that approached the vessel voluntarily. Mitigation was implemented for delphinids most commonly when feeding or resting, or when mother/calf pairs were seen within the mitigation zones, per the IHA. Common dolphins were primarily observed in areas outside the proposed cable approach and in the Lease Area. Common dolphins were seen primarily during late summer/fall.

Dolphins were the most frequent detection overall. Only one sea turtle was sighted in nearshore waters of the proposed cable approach, from the *Samantha Miller*. Sea turtles were seen predominantly in the Lease Area and >15 km from shore, well outside the cable approach areas.

6.2 Environmental Conditions and Detection Methods

Overall, excluding several hurricanes that delayed operations during fall, viewing conditions for PSOs were good. Over half of the observation periods were characterized by a Beaufort sea state of 3 or less. Effectiveness of protected species detection methods used during the G&G surveys are discussed in detail in Appendix G (the AMP report). The most effective method for detecting protected species was UE/RB during daylight. PAM detections were limited to delphinids, some of which were also detected with IR, NVD, and UE/RB. PAM occurred predominantly during darkness simultaneously with IR

monitoring. IR detections were made up to 1,250 m away and NVD detections were made up to 600 m away. However, relatively little dedicated effort involved use of the NVDs as on-duty PSOs during darkness relied mostly on monitoring two IR camera feeds on two monitors below deck. As summarized in Appendix G, there are pros and cons to each detection method. Using a combination of methods, and considering environmental conditions, was considered the most effective approach to maximizing detections.

The stationary *Seacor Supporter* lift boat provided an excellent platform to monitor for protected species. This was due to its stability above the water surface on stable leg supports. Thus, swells did not affect observations (they adversely affect the ability to use the IR cameras, for example). PSOs were also stationed higher above the waterline aboard the *Seacor Supporter*, providing a better field of view and enable PSOs to see farther away more clearly.

6.3 Mitigation

Mitigation measures were effectively implemented during both the geophysical and geotechnical surveys, and all measures requested by the PSO/PAM team were implemented by the vessel crew(s). The *Mysticetus* system setup facilitated rapid, unbiased determination of whether protected species were inside or outside of an EZ by plotting detections relative to the location of the vessel in real-time. A useful feature of *Mysticetus* is the ability to alert visual observers of the presence of vocalizing cetaceans. When a PAM or IR detection was made, the visual PSOs could see the PAM data being displayed in real-time (and vice versa), including bearings to acoustic detections. This was critical in alerting visual observers to the presence of cetaceans to visually confirm the detection. *Mysticetus* also quickly produced tabular, graphical and map summaries of the number and types of detections relative to EZs, at the user's discretion.

Securing a solid and reliable internet connection aboard the vessels was critical to sending observational data via the cloud to data analysts on shore. However, internet capabilities on the *Danielle Miller* were not reliable, such that critical information (e.g., NARW sightings, incidental sighting/stranding reports) often had to be communicated via the vessel's phone.

PSOs successfully reported NARW sightings rapidly to onshore POCs. PSOs and/or Deepwater Wind, CSA and/or Smultea Sciences managers also successfully reported the locations and details, including photographs, to NMFS and the NARW sighting network. This included via the Whale Alert app on cell phones and/or via the NMFS phone hotline. These reports contributed to sharing of information needed to alert mariners of NARW presence and in NMFS designation of DMAs. NARW sightings reported by the PSO/PAM team during the project were sometimes selected by NMFS to be displayed on the NMFS Whale Alert map location, when they met certain NMFS sighting criteria.

Having the IR and PAM stations near one another on the vessel below deck was also deemed critical. This facilitated quick sharing of PAM and IR detection data and alerted the two operators of the presence of protected species immediately. This also made it possible for the PSO monitoring with the IR camera to go above deck with the NVDs during darkness to obtain a higher resolution look at any nearby detections while the PAM operator temporarily monitored the IR and PAM displays. This partnership was critical in quickly identifying the presence of a NARW just outside the EZ during nighttime. The EZ line displayed on the IR camera monitor was also critical in

determining the distance of IR-detected sightings from the sound source. However, the distance display on the IR monitor was often problematic to read and rely upon, mainly during high swells that resulted in the view from the monitor swinging up and down in extreme motions (see Appendix G).

PSOs successfully alerted vessel crew of nearby protected species with recommendations on how to avoid potential vessel strikes. Having a high-quality marine very high frequency (VHF) handheld radio to communicate mitigation to equipment operators, vessel crew and fellow PSO/PAM was also a critical tool to immediate and effective mitigation.

6.4 Sound Exposures of Protected Species

A number of different G&G equipment was used during the surveys, some of which produced sounds exceeding the NMFS acoustic threshold criteria for marine mammals and operated at frequencies <200 kHz, which is within the range of most marine mammal hearing capabilities. Modeled Level A thresholds for equipment within the hearing range of all marine mammals except the harbor porpoise were very small and no such species were observed within these EZs. Further, only two harbor porpoises were observed, both when regulated sound sources were not operating. Results of SSVs and other sound propagation modeling studies provided critical information on the EZs associated with four types of regulated sound equipment used during the surveys. Thus, while the NMFS-issued IHA, BOEM Lease, AMP EZs and monitoring zones were followed, estimated exposures of protected species (Section 4) were based on numbers of individuals detected within the equipment-specific Level B isopleths (see Table 6). Applying this information, the number of estimated individual potential exposures (Section 5) during G&G surveys was well below the number of exposures authorized by the NMFS IHA (representing < 0.05 percent of any NMFS-recognized regional abundance estimates for those species).

A limitation of survey results was that PAM was not effective in localizing detections and thus determining whether acoustic detections were inside or outside the EZs. However, as mentioned above, PAM detections were critical in alerting visual PSOs to the presence and oftentimes the general bearing of the animal; PAM thus assisted in visual confirmation of acoustic detections. PAM also alerted PSOs as to when they should go above deck (away from the IR station lab station below deck) to search the area 360 degrees around and near the vessel with NVDs to confirm distance and species, as possible (the IR camera was only focused ahead of the vessel and could not detect close protected species because it was focused at farther distances).

We have high confidence in the ability of PSOs to effectively monitor within and near the designated EZs and NARW separation distances with the tools used during the survey during good viewing conditions. Thus, the number of estimated potential exposures reported herein are believed to represent a realistic minimum estimate of the numbers of animals at the surface of the water available for the PSOs to detect. For example, whales and delphinids were routinely detected well-beyond these EZs during the surveys, including with the IR camera, though mainly via UE or with RB during daylight. NVDs were useful in identifying sightings during darkness to species or genus. However, during high Beaufort sea states (e.g., > 4), rain, fog, snow, and sleet, conditions for detecting protected species are reduced. Since such conditions were relatively rare during operations, the estimated number of exposures discussed herein are believed to

represent a realistic minimum estimate of the numbers of animals within the implemented EZs.

Line-transect sampling and resultant estimates of abundance and density using Distance Sampling analyses is a well-respected method for providing the best estimates of sightings potentially missed by observers (Buckland et al. 2015). This analysis approach corrects for animals below the surface potentially missed by observers. However, this sampling technique is based on following systematic transect lines that are not possible to follow during the G&G operations associated with this project. The erratic movements and/or stop and start characteristics of the G&G surveys violate the assumptions needed to provide reliable estimates of density (Len Thomas, SMRU, pers. comm., 2018). Thus, the best available method for estimating minimum numbers of potential exposures of protected species to the G&G operations during the site characterization surveys is considered the directly observed detections made as reported herein.

7 Recommendations

Several facets of the PSO/PAM mitigation and monitoring program implemented during the project surveys could be improved and are discussed below as recommendations. These recommendations would be expected to increase the effectiveness of protected species detections well as the processing and analyses of these data relative to BOEM and NMFS mitigation, monitoring and reporting requirements. Recommendations herein are based on continuous feedback from the PSO/PAM team in the field, as well as those of other staff involved in supporting the PSO/PAM program. Some of these recommendations are specific to this project (e.g., internet availability, vessel characteristics) while others are more generally applicable across PSO/PAM programs during Atlantic G&G surveys.

7.1 Data Collection

Sufficient internet access and speeds are a critical component of offshore communications and facilitate compliance with BOEM Lease and/or IHA regulations. There are inherent challenges to maintaining enough bandwidth in a marine environment. However, internet is important for the following critical reasons: (1) to notify NMFS of NARW detections within the required timeframe, (2) for dissemination of NARW presence to area vessel traffic and other vessels on the project to avoid potential vessel strikes, (3) for routinely checking the NOAA NARW Sighting Advisory System for DMAs, (4) for maintaining and troubleshooting necessary software, (5) for submitting daily reports to onshore clients and points of contact, and (6) for alerting onshore support teams to safety conditions.

Each project vessel should ensure that internet communication is secured prior to the start of a project and throughout.

7.2 Data Standardization

Data collected on protected species during G&G surveys provides valuable information on their spatial and temporal occurrence, distribution, and behavior. Such information is relatively sparse and sporadic across the US Eastern coast. Yet this information is needed to plan and effectively manage future offshore wind and other development to minimize potential adverse effects on these species. Data collection templates and meta-dictionaries used by PSOs for mitigation and monitoring should be standardized across all G&G surveys. Standardization facilitates pooling data across vessels, surveys and Lease areas, increasing the sample size and statistical power to identify trends in habitat use, etc.

7.3 Logistics and Scheduling

Advance scheduling of crew changes is beneficial in maintaining budgets, staffing requirements, and safety standards. It is widely recognized across the maritime industry that consistent rotations benefit company and crew alike. However, given the operational variability, consistent crew rotations are not always feasible. In these cases, the ability to have PSOs pre-approved and not restricted to specific projects would be highly beneficial to maintaining a professional, knowledgeable PSO team but still allow

the flexibility in crew staffing. PSOs that have been approved to work on any regional wind lease G&G survey should be automatically approved for any other regional G&G surveys.

7.3.1 Vessels and Accommodations

To meet mitigation and monitoring requirements, a suitable observation platform is critical to effectively monitor EZs. Considerations need to be given to unobstructed viewing radius and height above water relative to the zone of influence for the species of concern in the area. Consideration should be given to vessel size and crewing and there should be some flexibility allowed in PSO schedules based on individual vessel conditions and PSO recommendations. Flexibility would allow PSOs to determine the most effective monitoring and fatigue reduction schedules and plans for the project-specific vessel conditions. Such modifications would be subject to BOEM review and approval. All vessel viewing areas used by PSOs should adhere to all safety standards to minimize the potential for slips, trips and falls. Cold and inclement weather hazards are an inherent risk in any northern marine environment; therefore, adequate alternative monitoring areas must be available on board the vessel. PAM and IR camera monitoring stations should have dedicated space with consideration of noise and light conditions that could affect monitoring. Additionally, 24-hour vessels should be equipped with adequate crew accommodations as well workspace for data management and PSO meetings. Day boats (those that survey during the day and return to port at night) need to provide adequate workspace for PSOs (dedicated desk space for data management) as well as a dedicated rest area that is not multi-use areas on the vessel. The PSO rotation schedule is critical to allow rest periods to minimize fatigue that affects both performance and safety. Dedicated PSOs areas on smaller boats can be challenging but should be considered in the survey planning process.

In the case of day vessels, equal consideration should be made to crew housing as distances between affordable housing and dockage locations can significantly increase PSO work times and reduce daily performance. Adjustments to the number of PSOs on the vessel everyday should be approved, based on the recommendations of the PSOs/PSO providers in order to account for overall work and transit schedules and improve the effectiveness and safety of PSO operations.

7.3.1 End of Project Demobilization

Upon completion of the geotechnical survey efforts, it is recommended that PSO teams be required to conduct a post-survey crew briefing/toolbox meeting with the vessel manager and the client representative prior to the start of any personnel or equipment demobilization. At this meeting: the time required to uninstall and prepare equipment for shipping will be identified; the non-PSO crew required for the uninstall will be identified and scheduled; PSO roles and responsibilities will be identified and scheduled; and a job safety analysis (JSA) for removal of each piece of equipment will be submitted and followed by PSO and vessel crew members.

7.3.2 Alternative Monitoring Equipment

The IR system, in general, is a functional system for protected marine species detection during darkness, especially in conjunction with PAM and the ability to utilize NVDs to assist species identification and distance. IR is considered to be approaching an equivalent caliber as visual effort and reticle binoculars during daylight under certain conditions. After using this specific system, it is recommended to continue to upgrade and streamline the image capture process along with debugging the software. Upgrading the system would reduce glitches, freezes, and delays experienced frequently during the surveys. Buffering capabilities when recording would significantly increase detection potential. Default playback with the demarcation line displayed would aid and is critical in precise distance determination for real-time mitigation (the EZ distance demarcation was not visible on the IR monitor during playback of IR video). Incorporating gimbals or gyroscopes with the cameras, or a more advanced stabilization system into their framework, would steady images in heavier rolling seas; this would facilitate improved detection potential. Keeping the two IR computer systems independent of one another would avoid shifting equipment around. However, an upgraded system should be less likely to experience the glitches, eliminating the need to swap equipment from one computer to the other.

The PAM manuals specific to the systems on board should be updated. Specifically, frequency, dynamic range, and hydrophone spacing specifications should be clearly diagrammed in the user manual. Additionally, some common troubleshooting methods should be included in hard copy (or as a pdf that can be pre-loaded) rather than relying on internet access for support.

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Appendix A Agency Reporting Requirements

Table 27. NMFS and BOEM Protected Species Reporting Requirements.

Document	Required Content	Online Location	Reference in Source Document
NMFS-issued Incidental Harassment Authorization 15 May 2018 – 14 May 2019	Within 90 days after completion of the marine site characterization survey activities, a draft technical report shall be provided to NMFS and BOEM that fully documents the methods and monitoring protocols; summarizes the data recorded during monitoring; estimates the number of marine mammals that may have been taken during survey activities; and provides an interpretation of the results and effectiveness of all monitoring tasks. Any recommendations made by NMFS shall be addressed in the final report prior to acceptance by NMFS.	IHA: https://www.fisheries.noaa.gov/action/incidental-take-authorization-garden-state-offshore-energy-geophysical-survey-skipjack-wind Federal Register notice: https://www.federalregister.gov/documents/2018/04/04/2018-06856/takes-of-marine-mammals-incidental-to-specified-activities-taking-marine-mammals-incidental-to	Section (iii) (d)
	In addition to the leaseholder's reporting requirements outlined above, the leaseholder shall provide an assessment report of the effectiveness of the various mitigation techniques, (i.e., visual observations during day and night, compared to the PAM detections/operations).		Section (iii) (e)
NMFS Incidental Take Statement	BOEM must require (Deepwater Wind/Garden State offshore Energy, LLC) to report all Skipjack Wind Project-related observations of ESA-listed species to NMFS Greater Atlantic Regional Office.	Biological Opinion: https://pcts.nmfs.noaa.gov/pcts-web/dispatcher/trackable/NER-2018-14820	Section 11.5.2 (Reasonable & Prudent Measures 3.)
	BOEM must submit a report to NMFS detailing the activities that occurred pursuant to the Site Assessment Plan that were subject to this consultation and any impacts to ESA-listed species from those activities.		Section 11.5.2 (Terms & Conditions 3.)
	BOEM must report any observations of injured or dead whales, sea turtles or Atlantic sturgeon observed in the Lease Area to NMFS within 24 h.		Section 11.5.2 (Terms & Conditions 4.)
	Submit to NMFS Greater Atlantic Regional Fisheries Office a report documenting survey activities along with a detailed description of any observation		Section 11.5.2 (Terms & Conditions 5.b.)

Document	Required Content	Online Location	Reference in Source Document
	and/or takes of ESA-listed species including ESA-listed whales.		
BOEM Lease OCS-A 0482	The Lessee must provide BOEM and NMFS with reports every 90-calendar days following the commencement of HRG and/or geophysical exploration activities, and a final report at the conclusion of the HRG and/or geophysical exploration activities. Each report must include a summary of survey activities, all protected species observer and incident reports (See Appendices A and B of the referenced document), a summary of the survey activities, and an estimate of the Number of listed marine mammals and sea turtles observed and/or taken during these survey activities.	https://www.boem.gov/Assignment-to-Skipjack-offshore-Energy/	Section 4.5.4
	REQUIRED DATA ELEMENTS FOR PROTECTED SPECIES OBSERVER (PSO) REQUIRED DATA ELEMENTS FOR PROTECTED SPECIES OBSERVER REPORTS The Lessee must ensure that the PSOs record all observations of protected species using standard marine mammal observer data collection protocols. The list of required data elements for these reports is provided below: 1. Vessel name: marine vessel (M/V) *Samantha Miller* and *Danielle Miller,* 2. Observers' names and affiliations; 3. Date; 4. Time and latitude/longitude when daily visual survey began; 5. Time and latitude/longitude when daily visual survey ended; 6. Average environmental conditions during visual surveys including: a. Wind speed and direction**; b. Sea state (glassy, slight, choppy, rough, or Beaufort scale); c. Swell (low, medium, high, or swell height in m); and d. Overall visibility (poor, moderate, good). 7. Species (or identification to lowest possible taxonomic level);		Appendix B

Document	Required Content	Online Location	Reference in Source Document
	8. Certainty of identification (sure, most likely, best guess); 9. Total Number of animals; 10. Number of juveniles; 11. Description (as many distinguishing features as possible of each individual seen, including length, shape, color and pattern, scars or marks, shape and size of dorsal fin, shape of head, and blow characteristics); 12. Direction of animal's travel relative to the vessel (preferably accompanied by a drawing); 13. Behavior (as explicit and detailed as possible, noting any observed changes in behavior); and 14. Activity of vessel when sighting occurred.		

** The *Samantha Miller* was not equipped with the instruments to provide wind speed and direction data; therefore, such data were not systematically collected but instead were estimated based on Beaufort sea state.

Appendix B Vessels

Figure 41. ***M/V Danielle Miller***

Figure 42. ***M/V Samantha Miller***

Figure 43. ***GZA Seacor Supporter***

Appendix C Supplemental Tables

Table 28. Behavior states of individual protected species detected visually in the Survey Area while regulated geophysical (GP) sound sources were on or off.

Species	Bow Riding	Dead	Fast Travel	Medium travel	Mill	Other	Rest	Rest/Slow Travel	Surface-Active Mill	Surface-Active Travel	Travel	Unknown\Blank	Grand Total
Atlantic white-sided dolphin	0	0	0	0	0	0	0	0	0	6	0	0	6
Bottlenose dolphin	36	0	5	88	342	100	66	17	724	321	628	50	2,377
Common dolphin	0	0	0	1	0	0	0	0	7	6	0	1	15
Green turtle	0	0	0	2	0	1	1	3	0	0	2	0	9
Humpback whale	0	0	0	6	0	0	0	7	1	1	1	1	17
Leatherback turtle	0	0	2	1	0	0	0	5	0	0	6	0	14
Loggerhead turtle	0	0	5	6	1	1	3	17	1	0	3	0	37
Other	0	1	0	0	0	0	0	0	0	0	0	0	1
Sperm whale	0	0	0	1	0	0	0	0	0	0	0	0	1
Unidentified delphinid	0	0	0	0	0	0	0	0	0	0	0	1	1
Unidentified dolphin	0	0	0	1	8	0	0	2	0	9	0	2	22
Unidentified sea turtle	0	1	0	1	0	0	0	7	0	0	1	1	11
Unidentified whale	0	0	1	3	0	1	0	3	0	0	0	1	9
Grand Total	**36**	**2**	**13**	**110**	**351**	**103**	**70**	**61**	**733**	**343**	**641**	**57**	**2,520**

Table 29. Behavior states of individual protected species detected visually in the Survey Area while regulated geotechnical (GT) sound sources were on or off.

Species	Fast Travel	Medium Travel	Mill	Other (see notes)	Rest/Slow Travel	Surface-Active Mill	Surface-Active Travel	Unknown/Blank	Grand Total
Bottlenose dolphin	0	1	9	0	0	0	0	0	10
Common dolphin	47	18	0	0	0	0	15	0	80
Fin whale	0	4	0	0	1	0	0	3	8
Gray seal	0	0	0	1	0	0	0	0	1
Harbor porpoise	0	1	0	0	0	0	1	0	2
Humpback whale	0	2	0	0	6	5	5	0	18
Leatherback turtle	0	0	0	0	1	0	0	0	1
Loggerhead turtle	0	0	2	0	10	0	0	0	12
North Atlantic right whale	0	0	0	0	1	0	0	0	1

Species	Fast Travel	Medium Travel	Mill	Other (see notes)	Rest/Slow Travel	Surface-Active Mill	Surface-Active Travel	Unknown/Blank	Grand Total
Sei whale	0	0	0	0	0	0	1	0	1
Unidentified dolphin	3	0	0	0	10	0	40	16	69
Unidentified dolphin or porpoise	0	0	0	0	1	0	0	0	1
Unidentified sea turtle	0	0	0	0	3	0	0	1	4
Unidentified whale	0	1	0	0	2	0	3	3	9
Grand Total	**50**	**27**	**11**	**1**	**35**	**5**	**65**	**23**	**217**

Table 30. Technical specifications of the 4-element MSeis hydrophone array.[1/]

System Components	Characteristics
Hydrophone array cable length	250 m
Deck cable length	100 m
Number of hydrophones	4
Frequency range of hydrophones	10 Hz – 200 kHz
Hydrophone Pair Type 1 range (LF to MF)[1/]	10 Hz - 30 kHz
Hydrophone Pair Type 2 range (MF to HF)[1/]	2 kHz – 200 kHz
LF Hydrophone sensitivity rating	-190 dB re 1V/µPa
HF Hydrophone sensitivity rating	-170 dB re 1V/µPa
Number of types of hydrophones	2
Integral screen and keyboard	yes
Spacing between hydrophones (H)	● 1.5 m H 1 & 2 ● 6 m H 2 & 3 ● 1.5 m H 3 & 4
Back-up system (100% replication)	yes
Depth sensor	yes
Minimum no. of active hydrophones needed to localize LF to HF species[2/]	2
Calibration	Yes. Transmitter sweep checked across frequencies before shipping. Manufacturer's figures for calibration used.
Adequate separation distances between hydrophones to allow localization of low-frequency vocalizations (depth <100 m)	PAMGuard fixes part of wavelength by mathematical matching, not whole wavelength, thus smaller hydrophone separations possible for localizing LF baleen whales
Used/accepted by BOEM/NMFS for previous US Atlantic G&G Surveys	yes

[1]/ LF = low frequency, MF = mid-frequency, HF = high frequency.
[2]/Per NOAA Acoustic Coordination Group, Inter-Agency Coordinating Group on Ocean Sound (headed by Dr. Aaron Thode of Scripps Institute of Oceanography, University of California at San Diego), and the Employer-provided 'BOEM-OREP Recommendations for Deepwater Wind's Alternative Monitoring Plan (11/4/2016)'.

Appendix D Mysticetus Data Elements and Definitions

These variables include all variables required to be collected per the Skipjack BOEM Lease and AMP and the NMFS-issued IHA.

Visual and IR Effort Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Date & Time (Local Time)	Time	*Auto-filled in* Mysticetus *when a new row is created.* Mysticetus *records in both local time and UTC. Displays local time. Format: YYYY-MM-DD HH;MM;SS.S*.
Vessel Name	Vessel	*Auto-filled with "*Samantha Miller*," "*Danielle Miller*," or "*Seacor Supporter*" for this survey*.
PSO 1 Full Name	PSO 1	Drop-down menu: Full Name of Observer. Values are stored in a list named "Observers." Eye-heights for each PSO are also stored in the Observers list.
Night	Night	True or false: did effort or detection occur during nautical night.
PSO 2 Full Name	PSO 2	Drop-down menu: Full Name of Second Observer on duty (if applicable).
Survey/Vessel Activity	Vessel Activity	Drop-down menu: Values are stored in a list named "VesselActivity." Values include: All Stop, Anchoring, Docked, Equipment Test, Deploying equipment, Retrieving equipment, Ramp-up, Surveying/Operational, Station keeping (DP), Spud down, Shutdown – mitigation, Shutdown – operational, Drifting, Drilling, CPT active, Coring, Transit, WOW, and Other - describe in notes.
Source Frequency	Source Freq	Drop-down menu: entries include: Above 200 kHz, Below 200 kHz, None, Other (see notes).
Source Status	Mit Source Status	Drop-down menu: On or Off
Monitoring and Mitigation Activity	Mon Mit Activity	Drop-down menu: Pre-clearance, Ramp-up, Operations, Powerdown, Shutdown, No Ops, Delay due to sighting
Speed Reduction Request	Speed Reduction	Drop-down menu: Yes or No
Speed Reduction Response	Sp Red Response	Drop-down menu: Yes, No, No-safety
Visual Effort on or off (i.e., start & end time/date)	Visual Effort	Drop-down menu: On or Off
Status Check for N Atlantic Right Whale (NARW) Presence and Designated Management Area (DMA) presence	DMA status	Check box: check box at time when NMFS NARW reporting system checked for NARW presence and DMA presence relative to project vessel location. Should be checked between PSO shifts. Date/time automatically recorded by *Mysticetus* when box checked. *(Lead PSO & PAM operator will subscribe for automatic notifications by sending a blank email to ne.rw.sightings@noaa.gov for an automatic response listing of all current DMAs)*

Visual and IR Effort Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Location of PSO on Vessel	PSO Location (Visual Effort only)	Drop-down menu: SM-Deck, DM-02, DM-Bridge, DM-03, SC-Wheelhouse, SC-Lower, Other
Beaufort	Bft	Drop-down menu: 0, 1, 2, 3, 4, 5, 6, 7, 8 (based on Beaufort Sea State)
Wind Speed (kt)	Wind speed (kt)	True wind speed from bridge instruments or estimate. Enter numerical whole number value of wind speed (kt)
Wind Direction	Wind Direction	True winds direction from bridge instruments or estimate
Swell Height (m)	Swell (m)	Estimated swell height (measured from mid-swell to top of swell, in m) --use vessel's reading if available
Precipitation	Precip	Drop-down menu: Clear, Partly Cloudy, Overcast, Hazy, Mist, Light Rain, Heavy Rain, Light Fog, Heavy Fog, Snow
Glare Severity	Glare Sev	Drop-down menu: Slight, visibility slightly impaired (< 10%), Moderate, visibility moderately impaired (11-50%), Extreme, visibility highly impaired (> 50%), None (0%)
Percent Cloud Cover	Cloud Cover	Enter estimated numerical % of observation area covered by clouds. Clear (0-25%), Partly Cloudy (26-75%), Overcast (76-100%)
Overall Visibility	Vis Quality	Drop-down menu: Poor = Bf>4 and/or vis < 500 m, Moderate = Bf 4 and/or vis 500-1km, Good = Bf 0-3 and vis >1 km
Visibility (km)	Vis Distance	Drop-down menu: 0, 0-0.5, 0.5-1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Temperature (°C)	Temp	Enter temperature from bridge instruments (°C)
Dewpoint	Dewpoint	Enter dewpoint from bridge instruments
Notes	Notes	Miscellaneous notes /more detailed description of observation conditions, vessel activity, etc., especially anything unusual (e.g., high swells make it difficult to observe, etc.)
GPS Position	GPS Pos	*GPS position (lat/long) of vessel, auto-recorded every 5 secs and whenever a new entry made in* Mysticetus
Vessel Speed	Vessel Speed	*Auto-filled by* Mysticetus *based on GPS data*
Vessel Course	Vessel Course	*Auto-filled by* Mysticetus *based on GPS data*

Visual and IR Sighting Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
ID	ID	*Auto-filled by* Mysticetus*: incremental count of sightings throughout the survey period* *Visual sightings = V#* *PAM Detections = P#* *(Note: Resightings/Redetections ID should be manually changed to maintain original ID for resight/redetection)*

Visual and IR Sighting Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Vessel Name	Vessel	*Auto-filled with "*Danielle Miller," *"Samantha Miller," or "*Seacor Supporter.*"*
Date & Time (Local Time)	Time	*Auto-filled in Mysticetus when new row is created and every 3 secs with GPS. Mysticetus records in both local time and UTC and displays local time. Format: YYYY-MM-DD HH;MM;SS.S*
Night	Night	True or false: did effort or detection occur during nautical night.
Detection Optics Type used to Make Sighting	Detection Optics (Visual Effort only)	Drop-down menu: Naked Eye, SM-Fujinon7x50-Deck, DM-Fujinon7x50-02, DM-Fujinon7x50-Bridge, DM-Fujinon7x50-03, NVD
Binocular Reticle	Reticle (Visual Effort only)	Binocular reticle at sighting location, record as decimal.
Sighting Distance	Sgt Dist	Auto-calculated based on detection optics, reticle and GPS position or hand-entered if detection optics is Naked Eye or IR.
Species (or Lowest Taxonomic Level)	Species	Drop-down menu: entries are stored in a list named "Species". The list of species includes names from IHA application, plus additional. Entries include: Atlantic white-sided dolphin, Blainville's beaked whale, Blue whale, Bottlenose dolphin, Bryde's whale, Clymene dolphin, Common dolphin, Cuvier's beaked whale, Dwarf sperm whale, Earless Seals (Phocidae), False killer whale, Fin whale, Fishing Gear, Gervais' beaked whale, Gray seal, Green turtle, Harbor porpoise, Harbor seal, Harp seal, Hawksbill turtle, Hooded seal, Humpback whale, Kemp's ridley turtle, Killer whale, Leatherback turtle, Loggerhead turtle, Long-finned pilot whale, Melon headed whale, Minke whale, North Atlantic right whale, Olive ridley turtle, Pan-tropical spotted dolphin, Pygmy sperm whale, Risso's dolphin, Sei whale, Short-beaked common dolphin, Short-finned pilot whale, Sowerby's beaked whale, Sperm whale, Spinner dolphin, Sturgeon, Striped dolphin, True's beaked whale, White-beaked dolphin, Other, Unidentified dolphin, Unidentified delphinid, Unidentified porpoise, Unidentified dolphin or porpoise, Unidentified delphinid or porpoise, Unidentified large whale, Unidentified marine mammal, Unidentified medium whale, Unidentified pinniped, Unidentified porpoise, Unidentified shark, Unidentified sea turtle, Unidentified small marine mammal, Unidentified small whale, Unidentified whale.
Certainty of Species Identification	Species Reliability	Drop-down menu: Sure, Most Likely, Best Guess.
Closest Observed Point of Approach to Sound Source	CPA	Drop-down menu: Yes or No. Is this record the closest point of approach?

Visual and IR Sighting Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Observer who Made Sighting (Full Name)	PSO	Drop-down menu: Full Name of Observer. Values are stored in a list named “Observers.”
Bearing from Observer to Sighting	Bearing To	True bearing from the observer to the sighting - check vessel compass display for current vessel's heading/orientation. In the format 180+2:00.
Direction Sighting Headed	Where To	True heading/direction of the animal or >50% of group heading/pointing. In the format 180+2:00.
Animal's direction of Travel (Relative to the ship)	Travel Direction	Drop-down menu: Towards bow, Away from bow, Toward midship, Away from midship, Toward stern, Away from stern, Parallel in same direction as boat, Parallel in opposite direction as boat, No clear direction / not able to determine, Variable, rapid changes of direction, Milling, Stationary (e.g., logging, basking).
Sighting Cue	Sgt Cue	Drop-down menu - what cued observer to initial sighting: Birds, Body, Blow, Dorsal, Fluke, Head, IR, Splash, PAM, Other.
Group Size	Min Count	Enter the numerical minimum of group size (including juveniles/calves).
	Max Count	Maximum estimate of group size.
	Best count	Best estimate of group size.
Number of Juveniles / Calves	Juveniles / Calves	Number of juveniles (including calves) with body length <1/2 of accompanying adult; numerical drop-down choice (0 through 25) including ND (not determined).
Behavior State	Behavior State	Drop-down menu (based on at least 50% of group's behavior state): Values are stored in a list named “Behavior State”. Values include: Bow Riding, Dead, Injured, Mill, Rest/Slow Travel, Medium Travel, Fast Travel, Surface-Active Travel, Surface-Active Mill, Other (see notes), Unknown.
Individual Behavior Event	Ind Behav Event	Drop-down menu of individual behavioral events: Blow, Bow Riding, Breach, Chasing fish, Dead, Feeding on observed fish, Fluke up, Injured, Porpoising, Socializing (animals touching), Splashing, Tail slap, None, Other (see notes), Unknown.
Behavioral Reaction to Source/Vessel	Behav Reaction	Drop-down menu for a reaction to vessel/source: Direction of Travel, Dive, Slow Down, Speed Up, None, Other (see notes).
Source Status	Mit Source Status	*Auto-filled by* Mysticetus *from Effort tab.*
Mitigation Request	Mit Request	Drop-down menu: Alter Course, Delay, Engine Neutral, Powerdown, Shutdown, Speed Reduction, None, Other.
Mitigation Response	Mit Response	Drop-down menu: Alter Course, Delay, Engine Neutral, Powerdown, Shutdown, Speed Reduction, None, Denied, Other.
Photographs	Images	Upload the best of photos and add frame number.

Visual and IR Sighting Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Name of Person Who Took Photographs/ Image	Image Credit	Text field: may be filled in after watch period.
Description of Sighting	Sgt Desc Notes	List as many distinguishing features as possible of each individual seen, including length, shape, color and pattern, scars or marks, shape and size of dorsal fin, shape of head, and blow characteristics, that helped you identify to lowest taxonomic level.
Notes	Notes	Miscellaneous notes /more detailed description of sighting, bird association, etc.
GPS Position	GPS Pos	*Auto-filled by* Mysticetus *from GPS*
Bearing Absolute	Bearing Abs	*Auto-filled by* Mysticetus *from GPS*
Vessel Speed over Ground	Ves Spd	*Auto-filled by Mysticetus from GPS*
Sighting Position	Sgt Pos	*Auto-calculated by Mysticetus: location of sighting calculated from Sgt Dist, Bearing Abs, GPS Pos*
Sighting Latitude	Sgt Lat	*Auto-calculated by Mysticetus: location of sighting calculated from Sgt Dist, Bearing Abs, GPS Pos*
Sighting Longitude	Sgt Lon	*Auto-calculated by Mysticetus: location of sighting calculated from Sgt Dist, Bearing Abs, GPS Pos*
Water Depth at Sighting	Depth (m)	*Auto-calculated by Mysticetus: location of sighting calculated from Sgt Dist, Bearing Abs, GPS Pos*
Lease Area (Inside or Outside)	Lease Area	*Auto-calculated by Mysticetus: location of sighting calculated from Sgt Dist, Bearing Abs, GPS Pos*
Sighting Course over Ground	Sgt Cog	*Auto-filled by Mysticetus - course-over-ground of the sighting*
Sighting Speed over Ground (kts)	Sgt Sog (kts)	*Auto-filled by Mysticetus - speed-over-ground of the sighting*
Beaufort	Bft	*Auto-filled by Mysticetus from Effort tab*
Visibility Distance	Vis Dist (m)	*Auto-filled by Mysticetus from Effort tab*
Visibility Quality	Vis Quality	*Auto-filled by Mysticetus from Effort tab*
Severity of Glare	Glare Sev	*Auto-filled by Mysticetus from Effort tab*
Mitigation Source Frequency	Source Freq	*Auto-filled by Mysticetus from Effort tab*
Vessel Activity	Vessel Activity	*Auto-filled by Mysticetus from Effort tab*

Visual and IR Sighting Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Precipitation	Precip	*Auto-filled by Mysticetus from Effort tab*
% Cloud Cover	Cloud Cover	*Auto-filled by Mysticetus from Effort tab*
Detection Optics Type used to Make Sighting	Detection Optics	*"IR" auto-filled by Mysticetus. Required for detection summary reports.*

PAM Effort Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Date & Time (Local Time)	Time	Auto-filled in *Mysticetus* when new row is created and every 3 secs with GPS. *Mysticetus* records in both local time and UTC and displays local time. Format: YYYY-MM-DD HH;MM;SS.S
Name of Vessel	Vessel	Auto fill with "Samantha Miller," "Danielle Miller" or "*Seacor Supporter*" for this survey
Night	Night	True or false: did effort or detection occur during nautical night.
Deployment Identification Number	Deployment ID	Auto-filled chronologically by *Mysticetus* throughout survey
Deployment Method	Deployment Method	Drop-down menu: Port mid-ship vertical/stationary, Port mid-ship towed, Stbd mid-ship vertical/stationary, Stbd mid-ship towed, Stern vertical/stationary, Stern towed, Other, Not Deployed
Signal to Noise Ratio	Signal Noise Ratio	Drop-down menu: 0, 1, 2, 3, 4, 5 (scaled estimate of signal to noise ratio where 1 = lowest signal to noise ratio and 5 = best signal to noise ratio), 0 represents no auditory detection
PAM Operator Full Name	PAM Op	Drop-down menu: Full Name of Observer. Values are stored in a list named "Observers".
PAM Effort (start & end times)	PAM Effort	Drop-down menu: PAM Effort on or off, to mark start and end times of PAM
Source Frequency	Source Freq	Drop-down menu: entries include: Above 200 kHz, Below 200 kHz, None, Other (see notes).
Notes	Notes	Additional details, unusual events, etc.

PAM Effort Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Status Check for N Atlantic Right Whale (NARW) presence and Designated Management Area (DMA) presence	DMA status	Check box: check box at time when NMFS NARW reporting system checked for NARW presence and DMA presence relative to project vessel location. Should be checked between PSO shifts. Date/time automatically recorded by *Mysticetus* when box checked. (Lead PSO & PAM operator will subscribe for automatic notifications by sending a blank email to ne.rw.sightings@noaa.gov for an automatic response listing of all current DMAs)
Vessel Activity	Vessel Activity	Drop-down menu: Values are stored in a list named "VesselActivity". Values include: All Stop, Anchoring, Docked, Equipment Test, Deploying equipment, Retrieving equipment, Ramp up, Surveying / Operational, Station keeping (DP), Spud down, Shutdown – mitigation, Shutdown – operational, Drifting, Drilling, CPT active, Coring, Transit, WOW, and Other - describe in notes.
GPS Position	GPS Pos	Auto-calculate vessel position by *Mysticetus*
Vessel Speed (kts)	Speed (kts)	Auto-filled by *Mysticetus*
Vessel Course Heading	Course	Auto-filled by *Mysticetus*
Identification Number	ID	Auto-filled by *Mysticetus*: incremental count of sightings throughout the survey period Visual sightings = V# PAM Detections = P# (Note: Resightings/Redetections ID should be manually changed to maintain original ID for resight/redetection)
Vessel Name	Vessel	Auto-filled with "*Danielle Miller*", "*Samantha Miller'*, or "*Seacor Supporter*".
Initial Detection Method	Initial Det Met	Initial Detection Method for Detection Event (i.e. Visual or PAM). Drop-down menu: naked eye, RB (reticle binocular), PAM
Visual Confirmation of PAM Detection (yes or no)	Visual Conf	Checkbox: check box if visual confirmation of PAM detection
Date & Time (Local Time)	Time	Auto-filled in *Mysticetus* when new row is created and every 3 secs with GPS. *Mysticetus* records in both local time and UTC and displays local time. Format: YYYY-MM-DD HH;MM;SS.S
PAM Operator Who Made Detection (Full Name)	PAM Op	Drop-down menu: Full Name of Observer. Values are stored in a list named "Observers".
Bearing from PAM Array to PAM Detection	Bearing	Auto-filled in *Mysticetus* using TowedArrayBearing formula.

PAM Effort Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Mitigation Source Frequency	Source Freq	Auto-filled by *Mysticetus* from Effort tab
Source Status	Mit Source Status	Auto-filled by *Mysticetus* from Effort tab
First Type of Call Detected	Call Type 1	Drop-down menu: Clicks, Whistles, Buzzes, Moans, LF Pulse, Thump Train, Burst-Pulsed, Song, Other (describe in notes)
Second Type of Call Detected	Call Type 2	Drop-down menu: Clicks, Whistles, Buzzes, Moans, LF Pulse, Thump Train, Burst-Pulsed, Song, Other
Species (or Lowest Taxonomic Level)	Species	Drop-down menu: entries are stored in a list named "Species". The list of species includes names from IHA application, plus additional. Entries include: Atlantic white-sided dolphin, Blainville's beaked whale, Blue whale, Bottlenose dolphin, Bryde's whale, Clymene dolphin, Common dolphin, Cuvier's beaked whale, Dwarf sperm whale, Earless Seals (Phocidae), False killer whale, Fin whale, Fishing Gear, Gervais' beaked whale, Gray seal, Green turtle, Harbor porpoise, Harbor seal, Harp seal, Hawksbill turtle, Hooded seal, Humpback whale, Kemp's-Ridley turtle, Killer whale, Leatherback turtle Loggerhead turtle, Long-finned pilot whale, Melon headed whale, Minke whale, North Atlantic right whale, Olive Ridley turtle, Pan-tropical spotted dolphin, Pygmy sperm whale, Risso's dolphin, Sei whale, Short-beaked common dolphin, Short-finned pilot whale, Sowerby's beaked whale, Sperm whale, Spinner dolphin, Sturgeon, Striped dolphin, True's beaked whale, White-beaked dolphin, Other, Unidentified dolphin, Unidentified delphinid, Unidentified porpoise, Unidentified dolphin or porpoise, Unidentified delphinid or porpoise, Unidentified large whale, Unidentified marine mammal, Unidentified medium whale, Unidentified pinniped, Unidentified porpoise, Unidentified shark, Unidentified sea turtle, Unidentified small marine mammal, Unidentified small whale, Unidentified whale
Species Reliability	Species Reliability	Drop-down menu: Sure, Most Likely, Best Guess
Signal to Noise Ratio	Signal Noise Ratio	Drop-down menu: 1, 2, 3, 4 (scaled, where 1 = low signal to noise ratio and 4 - best signal to noise ratio). However, the drop-down menu allows 0 through 5.
Depth of Hydrophones in Array	Array Depth (m)	Water depth of hydrophones in array (m), entered numerically by operator

PAM Effort Data		
Variable	**Column Name in *Mysticetus***	**Definition/drop-down selection in *Mysticetus* field form**
Method used to Localize PAM Detection	Localization Method	Drop-down menu: Target Motion, Hyperbolic, TDOA (time difference of arrival), Other
Visual Confirmation	Visual Confirmation	Duplication of “Visual Conf” field.
Time Detection Last Heard	Detection End Time	Time last heard. Enter “x” and *Mysticetus* will fill in the current time.
Best Count	Best count	Best estimate of group size
Mitigation Request	Mit Request	Drop-down menu: Alter Course, Delay, Engine Neutral, Powerdown, Shutdown, None, Other
Mitigation Response	Mit Response	Drop-down menu: Alter Course, Delay, Engine Neutral, Powerdown, Shutdown, None, Denied, Other
Spectrogram Screenshot	Images	Spectrogram screen shot file name
Notes/Detection Description	Notes	Detailed notes of detection, anything unusual, descriptive (e.g., likely sperm whale because of XXXX), etc.
GPS Position	GPS Pos	Auto-filled by *Mysticetus* of PAM detection if bearing & distance entered; otherwise, Auto-filled of vessel position
Water Depth	Depth (m)	Auto-filled by *Mysticetus* Where Hydrophone Array Deployed, or from PAM Detection if Localized
Lease Area (Inside or Outside)	Lease Area	Auto-calculated by *Mysticetus*: location of sighting calculated from Sgt Dist, Bearing Abs, GPS Pos
Beaufort	Bft	Auto-filled by *Mysticetus* based on Visual Effort, if applicable
Precipitation	Precip	Auto-filled by *Mysticetus* based on Visual Effort, if applicable
% Cloud Cover	Cloud Cover	Auto-filled by *Mysticetus* based on Visual Effort, if applicable
Detection Optics Type used to Make Sighting	Detection Optics	“PAM” auto-filled by *Mysticetus*. Required for detection summary reports.
Behavioral Reaction to Source/Vessel	Behav Reaction	“N/A PAM” auto-filled by *Mysticetus*. Required for detection summary reports.

Appendix E Example Daily PSO/PAM Report Data Form

DAILY Preliminary Summary Report for PSO Visual Observations and PAM Acoustic Detections - 2018 Deepwater Wind Skipjack HRG Survey
Created by Smultea Sciences

Prepared by: **Vessel Name:** **BOEM Lease Area: OCS-A 0482**
Date: **Duration Visual Effort:**

Species (one line per PSO Sighting/PAM Detection)	Initial Detection Method (Visual; unaided eye, reticle binoculars)	Check if Initial Detection Method was PAM	Group Size	Time First Sighted/ Detected	Vessel Activity at Time of Sighting/Detection	No. Indiv. Marine Mammal Observed 500-m EZ*	No. Indiv. Sea Turtles Observed 500-m EZ*	No. Indiv NARW Observed in 500-m EZ*	Approx. Closest Observed Distance (m)	Observed Behavior during Sighting	Mitigation Measures Taken	Comments / Details

RECORD OF DAILY & CUMULATIVE TOTAL NUMBER OF INDIVIDUALS OBSERVED WITHIN 500-m EXCLUSION ZONE (EZ)
(ADD NEW SPECIES AS RELEVANT)
*****THIS TABLE SHOWS ONLY INDIVIDUALS SEEN WHILE AGENCY-REGULATED HRG EQUIPMENT OPERATING*****

Protected Species (Marine Mammal, Sea Turtle, or Atlantic Sturgeon)	No. Indiv. Marine Mammals Observed 500-m EZ*	Cumulative No. Indiv. Marine Mammals Observed 500-m EZ*	No. Indiv. Sea Turtles Observed 500-m EZ*	Cumulative No. Indiv. Sea Turtles Observed 500-m EZ*	No. Indiv NARW Observed in 500-m EZ*	Cumulative No. Indiv. NARW Observed 500-m EZ*
North Atlantic right whale (*Eubalaena glacialis*)						
Unidentified large whale						
Harbor porpoise (*Phocoena phocoena*)						
Unidentified pinniped (seal)						
Grey seal (*Halichoerus grypus*)						
Unidentified medium whale						
Fin whale (*Balaenoptera physalus*)						
Humpback whale (*Megaptera novaeangliae)*						
Minke whale (*Balaenoptera acutorostrata)*						
Harbor seal (*Phoca vitulina*)						
Sperm whale (*Physter macrocephalus*)						
Unidentified dolphin/porpoise						
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)						
Unidentified sea turtle						
Green sea turtle (*Chelonia mydas*)						
Kemp's Ridley sea turtle (*Lepidochelys kempii*)						
Leatherback sea turtle (*Dermochelys coriacea*)						
Loggerhead sea turtle (*Caretta caretta*)						
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)						
TOTAL						

***EZ = Exclusion Zone as defined by NMFS-issued IHA**
**** WZ = Marine Mammal Watch Zone as defined by NMFS-issued IHA**

Appendix F Geophysical and Geotechnical Survey Equipment

Equipment List, *Danielle Miller* - Geophysical Survey

Qty	Description
2	Two (2) CNAV-3050 DGNSS positioning systems
1	one (1) Kongsberg EM3002 Dual head 300-kHz High Resolution Multibeam Sonar
1	one (1) IXSEA GAPSII USBL underwater tracking system with four (4) beacons, topside, integrated with Octans IMU
2	Two (2) Valeport Tide Gauges
2	Two (2) Valeport Rapid Sound velocity profilers - capable for underway casting
1	Two (2) AGO CSW-7 Data Winch with multiconductor cable and slip ring
2	Two (2) Geometrics Transverse Gradiometer (TVG) mount and altimeter - to be interfaced with the SSS towfish
4	Three (3) Geometrics 882 Cesium Magnetometers - two to be installed on the TVG, the third for backup.
2	Two (2) EdgeTech DSS-2000 Combined Sonar with 2-16kHz Chirp Sub-bottom profiler, 300/600 kHz Side-scan sonar system, and Magnetometer interface. one primary and one backup.
2	Two (2) Applied Acoustics S-boom Triple Plate Boomer with single channel hydrophone array and CSP 1250 Energy Source
1	one (1) Seismic Streamer - containing a lead-in section, stretch, GPS active head, tail buoy, Seabirds, tow (2) active 12.5m sections (1 section with 1.56m group intervals, 1 section with 3.125m group intervals) – Fully spared for deck lay deployment
1	Oceaneering SAIL – high speed, high volume internet dome with service
2	Two (2) CLIENT PROVIDED - Passive Acoustic Monitoring (PAM) System - 250m, 6 hydrophone arrays
2	Two (2) CLIENT PROVIDED - HD Thermal Imaging Camera Systems (120 degree)
1	one (1) CLIENT PROVIDED – Bat monitoring system

Equipment List, *Danielle Miller* - Geotechnical Survey

Qty	Description
2	Two (2) CNAV-3050 DGNSS positioning systems
1	one (1) Coda F180 – with cables, topside, antennas
1	one (1) Neptune 3000 mini-CPT System with spares (installed during Geotechnical Transition)
1	one RIC 6500 Vibracore system capable of 3m and 6m coring. (installed during Geotechnical Transition)
2	Two (2) DT Marine 3050 50HP lifting data winch with soft start, cable counter. (installed during Geotechnical Transition)
1	Oceaneering SAIL – high speed, high volume internet dome with service
2	Two (2) **CLIENT PROVIDED** - Passive Acoustic Monitoring (PAM) System - 250m, 6 hydrophone array
2	Two (2) **CLIENT PROVIDED** - HD Thermal Imaging Camera Systems (120 degree)

Qty	Description
1	one (1) **CLIENT PROVIDED** – Bat monitoring system

Equipment List, *Samantha Miller* - Geophysical Survey

Qty	Description
2	Two (2) CNAV-3050 DGNSS positioning systems
1	one (1) Inertial Motion Unit: NG LCI, (either POS MV Surfmaster/Wavemaster or Novatel
1	one (1) Norbit iWBMS (c) IMU integrated High Resolution Multibeam Sonar
2	Two (2) Valeport Rapid Sound velocity profilers - capable for underway casting
2	Two (2) EdgeTech 4200 – 300/600 kHz Side-scan Sonar systems - with mag interface
1	one (1) Geometrics Transverse Gradiometer (TVG) mount and altimeter - to be interfaced with the SSS towfish
3	Three (3) Geometrics 882 Cesium Magnetometers - two to be installed on the TVG, the third for backup.
1	one (1) EdgeTech 512i (0.5-12kHz) OR EdgeTech 216 (2 to 16 kHz) Chirp Sub-bottom profiler - for high resolution vertical profiling.

Equipment List, *Seacor Supporter* Class 200' Liftboat - Geophysical Investigations

Qty	Description
1	Atlas-Copco T3WDH drill rig
1	Digital P-S Suspension log probe

Appendix G Alternative Monitoring Plan Effectiveness Report for Geophysical and Geotechnical Surveys

During the Skipjack Wind Project G&G surveys, four different yet complementary methods were used to detect marine mammals and sea turtles. Some of these methods were used simultaneously (see 3 *Methods*):

1) Unaided Eye (UE) / Reticle Binocular (RB)
   a. During daylight: UE (with occasional use/sweeps of RB)
   b. Night Vision Devices (NVD) during darkness (and some periods of daylight at twilight; included occasional sweeps with the naked eye via artificial illumination from the vessel lights (when lights on);
2) Infrared (IR) devices during darkness (via 2 remotely monitored mounted IR cameras); and
3) Passive Acoustic Monitoring (PAM) during darkness.

In the field, the monitoring method used at first detection of a marine mammal or sea turtle was recorded as the initial detection method. Any subsequent detections of the same animal using a different monitoring method was also recorded (**Error! Reference source not found.**). To maximize sample size all combined-method detections inside and outside the Lease Area and within the cable approaches were pooled and resulted in the following dataset:

Table 31. Sightings made by multiple simultaneous detection methods [1/].

Initial Detection ID Number	Species	PAM Count	PAM Mitigation Source Status	IR Count	IR Mitigation Source Status	IR Sighting Distance (m)	Visual Count	Visual Mitigation Source Status	Visual Sighting Distance (m)
P4	Unidentified dolphin	4	on	1	on	100	--	--	--
P5	Common dolphin	--	--	--	--	--	1	on	1
V126	Unidentified dolphin	--	on	1	on	500	1	on	10
I2	Common dolphin	--	on	4	on	1,000	4	on	0
I3	Unidentified dolphin	--	on	3	on	90	2	on	10

[1/] Red numbers indicate which detection method provided the best data for each simultaneous sighting. In reporting, this is the data that was used regardless of the initial detection method.

-- = No applicable data

G.1. Detections in Daylight vs. Darkness

The four complementary detection methods were used during periods of both daylight and darkness.

- Of the 397 initial visual detections, 92% (n = 367 detections) occurred during daytime and 8% (n = 30 detections) occurred during darkness.
- Of the 30 initial detections in darkness, 40% occurred from PAM, 7% were made using NVD, 3% occurred with the UE (where artificial illumination occurred from the vessel lights), and 50% occurred using the IR.

G.2. Detection Rates

To standardize for differences in effort across detection methods, we calculated detection rates (number of detections per hour of effort) based on which detection method made the initial detection. Detection rate was calculated separately for each of the different detection methods by dividing the total number of detections by the total PSO or PAM effort using that method. Details on the detection rates by each monitoring method are presented in Table 32 through Table 34.

- By species/grouping (Table 32):
  - Large whales were observed primarily with the UE/RB.
  - Pooled delphinids/porpoises were observed at a rate of approximately five times greater than the detection rate of pooled whales using the UE/RB (11.7 versus 2.3, respectively).
  - Pooled delphinids/porpoises were detected by IR and NVD at similar rates (0.8 versus 0.7, respectively).

- Overall (Table 32):
  - UE resulted in the highest detection rate (18.5 detections/100 h of UE effort) followed by PAM (2.3 detections/100 h of PAM effort).
  - IR resulted in 1.6 detections/100 h of effort.
  - NVD detection rates were lower (1.1 detections/100h of NVD effort).

- During daylight (Table 33):
  - UE had the highest detection rate (20.5) and was approximately five times that of PAM (4.0).
  - Two NVD detections were made during "daylight" (near twilight, as stronger daylight rendered them useless).

- During darkness (Table 33):
  - PAM (2.1) had the highest detection rate followed by IR (1.9).
  - The NVD detection rate (0.4) was considerably lower than either IR or PAM (1.9 and 2.1, respectively), in areas well-lit by the vessel operating lights, the PSOs considered the UE more effective and efficient at scanning these areas than the NVD. This is because NVD effectiveness was negatively impacted by strong ambient lights (causing a blurry and/or useless image/view).
  - In contrast, in areas where the vessel operating lights were limited or non-existent, the NVD was clearly more effective than the UE, if there was some amount of low ambient light to help illuminate the view through the NVD.

Table 32. Detection rates (number of initial[1/] detections for per-person decimal hours of effort[2/]) for visual and PAM methods by groupings in the Survey Area during the geophysical and geotechnical surveys

Species	Infrared (IR) 854.5 h		Night Vision Devices (NVD) 281.4 h		Passive Acoustic Monitoring (PAM) 710.8h		Unaided Eye (UE) 1,960.4 h		All Methods Totals 3,807.1 h	
	Number of Detections	Detection Rate (No. IR Detections / 100 h IR Effort	Number of Detections	Detection Rate (No. NVD Detections / 100 h NVD Effort	Number of Detections	Detection Rate (No. PAM Detections / 100 h PAM Effort	Number of Detections	Detection Rate (No. Visual Detections / 100 h Visual Effort	Total Number of Detections	GP Total Detection Rate (No. Detections / 100 h Effort)
Delphinid Total	7	0.8	2	0.7	16	2.3	229	11.7	254	6.7
Seal Total	0	0.0	0	0.0	0	0.0	1	0.1	1	0.0
Turtle Total	1	0.1	0	0.0	0	0.0	87	4.4	88	2.3
Whale Total	6	0.7	1	0.4	0	0.0	46	2.3	53	1.4
Grand Total	**14**	**1.6**	**3**	**1.1**	**16**	**2.3**	**363**	**18.5**	**396**	**10.4**

1/ Detections presented are initial detections from each monitoring method. UE = Unaided Eye (during daylight this included occasional use of 7 x 50 reticle binoculars primarily to confirm sightings, species, etc.), IR = Infrared binoculars, NVD = Night Vision Device (night vision binoculars).
2/ Effort includes all periods (daylight and darkness) and simultaneously occurring Effort, representing totals for each person on watch by method. See Methods section.
3/ Results do not include one badly decomposed unidentified animal carcass seen from the Danielle Miller during the survey period.

Table 33. Geophysical survey detection rates (number of initial[1/] detections for per-person decimal hours of effort[2/]) in daylight vs. darkness for visual and PAM methods by species and groupings in the Survey Area by vessel during the geophysical survey. [6/]

Species	Day [3/ 4/]								Night [3/ 4/]								Grand Total 3,807.1 h	
	NVD [5/] 0.0 h		PAM 49.5 h		UE 1,770.2 h		Day Total 1,872.0 h		IR 802.1 h		NVD 281.4 h		PAM 661.3 h		Night Total 1,935.1 h			
	Number of Detections [5/]	Detection Rate (No. NVD Detections / 100 h NVD Effort	Number of Detections	Detection Rate (No. PAM Detections / 100 h PAM Effort	Number of Detections	Detection Rate (No. Visual Detections / 100 h Visual Effort	Total Daytime Detections	Total Detection Rate No. Detections / 100 h Effort)	Number of Detections	Detection Rate (No. IR Detections / 100 h IR Effort	Number of Detections [5]	Detection Rate (No. NVD Detections / 100 h NVD Effort	Number of Detections	Detection Rate (No. PAM Detections / 100 h PAM Effort	Total Daytime Detections	Total Detection Rate No. Detections / 100 h Effort)	Total Number of Detections	GP Total Detection Rate (No. Detections / 100 h Effort)
Delphinid Total	1	--	2	4.0	228	12.9	231	12.3	7	1.0	1	0.4	14	2.1	23	1.2	254	6.7
Pinniped Total	0	0.0	0	0.0	1	0.1	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
Turtle Total	0	0.0	0	0.0	87	4.9	87	4.6	1	0.1	0	0.0	0	0.0	1	0.1	88	2.3
Whale Total	1	--	0	0.0	46	2.6	47	2.5	6	0.7	0	0.0	0	0.0	6	0.3	53	1.4
Grand Total	**2**	--	**2**	**4.0**	**362**	**20.5**	**366**	**19.6**	**14**	**1.9**	**1**	**0.4**	**14**	**2.1**	**30**	**1.6**	**396**	**10.4**

[1/] Detections presented are initial detections from each monitoring method. UE = Unaided Eye (during daylight this included occasional use of 7 x 50 reticle binoculars primarily to confirm sightings, species, etc.), IR = Infrared binoculars, NVD = Night Vision Device (night vision binoculars).
[2/] Effort includes simultaneously occurring effort, representing totals for each person on watch by method. See Methods section.
[3/] There were zero IR detections during daytime and zero UE detections during night.
[4/] IR hours during daytime = 52.35. UE hours during nighttime = 190.27
[5/] The two NVD detections occurred outside of NVD watch hours.
[6/] Results do not include one badly decomposed unidentified animal carcass observed during the Danielle Miller geophysical survey.

Table 34. Geotechnical survey detection rates (number of initial[1/] detections for per-person decimal hours of effort[2/]) while the sound source was on or off for visual and PAM methods by species and groupings in the Survey Area by vessel during the geophysical survey. [3/]

Species	Sound Source On										Sound Source Off										All Totals 3,807.1	
	Infrared (IR) 377.6		Night Vision Devices (NVD) 0.5 h		Passive Acoustic Monitoring (PAM) 414.9 h		Unaided Eye (UE) 650.5 h		Sound Source On Total 1,443.4 h		Infrared (IR) 477 h		Night Vision Device (NVD) 280.9 h		Passive Acoustic Monitoring (PAM) 295.9 h		Unaided Eye (UE) 1,310 h		Sound Source Off Total 2,363.8 h			
	Number of Detections	Detection Rate (No. IR Detections / 100 h IR Effort	Number of Detections	Detection Rate (No. NVD Detections / 100 h NVD Effort	Number of Detections	Detection Rate (No. PAM Detections / 100 h PAM Effort	Number of Detections	Detection Rate (No. Visual Detections / 100 h Visual Effort	Total Detections	Total Detection Rate No. Detections / 100 h Effort)	Number of Detections	Detection Rate (No. IR Detections / 100 h IR Effort	Number of Detections	Detection Rate (No. NVD Detections / 100 h NVD Effort	Number of Detections	Detection Rate (No. PAM Detections / 100 h PAM Effort	Number of Detections	Detection Rate (No. Visual Detections / 100 h Visual Effort	Total Detections	Total Detection Rate No. Detections / 100 h Effort)	Total Number of Detections	GP Total Detection Rate (No. Detections / 100 h Effort)
Delphinid Total	1	0.3	1	206.9	3	0.7	31	4.8	36	2.5	6	1.3	1	0.4	13	4.4	198	15.1	218	9.2	254	6.7
Seal Total	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	1	0.0	1	0.0
Turtle Total	0	0.0	0	0.0	0	0.0	33	5.1	33	2.3	1	0.2	0	0.0	0	0.0	54	4.1	55	2.3	88	2.3
Whale Total	2	0.5	1	206.9	0	0.0	8	1.2	11	0.8	4	0.8	0	0.0	0	0.0	38	2.9	42	1.8	53	1.4
Grand Total	**3**	**0.8**	**2**	**413.8**	**3**	**0.7**	**16**	**2.5**	**80**	**5.5**	**11**	**2.3**	**1**	**0.4**	**13**	**4.4**	**291**	**22.2**	**316**	**13.4**	**396**	**10.4**

1/ Detections presented are initial detections from each monitoring method. UE = Unaided Eye (during daylight this included occasional use of 7 x 50 reticle binoculars primarily to confirm sightings, species, etc.), IR = Infrared binoculars, NVD = Night Vision Device (night vision binoculars).
2/ Effort includes all periods (daylight and darkness) and simultaneously occurring Effort, representing totals for each person on watch by method. See Methods section.
3/ Results do not include one badly decomposed unidentified animal carcass observed during the Danielle Miller geophysical survey

G.3. Unaided Eye Effectiveness

Over 90% of the detections occurred by UE/RB. In general, during the day, PSOs considered the UE/RB to be the most effective observation method for visually detecting protected species during this survey. This was attributed to the wider field of view afforded by the UE/RB within the 500-m EZ for NARW than the IR, and the ability to see clearer images and apparently farther than the IR. However, during daylight, the RB were the most useful for obtaining more detail on sightings, including identification to species or genus, group size, group composition, heading, and behavior; further, the RB could see farther than the UE, though within a much narrower field of view than the UE.

During darkness, UE was considered most effective at visually detecting delphinids in areas near the vessel that were well-lit by the vessel operating lights. This is because the NVDs were ineffective in strong ambient light conditions (the image became distorted with too much light interference). The IR field of view was also limited compared to the UE in these well-lit areas during darkness. However, in dark areas away from the vessel operating lights, NVDs were considered most effective.

The following expected conditions were reported by PSOs to reduce effectiveness of the UE:

- High Beaufort sea state (> 4)
- Darkness with no ambient light
- Fog

Environmental conditions and results of monitoring are discussed further in the body of this Technical Report as required by BOEM and the NMFS-issued IHA.

G.4. Night Vision Device Effectiveness

NVDs were used during darkness and dusk/dawn to monitor for protected species. Specifications for the NVD model and make used during the survey can be found in the project AMP. NVDs were used during the surveys to supplement IR during darkness when the IR or PAM had a possible detection. NVDs were used more regularly after 01 November 2018 during transits while the vessel was underway to and from geotechnical coring/drilling stations. This period coincided with the expected peak occurrence of migrating NARW in the region. Use of NVDs served to assist with vessel strike avoidance during peak hours of nighttime darkness. At these times, one dedicated PSO used the NVDs simultaneous to a second visual PSO monitoring with the IR system from a lab station. Effective use of the NVD requires a low-level of ambient light. Too much light overloads the detectors and renders their utility useless.

Challenges with using the NVDs include eye strain and muscle strain from holding the relatively heavy device up to one’s eyes. To alleviate eye strain, each PSO rotated between UE (to search areas illuminated by the vessel’s running lights or the moon) and the NVD. This allowed the eyes and arms to rest.

Of the 30 total detections in darkness, only one was made using NVD. Two additional NVD detections technically occurred in daylight. However, early dawn conditions necessitated NVD use. Detection distance with NVD ranged from 10-600 m (mean 219 m). NVD resulted in the 1.1 overall detection rate (3 detections/281.4 h of NVD effort). In general, NVDs were

considered by the PSOs to be most effective at detecting cetaceans near the vessel. The NVDs could be held at any angle by the user versus the fixed installation of the IR cameras, thereby allowing monitoring along the sides of the vessel if necessary. The image seen through the NVDs was consistently clearer than the IR device under the same/simultaneous environmental conditions; however, the IR performed better during fog than the NVD. For example, common dolphins could be identified to species during darkness using the NVD but not the IR device.

The following conditions were reported by PSOs to reduce effectiveness of the NVD:

- Degree of background and ambient light: Effective scanning with the NVD within the water area strongly illuminated by the vessel's floodlights (located amidships and the stern) was not possible; the strong floodlight created a fuzzy indistinguishable view due to too much light interference. However, when the PSOs moved to darker areas (e.g., the bow), NVD effectiveness improved.
- Reflectiveness of the windows inside the bridge: The NVD had reduced effectiveness inside the bridge at night when the interior bridge lights were on full brightness. These bright interior lights reflected in the bridge windows, causing the image as seen through the NVD to be compromised or interfered by other images.
- Poor weather conditions: high Beaufort sea state (> 4), fog and precipitation/snow made it difficult to differentiate sightings among the whitecaps or through these weather layers.
- Moon phase: The clearest images through the NVD occurred during clear skies with full- or nearly full-moon conditions. New moon phases were considered less effective conditions for NVD use as were overcast skies.

G.5. IR Effectiveness

Fourteen detections were made during darkness using the IR. Based on these detections in darkness and previous use of IR for protected species monitoring from large vessels in the U.S. mid-Atlantic, the IR device can detect cetaceans at farther distances than the NVD. High contrast of white to a gray background with white indicating the temperature difference of an animal or blow allows for quick recognition of changes on the display. In addition, the IR is less influenced by ambient light from the vessel than the NVD; the IR allows for vision in areas obscured for NVD use by vessel light. The IR device worked best in calm sea conditions (Beaufort sea state <4).

G.6. Geophysical

The *Samantha Miller* operated during daylight hours only, and therefore, did not use IR technology. There were four IR detections during darkness made from the *Danielle Miller* where IR was the initial sighting method. Animals were observed on the IR display on two other occasions after the initial detection was made by another method, one by PAM and the other by NVD.

G.7. Geotechnical

The *Seacor Supporter* had four IR detections in darkness, one of which was initially detected by PAM. The three initial IR detections included a sea turtle at 72 m and again at 111 m; a

fin whale at 169 m; and a NARW at 1,251 m. The IR detection of the NARW allowed for approximately 10 min of observation until the animal moved out of the camera view, during which a series of distinct v-shaped blows were observed and documented (see Appendix H for IR image).

All seven of the IR detections made during the *Danielle Miller's* geotechnical survey efforts were initially made using IR and occurred during darkness. Five of the detections were unidentified dolphins; one IR-detected humpback whale; and one IR detection logged as an unidentified whale but reported to NMFS as a NARW. Like with the *Seacor Supporter's* NARW IR detection, only blows were visible. However, whereas the Seacor *Supporter's* orientation to the animal was straight on (i.e., perpendicular), the perspective from the *Danielle Miller* was from the side (i.e., parallel), increasing the difficulty with which to make a positive identification to species at 800 m (see Appendix H for IR image).

The following conditions reduced effectiveness of the IR system, as reported by PSOs:

- Viewing range limitations:
  - The vessel-mounted cameras captured an area of visibility that extended to the horizon, however, anything immediately next to the vessel was not visible.
  - A 210-degree area could not be captured by the IR cameras. Relying on NVDs to aid the visual effort over that area reduced the distance to which animals could be detected.
  - During exaggerated vessel pitching and rolling, the EZ was not in view for multiple seconds during each pitch and roll due to the fixed nature of the cameras, reducing viable detection time.
  - When panning past a large ship with many lights, the screen would turn black, limiting detections for the period it took the ship to pass or the panning angle to be beyond the ship.
  - The demarcation and horizon lines were thick enough as to possibly hinder animal detection when observed close to the line. The wording '500-meter demarcation' on the screen diverts attention from searching for detections and is unnecessary.
- Camera:
  - Camera limitations were most notable when identifying species, having difficulty tracking fast-moving, low-profile animals such as delphinids, which appeared as bright white streaks just above the surface as they porpoise through the water. Lack of definition in the image along with inability to distinguish shades of color on the animal made species identification very difficult since many delphinids are identified by color markings or head shape. Larger mammals (i.e., whales) were easier to identify to species due to distinct blow shapes and patterns, larger and identifiable body features exposed above the water, and slower and unique behavior of some species.
  - The cameras froze in position multiple times requiring several troubleshooting attempts until it eventually began panning again.
  - On occasion, when manual panning, the camera view onscreen would not switch directions with the manual arrows. It continued panning the direction it was already going.
- Humidity: Detectability decreased with an increase in relative humidity, apparent as a

loss of visual clarity and overall fogginess to the display image.

- Software:
  - The default playback software did not show the demarcation line on the recorded footage, making it difficult to determine exact distance of a detection. If an animal was near to the demarcation line when originally spotted, the PSO was unable to replay the recording with the demarcation line in view and only saw the normal view void of the mitigation area.
  - A buffer in the recording system is needed. By the time a PSO had observed something and hit the "record" button, the animal might have already dived out of sight. Adding a buffer to the recording would capture and limit the potential loss of sighting data.
  - The IR software system crashed when pausing or during image capture. This required a complete shutdown of the system to fix it. The two computers were set up on a synergy system, with two separate computers sharing one mouse and keyboard. This worked only until a computer froze, otherwise the computer that froze did not respond to the mouse or keyboard unless plugged directly into it. We recommend leaving the systems separate.

G.8. PAM Effectiveness

- Overall, PAM resulted in a detection rate of ≈2.3 detections/100 h of PAM effort.
- There were 16 total initial PAM detections; most occurred during darkness (Table 33).
- There were no 'LF' or 'HF' detections during the cruise. All detections contained signals characteristic of delphinid vocalizations, which are arbitrarily labeled as MF for the purposes of this report (Table 30).

The following conditions have the potential to reduce effectiveness of the PAM system:

- Sound sources: The operation of the geophysical sub-bottom profiler, S-Boom, USBL/Gaps system introduced wide-band background noise below 200 kHz with potential to mask the energy of marine mammal calls occurring in an overlapping frequency range. A masking effect on the LF ranges (10 kHz and below) had the potential to mask the LF calls of baleen whales such as the NARW and fin whale, unless their vocalizations were louder and/or at different frequencies. However, it is unlikely that MF vocalizations typical of the delphinid species would have been affected by the noise and were detected with PAM on multiple occasions.
- Environmental conditions: High Beaufort sea states, waves, and precipitation introduce background noise into the environment with potential for reducing the PAM system effectiveness. This can mask the energy of marine mammal calls occurring in overlapping frequencies. For this project operation, there was no direct evidence of call masking because of environmental noise; however, this effect is difficult to quantify and was not directly assessed for this project. It should be noted that, for the current operation, the effects of Beaufort sea state appeared negligible, as there was no apparent trend of decreasing PAM detections with increased Beaufort sea state based on preliminary data.
- Behavior: PAM-based detections rely on the presence of vocalizing marine mammals; however, vocalization rates can be highly variable as a function of activity (such as travelling vs. socializing or foraging), sex, season, and time of day. Therefore, marine mammals that may have occurred within the detection range of the PAM system were not detected by PAM if they were not vocalizing at that time.

- Species: Marine mammal species occurring in the Survey Area range from LF-calling (< 40 Hz) baleen whales to ultrasonic frequency (>150,000 Hz) calling porpoises. Sound propagation loss models suggest that baleen whale calls may be audible for 10+ km under many circumstances. However, the highly directional and rapid propagation loss characteristic of ultrasonic porpoise clicks may limit their detection distance to < 500 m. Given that only two harbor porpoises were visually detected during the project, we believe there is a low probability that porpoise detections via the PAM system were missed by the PAM technician.
- Hardware: Limited deployment options on the *Danielle Miller* posed an entanglement risk with the magnetometer or vessel props or rudders, as well as areas with dense fishing buoys/set nets.
- Software:
  - PAM computers lacked a valid sound file analysis program which required admin rights to install, which the PAM operators did not possess.
  - The screen capture program was inefficient, hindering real-time capture screenshots of enough and quality necessary for acoustic detection analysis.
  - Acquisition of specific offset values for calibrating the depth gauge were to be obtained online which is an inherent challenge with limited access to Internet offshore.

Appendix H North Atlantic Right Whale Sighting Reports

NARW
05 October 2018
Wind farm lease area (OCS-A 0482)
GZA Seacor Supporter
Felix Smith (Lead Protected Species Observer), Smultea Sciences
North Atlantic Right Whale detection

Sighting Details
Position: 38°35'39.2''N 74°40'33.3''W
Time: 04:11:42 EDT

A series of blows were seen on the Seiche IR Camera system on board the Seacor Supporter Lift Boat at 04:11 EDT on 05 October 2018. The first of these blows were distinctly V-shaped. In subsequent blows, although viewed from an angle, two distinct mist columns were visible. one IR camera picture was taken and is attached below.

The animal was seen 1251 m astern of the vessel, slowly moving in a northwesterly direction. After approximately 10 minutes the animal moved behind the ship's crane and was not able to be seen with the IR camera system.

At the time of the sighting the vessel was stationary, lifted out of the water on the jack-up legs. The vessel was taking on water to pre-load the ballast tanks, prior to the deployment of drilling equipment. No drilling activity was occurring during the sighting event. Deployment of the drill equipment did not begin until 09:30 EDT and drilling operations began at 14:41 EDT.

The sighting was reported via the Whale Alert application at 19:45 on 05 October 2018.

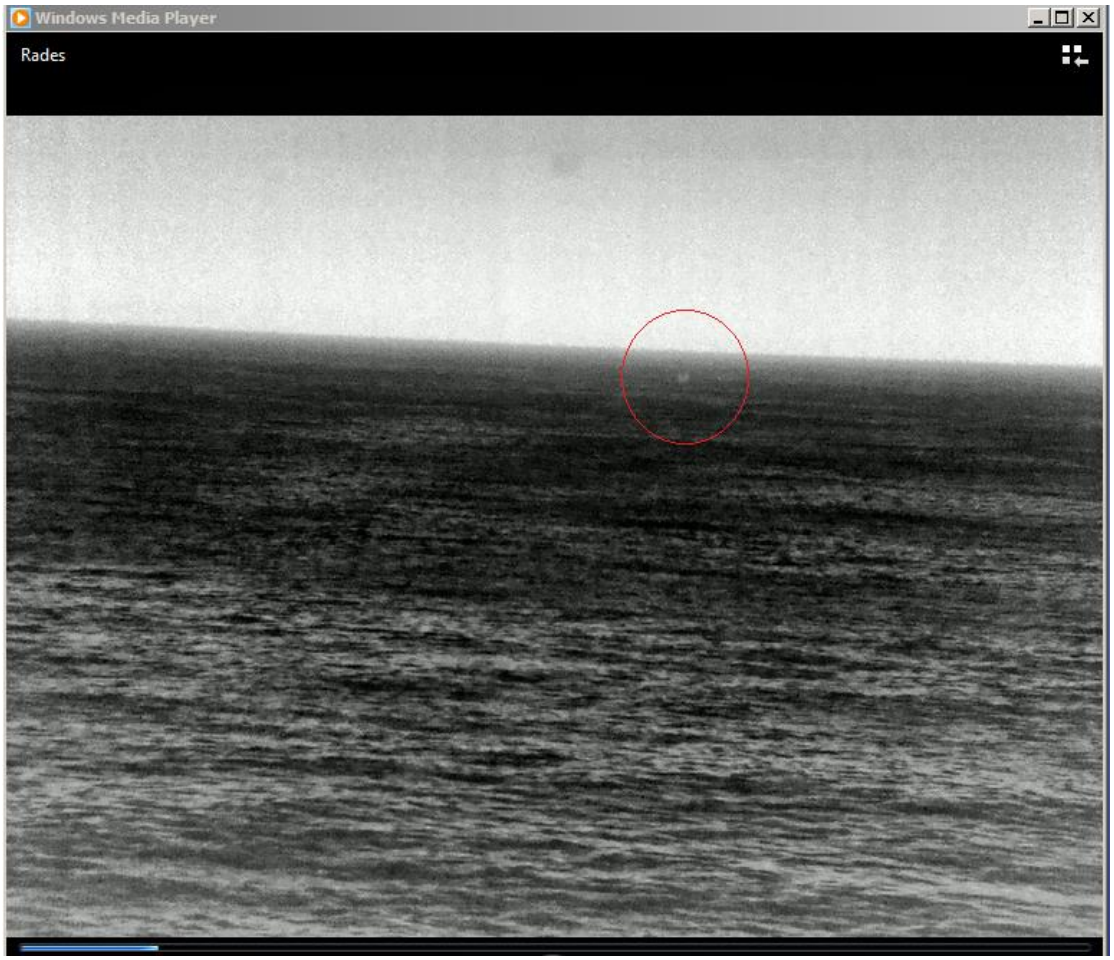

Figure 44. Infrared image of v-shaped North Atlantic right whale (*Eubalaena glacialis*) blow 1,251 m from the *Seacor Supporter* the night of 05 October 2018 during the Skipjack Wind Project.

Probable NARW
25 December 2018
Wind farm lease area (OCS-A 0482)
M/V *Danielle Miller*
Neil Duffy (Lead Protected Species Observer), Smultea Sciences
Probable North Atlantic Right Whale detection

Sighting Details
Position: 38°34'19.7''N 74°51'52.3''W
Time: 021:56:51.00 EDT

This sighting occurred with the Seiche IR Camera system utilizing the RADES program on board the Danielle Miller on December 25th, 2018.

Three blows were seen from the same whale. First at 21:56:51.00 EDT and distance of 800m. The second blow came at 21:58:02.00 EDT. The final blow was seen at the CPA distance of 500m at 21:59:07.3 EST. The video of this sighting taken with the RADES program captured the second and third blows. Still photos were taken of the paused clips in this video which indicate most strongly the shape of the blows.

The PSO assigned to the IR cameras saw the first blow prior to starting the recording and subsequent blows included in the video as they occurred. After reviewing the video several times, the PSO made the following comments in the Mysticetus data entry program:

"only the blow was observed, no body or dorsal fin. It was a relatively narrow blow and appears to be possibly V-shaped when looked at through the video. The whale appeared to be moving parallel with the vessel in the opposite direction. A faint blow was observed approximately 800 meters off the vessel's starboard side. Video recording began approximately 5 seconds later. A second blow was observed approximately 1:10 minutes later. The third and final blow was observed 1:04 seconds after the second blow. PSO attempted to re-sight whale by panning IR camera within a narrow range."

Based on the Lead PSO's review of the video I would have to agree with the IR PSO that this whale could be a North Atlantic Right Whale. Winds at the time of this sighting were between 10-15 knots. The shape of the second blow, starts and finishes with what appears to be two separated columns of misting water. The video was closely studied multiple times to see if a dorsal fin or any part of the body was visible at any time during the sighting, none were seen.

At the time of the sighting the vessel was stationary, having last completed coring operations at 21:08:12.9 EST. The vessel stayed at this location processing geotechnical tests on the last core taken. No equipment was deployed in the water at the time of the sighting.

The detection was reported to NOAA NMFS via the NOAA Fisheries Greater Atlantic Regional 24-hour Hotline (866.755.6622) at 08:33 EST on 26 December 2018.

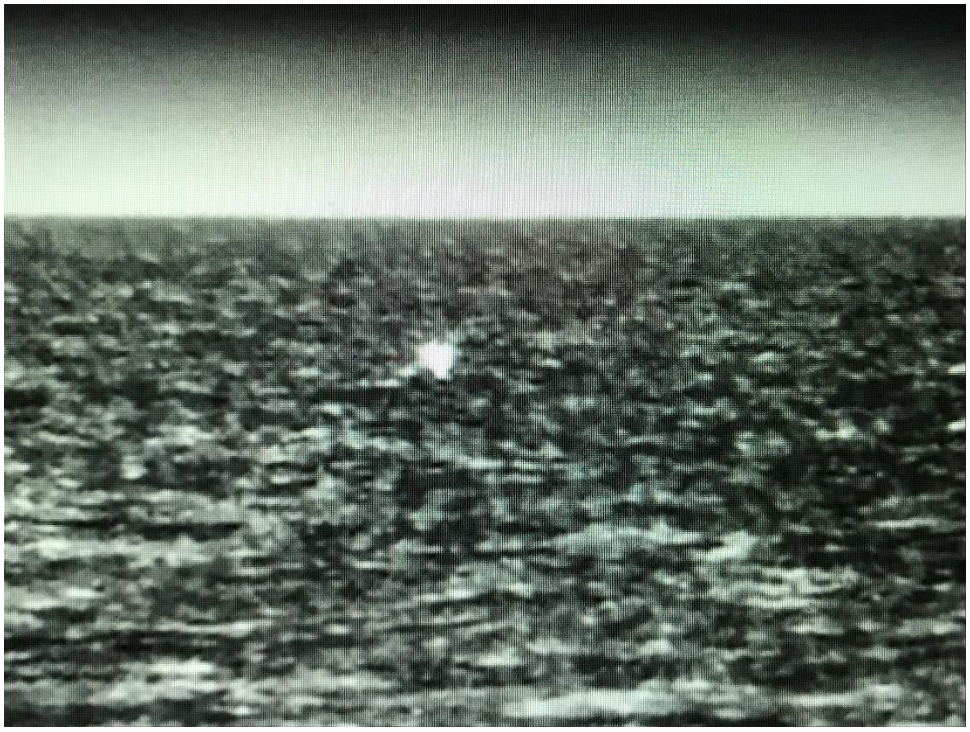

Figure 45. Infrared image of the beginning of the second v-shaped blow considered to be from a North Atlantic right whale (*Eubalaena glacialis*) 800 m from the *Danielle Miller* the night of 25 December 2018 during the Skipjack Wind Project.

Figure 46. Infrared image of the end of the second blow considered to be from a North Atlantic right whale (*Eubalaena glacialis*) 800 m from the *Danielle Miller* the night of 25 December 2018 during the Skipjack Wind Project.

Figure 47. Infrared image at the height of the third blow what was considered to be a North Atlantic right whale (*Eubalaena glacialis*) 500 m from the *Danielle Miller* the night of 25 December 2018 during the Skipjack Wind Project.

Appendix I Photographs

Figure 48. Leatherback turtle (*Dermochelys coriacea*) observed on 22 October 2018 from the *Danielle Miller* during the Skipjack Wind Project.

Figure 49. Adult and calf bottlenose dolphins (*Tursiops truncatus*) observed on 05 July 2018 from the *Samantha Miller* during the Skipjack Wind Project.

Figure 50. Blow of an unidentified whale (probable North Atlantic right whale, *Eubalaena glacialis*) observed at night on 25 December 2018 through the IR thermal cameras and RADES program from the *Danielle Miller* during the Skipjack Wind Project.

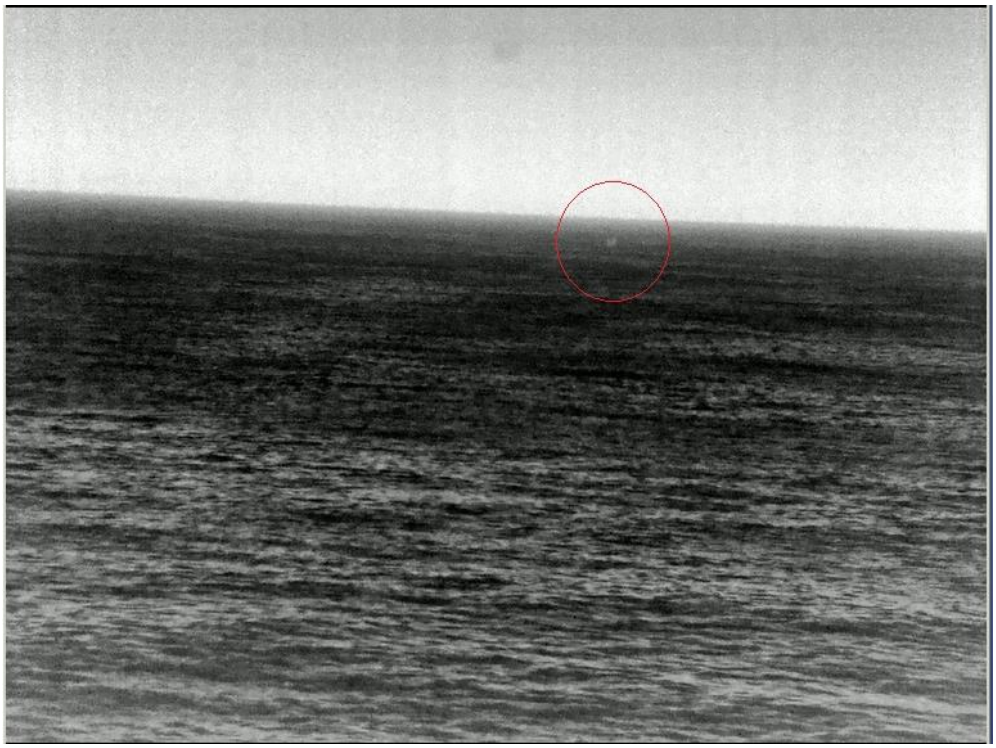

Figure 51. A North Atlantic right whale (*Eubalaena glacialis*) blow observed at night on 05 October 2018 through the IR thermal cameras and RADES program from the *Seacor Supporter* during the Skipjack Wind Project.

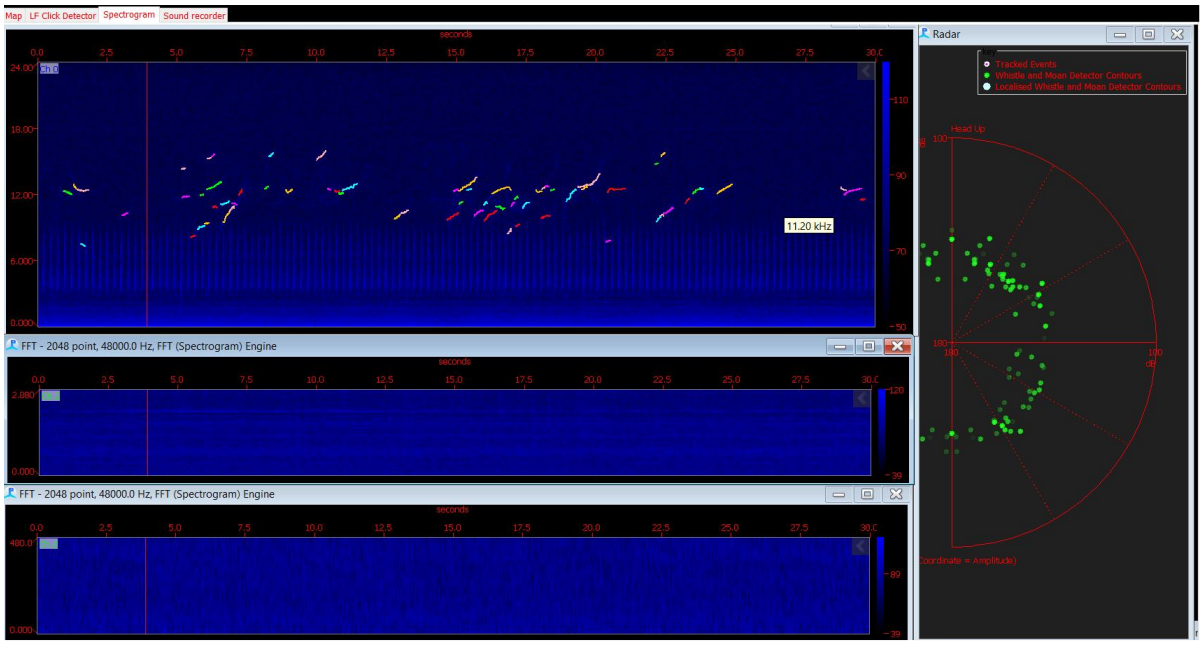

Figure 52. Spectrogram of unidentified dolphin whistles detected by the PAM system on the *Danielle Miller*.