Protected Species Observer Technical Report
OCW01 Geotechnical Investigation 1A
New Jersey (2017 & 2018)

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OCW01 Geotechnical Investigation 1A (2017/2018)
BOEM Lease OCS-A 0498

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Acronyms and Abbreviations

Bft	Beaufort
BH	Sampling Borehole
BOEM	Bureau of Ocean Energy Management
bsf	below sea floor
CPT	Cone Penetration Test
CPTU	Piezocone Penetration Test
DCPT	Downhole Cone Penetration Test
DMA	Dynamic Management Area
DP	Dynamic Positioning
DPT	Dynamic Positioning Thrusters
DVR	Digital Video Recorder
FUSAMI	Fugro USA Marine, Inc.
G&G	Geophysical and Geotechnical
h	hour
HRG	high-resolution geophysical
Hz	hertz
IHA	Incidental Harassment Authorization
IR	Infrared
ITS	Incidental Take Statement
kHz	kilohertz
MMPA	Marine Mammal Protection Act
m	meters
min	minute
M/V	Merchant Vessel
MZ	Monitoring Zone
NA IDQ	National Instruments Data Acquisition
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

NVD	Night Vision Device
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
POC	Point of Contact
PSO	Protected Species Observer
RB	Reticle Binoculars
RADES	Real-time Automated Distance Estimation Software
SAP	Site Assessment Plan
SMA	Seasonal Management Area
SSV	Sound Source Verification
TDOA	Time Difference of Arrival
UE	Unaided Eye
WTG	Wind Turbine Generator

1 Introduction

1.1 Background

Ørsted Wind Power North America, LLC (Ørsted) selected Fugro USA Marine, Inc. (FUSAMI) to conduct a geotechnical survey for the Ocean Wind project that began in November 2017. The geotechnical survey, herein referred to as *OCW01 Geotechnical Investigation 1A (2017 & 2018)* occurred off the coast of New Jersey the area of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0498), referred to throughout as the Lease Area (Figure 1).

The purpose of the geotechnical survey was to provide soils information to assist in development of the Ocean Wind Offshore Wind Farm (OCW01). The survey was conducted from the DP2 geotechnical deepwater vessel *M/V Fugro Explorer*. *M/V Fugro Explorer* is a 79.6-meter (m) research and survey vessel that uses a dynamic position 2 system (i.e. DP thruster (DPT)) (Figure 2).

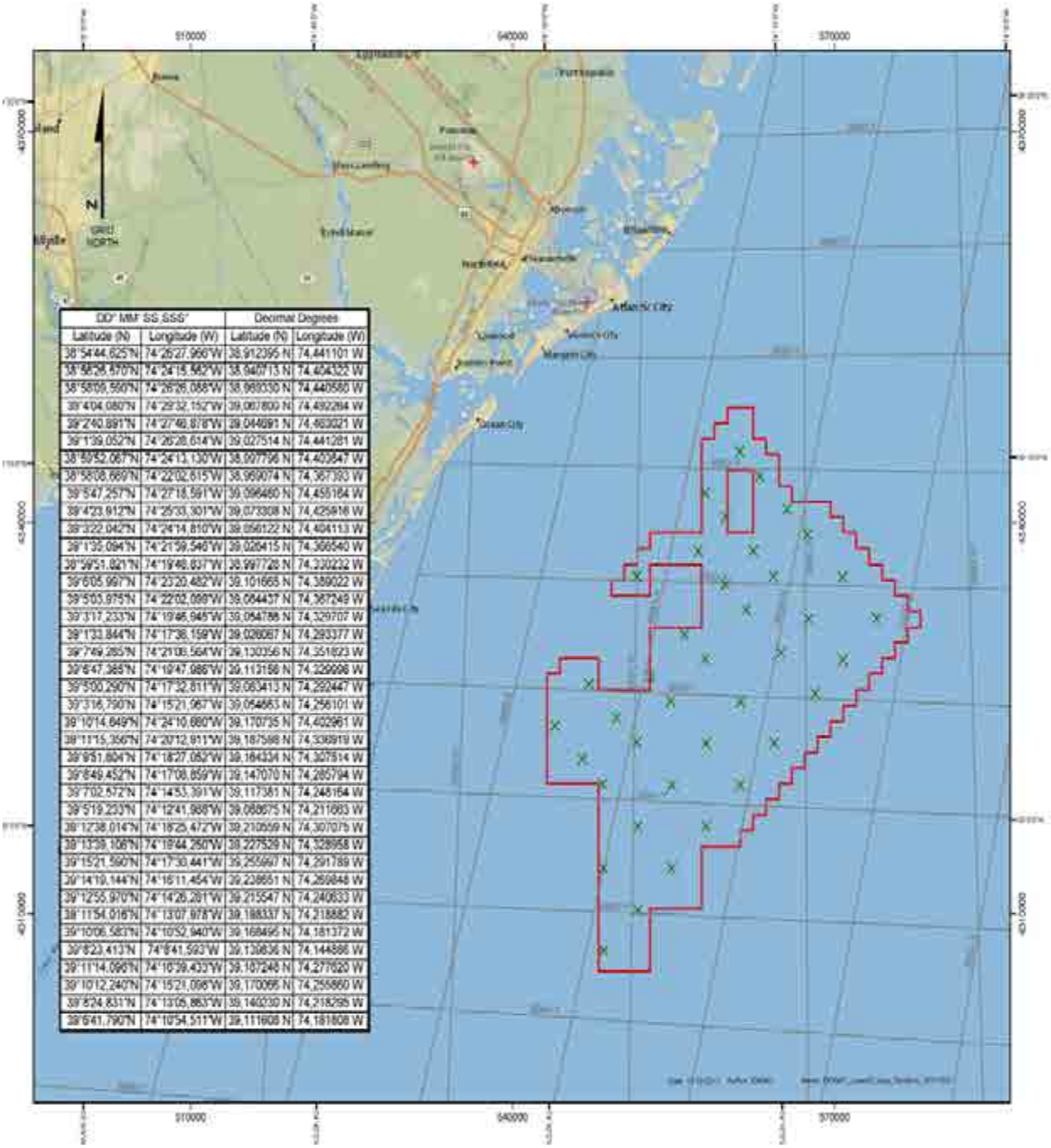
The scope of work for the geotechnical investigation involved the use of cone penetration tests (CPT) performed with piezocone penetration tests (CPTUs) and friction cones, and sampling boreholes (BH). The use of the piezocones and friction cones were performed in non-drilled and drilling mode. Non-drilling mode was used on Seabed CPTs (CPT), and drilling mode was performed in the downhole CPTs (DCPT) boreholes. The vessel used DPT to maintain position at each location during drilling, sampling, and testing operations. The vessel conducted these operations while on each site for a number of hours, moving consecutively to various pre-planned sites. DPT were engaged primarily during coring operations, but are also occasionally used during other vessel activities, including during weather or operational standby. The level of noise produced by the DPT ranges depending on the power level of engagement and sea conditions.

Smultea Environmental Sciences, LLC. (Smultea Sciences) was contracted by FUSAMI to conduct monitoring and mitigation for protected species including marine mammals, sea turtles and Atlantic sturgeon. Protected Species Observer (PSO) and Passive Acoustic Monitoring (PAM) services were provided, as required by the Bureau of Ocean Energy Management (BOEM) Lease OCS-A 0498 (https://www.boem.gov/NJ-SIGNED-LEASE-OCS-A-0498/). The primary on-site responsibilities of the PSO and PAM team were to monitor and implement mitigation measures to avoid and minimize potential adverse impacts to protected species by conducting visual observations 24 hour (h) per day and PAM during darkness and during daylight periods when the 500-meter (m) monitoring zone (MZ) vision was limited. Mitigation measures included (1) a 60-minute (min) "clearing" period of the 500-m MZ prior to starting DPT, (2) vessel strike avoidance protocol, and (3) North Atlantic right whale (*Eubalaena glacialis*) separation distance and seasonal operating procedures (detailed in Section 3.4.3), and (4) documentation of any injured or dead protected species observed during the survey, as described herein and in the BOEM Lease OCS-A 0498.

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) issued an Incidental Harassment Authorization (IHA) to Ocean Wind on 8 June 2017 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 high-resolution geophysical (HRG) and geotechnical survey investigations. NMFS also issued an Incidental Take Statement (ITS) for the project. The activities for the *OCW01 Geotechnical Investigation 1A (2017 & 2018)* permitted under the IHA and ITS are described in the project IHA application (www.nmfs.noaa.gov/pr/permits/incidental/energy/oceanwind_2017iha_issuediha.pdf) and Site Assessment Plan submitted to BOEM. The IHA authorized small numbers of takes from 8 June 2017 through 7 June 2018 of the following species; fin whale (*Balaenoptera physalus*), common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*), harbor porpoise (*Phocoena phocoena*), and harbor seal (*Phoca vitulina*). Prior to starting the geotechnical survey, an acoustic field verification test (i.e., Sound Source Verification [SSV]) was performed to assess sound source levels from the *M/V Fugro Explorer's* DPT and to determine if the proposed 500-m MZ identified in the NMFS IHA for the DPT was accurate (as required by BOEM and NMFS). The SSV report is provided in Appendix D.

The *OCW01 Geotechnical Investigation 1A (2017 & 2018)* was performed into two phases; *Phase 1* occurred from 29 November 2017 through 12 January 2018, including mobilization and demobilization and *Phase 2* occurred 22 May 2018 through 07 June 2018, including mobilization and demobilization.

This Protected Species Observer Technical Report addresses only the geotechnical survey reporting requirements as identified in the project IHA, ITS and BOEM Lease. The IHA is provided in Appendix C. For the purpose of this report "inside the Lease Area" is defined as any area within the OCS-A 0498 Lease Area (Figure 1) and "outside the Lease Area" is any area outside the OCS-A 0498 Lease Area.



DD° MM' SS.SSS"		Decimal Degrees	
Latitude (N)	Longitude (W)	Latitude (N)	Longitude (W)
38°54'44.625"N	74°26'27.966"W	38.912395 N	74.441101 W
38°56'26.670"N	74°24'15.562"W	38.940713 N	74.404322 W
38°58'09.560"N	74°26'26.088"W	38.969330 N	74.440580 W
39°4'04.080"N	74°29'32.152"W	39.067800 N	74.492284 W
39°2'40.891"N	74°27'49.878"W	39.044691 N	74.463021 W
39°1'39.052"N	24°26'28.614"W	39.027514 N	74.441281 W
38°59'52.067"N	74°24'13.130"W	38.997796 N	74.403647 W
38°58'08.669"N	74°22'02.615"W	38.969074 N	74.367393 W
39°5'47.257"N	74°27'18.591"W	39.096460 N	74.455164 W
39°4'23.912"N	74°25'33.301"W	39.073308 N	74.425918 W
39°3'22.042"N	74°24'14.810"W	39.056122 N	74.404113 W
39°1'35.094"N	74°21'59.546"W	39.026415 N	74.366540 W
38°59'51.821"N	74°19'46.637"W	38.997726 N	74.330232 W
39°6'05.997"N	74°23'20.482"W	39.101665 N	74.389022 W
39°5'03.975"N	74°22'02.099"W	39.084437 N	74.367249 W
39°3'17.233"N	74°19'46.945"W	39.054786 N	74.329707 W
39°1'32.844"N	74°17'36.159"W	39.026067 N	74.293377 W
39°7'49.285"N	74°21'08.564"W	39.130356 N	74.351823 W
39°6'47.365"N	74°19'47.086"W	39.113156 N	74.329698 W
39°5'00.290"N	74°17'32.811"W	39.083413 N	74.292447 W
39°3'16.790"N	74°15'21.967"W	39.054663 N	74.256101 W
39°10'14.649"N	74°24'10.880"W	39.170735 N	74.402961 W
39°11'15.356"N	74°20'12.911"W	39.187598 N	74.336919 W
39°9'51.804"N	74°18'27.082"W	39.164334 N	74.307514 W
39°8'49.452"N	74°17'08.859"W	39.147070 N	74.285794 W
39°7'02.572"N	74°14'53.391"W	39.117381 N	74.248164 W
39°5'19.233"N	74°12'41.988"W	39.088675 N	74.211663 W
39°12'38.014"N	74°18'25.472"W	39.210559 N	74.307075 W
39°13'39.108"N	74°19'44.250"W	39.227529 N	74.328958 W
39°15'21.590"N	74°17'30.441"W	39.255997 N	74.291789 W
39°14'19.144"N	74°16'11.464"W	39.238651 N	74.269848 W
39°12'55.970"N	74°14'26.281"W	39.215547 N	74.240833 W
39°11'54.016"N	74°13'07.978"W	39.198337 N	74.218882 W
39°10'06.583"N	74°10'52.940"W	39.168495 N	74.181372 W
39°8'23.413"N	74°8'41.593"W	39.139836 N	74.144886 W
39°11'14.096"N	74°16'39.433"W	39.187248 N	74.277620 W
39°10'12.240"N	74°15'21.096"W	39.170066 N	74.255860 W
39°8'24.831"N	74°13'05.883"W	39.140230 N	74.218295 W
39°6'41.790"N	74°10'54.511"W	39.111608 N	74.181808 W

Figure 1. Ocean Wind Lease Area BOEM OCS-A 0498 (red polygon) off New Jersey and project feature locations (x's indicate survey station locations as listed in box inset).

Figure 2. ***M/V Fugro Explorer.***

1.2 BOEM and NMFS Reporting Requirements

This Technical Report summarizes the information required by the IHA, ITS, and BOEM Lease (OCS-A 0498) as identified in Table 1. Data recorded in the field were provided to FUSAMI and Ørsted in an Excel database, and include the specific data elements identified in Appendix B of BOEM Lease OCS-A 0498.

Table 1. NMFS and BOEM Protected Species Reporting Requirements.

Document	Required Content	Online Location	Source Reference in Document
NMFS Incidental Harassment Authorization (IHA) 08 June 2017 – 08 June 2018	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.	www.nmfs.noaa.gov/pr/permits/incidental/energy/oceanwind_2017iha_issuediha.pdf	Section (iii) (d)
	In addition to the Holder's reporting requirements outlined above, the Holder 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 (ITS)	BOEM must require Ocean Wind to report all project-related observations of listed species to NMFS Greater Atlantic Region.	https://www.greateratlantic.fisheries.noaa.gov/protected/section7/bo/biological_opinions.html	Section 11.5.2 (Reasonable & Prudent Measures 3.)
	BOEM must submit a report to NMFS detailing the activities that occurred pursuant to the SAP that were subject to this consultation and any impacts to 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-hr.		Section 11.5.2 (Terms & Conditions 4.)
	Submit to NMFS Greater Atlantic Region a report documenting survey activities along with a detailed description of any observation and/or takes of ES- listed		Section 11.5.2 (Terms & Conditions 5.b.)

	species including ESA-listed whales.		
BOEM Lease OCS-A 0498	The Lessee must provide BOEM and NMFS with reports every 90-calendar days following the commencement of HRG and/or geotechnical exploration activities, and a final report at the conclusion of the HRG and/or geotechnical exploration activities. Each report must include a summary of survey activities, all protected species observer and incident reports (See Appendices A and B), 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.		Section 4.5.4
	REQUIRED DATA ELEMENTS FOR PROTECTED SPECIES OBSERVER REPORTS The Lessee must ensure that the protected-species observer 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; 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; and 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 meters); and		Appendix "B"

	d. Overall visibility (poor, moderate, good). 7. Species (or identification to lowest possible taxonomic level); 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); 14. Activity of vessel when sighting occurred.		

2 Survey Overview

2.1 Summary of Geotechnical Survey Activities

As stated in the Introduction, the *OCW01 Geotechnical Investigation 1A (2017 & 2018)* was completed into two phases; *Phase 1* occurred from 29 November 2017 through 12 January 2018, including mobilization and demobilization and *Phase 2* occurred 22 May 2018 through 07 June 2018, including mobilization and demobilization. Details of the survey schedule are provided in Table 2.

The complete scope for OCW01 Geotechnical Investigation 1A (2017 and 2018) for *Phase 1* and *Phase 2* aboard the *M/V Fugro Explorer* included 38 seabed cone penetration tests (CPT), eight (8) downhole CPT boreholes and eight (8) sample boreholes (excluding alternate and retest locations). The *M/V Fugro Explorer* utilized DPT during drilling, sampling and testing operations. DPT produced in-water sound that required protected species monitoring and mitigation per BOEM Lease OCS-A 0498 and the NMFS IHA.

During *Phase 1* PSOs and PAM Operators boarded the *M/V Fugro Explorer* on 29 November and began 24-hour (h) PSO visual monitoring effort on 2 December. Monitoring occurred throughout transits (to and from) and during the SSV until disembarking of the SSV team on 3 December. PSO visual effort recommenced on 6 December when the vessel left port to transit to the first geotechnical Seabed CPT operation location within the Lease Area, at which time PAM effort began.

During *Phase 2* PSOs and PAM Operators boarded the *M/V Fugro Explorer* on 21 May 2018 and began 24-h PSO visual monitoring effort on 22 May, including during transits to and from the Lease Area.

While PSO visual effort occurred 24-h per day throughout the survey, PAM effort occurred only at night while the vessel was on station conducting non-drilling and drilling operations, and during daylight hours when visibility was limited (i.e. fog). The only exception to 24-h visual observations occurred near port on occasions when the Pilot or Bridge Crew requested the bridge be cleared for transit through New York Harbor and an alternative viewing platform was not available (Figure 5). Totals in this report represent data collected during *Phase 1* for the 42 survey days between 2 December and January 12 (dates inclusive) and *Phase 2* are for the 17 survey days between 22 May and 7 June (dates inclusive).

Table 2. Phase 1 and Phase 2 ummary of event dates during the *OCW01 Geotechnical Investigation 1A (2017 & 2018).*

Event	Date
OCW01 Geotechnical Investigation 1A (2017 & 2018): Phase 1	
M/V Fugro Explorer mobilization at Port Elizabeth, New Jersey; PSO and PAM team board the vessel	29 November 2017
Mobilization and kick off meeting	29 November 2017
Depart Port Elizabeth and transit to Lease Area with PSO visual effort	2 December 2017
Sound Source Verification (SSV) with 24-h visual effort (no PAM effort)	2-3 December 2017

Event	Date
SSV Initial Report submitted to BOEM	
Ocean Wind received confirmation and permission from BOEM to start geotechnical survey after SSV deemed complete	6 December 2017
Geotechnical operations involving CPT, SCPT, DCPT and BHs operations, 24-h PSO visual effort starting and ending at port. PAM during geotechnical operations while vessel is on DPT with limited visibility.	6 December 2017 – 11 January 2018
Demobilization at Port Elizabeth, PSO/PAM monitoring complete	12 January 2018
OCW01 Geotechnical Investigation 1A (2017 & 2018): Phase 2	
MODU Fugro Explorer mobilization at Port Elizabeth, New Jersey; PSO and PAM team board the vessel	21 May 2018
Geotechnical operations involving CPT, SCPT, DCPT and BHs operations, 24-h PSO visual effort starting and ending at port. PAM during geotechnical operations while vessel is on DPT when 500-m EZ not fully visible (e.g., fog)	22 May – 7 June 2018
Demobilization at Port Elizabeth, monitoring complete	7 June 2018

3 Monitoring and Mitigation Program

This section describes the protected species monitoring and mitigation measures implemented to address requirements specified in the NMFS-issued IHA and ITS and BOEM Lease requirements. The *Mysticetus*™ Observation Software (*Mysticetus*™) data collection template used during the survey contained prompts for all the BOEM- and NMFS-required data elements, including those identified in Table 1 and Appendix B of the project BOEM Lease. All data recorded in the field was provided to FUSAMI and Ørsted in an Excel database, including the specific data elements identified in Appendix B of BOEM Lease OCS-A 0498 (Table 1).

3.1 Protected Species Observers

During the *OCW01 Geotechnical Investigation 1A (2017 & 2018),* four PSOs and two PAM technicians were stationed on the *M/V Fugro Explorer* and were responsible for monitoring for protected species and requesting associated 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 direct field experience on a protected species observation vessel and/or aerial surveys in the Atlantic Ocean/Gulf of Mexico. Credentials of PSOs/PAM technicians were provided to and approved by Ørsted, BOEM and NMFS prior to the start of field project observations. PSOs were trained on specific project details and requirements and were provided with/trained in sighting identification information for protected species (i.e., marine mammals, sea turtles and Atlantic sturgeon) occurring in the Lease Area prior to mobilization. Species identification guides and references were available at the PSO station on the vessel.

3.2 Visual Observation Methods

Four visual PSOs were stationed on the *M/V Fugro Explorer* to monitor for protected species prior to, during, and after geotechnical activity. Visual observations also occurred during all periods when geotechnical activity did not occur. PSOs rotated observation shifts every 1–4 h to effectively monitor the Lease Area, implement mitigation measures, and avoid observer fatigue. Visual observations by one or two observers occurred 24-h/day covering periods of daylight and darkness. Detailed information on all protected species sightings was recorded.

PSOs visually monitored using three different methods (further details are provided in later subsections):

1) Unaided (i.e., naked) Eye (UE). (During daytime, this included occasional use of Fujinon™ 7 × 50 reticle binoculars (RB) to provide a closer look at visual sightings to identify species, composition, etc. During darkness, UE was used to monitor for protected species in in waters artificially illuminated by the vessel's lights.)
2) FLIR Command hand-held bi-ocular Infrared (IR) device
3) PVS7 Generation III Armasight night vision device (NVD)

PSOs monitored for protected species from outside on the bridge wings when weather permitted; during extreme weather conditions (e.g., snow, freezing rain), PSOs observed from inside the bridge, alternating with short periods outside the bridge. PSOs used the bridge because it was the best available vantage point on the vessel in terms of height above sea level, percent of 360° view, and shelter from inclement weather. It also allowed direct communications with the bridge crew and operations team. Occasionally, PSOs observed from the monkey deck and the bow during darkness when the vessel's operating lights (on the bridge deck and stern) interfered with the detection effectiveness of the NVD.

Vessel stern operating lights remained on during all periods of darkness for safety reasons. Bridge operating lights were kept on as directed by the Vessel Captain (as communicated to the PSO/PAM Manager) for safety reasons from 2 December until the 17 December crew change. After Dec 17, the Vessel Captain agreed to keep the bridge operating lights off whenever possible, as requested by the PSO/PAM Manager, to minimize interference with the detection ability of the NVD and IR bi-oculars. When the bridge operating lights were on during darkness, waters within approximately 30-50 m from the vessel were illuminated sufficiently for the PSOs to observe for protected species using the UE (representing up to approximately 10-15 percent of the area within view from near mid-ships forward). When the stern operating lights were on during darkness, waters within approximately 30-50 m from the vessel were illuminated sufficiently for the PSOs to observe for protected species using the UE (representing approximately 35 percent of the area within view). When both the stern and bridge operating lights were on, up to approximately 50 percent of waters within 30-50 m of the vessel were sufficiently illuminated for UE observations.

During geotechnical operations while the vessel was on station (i.e. CPT, DCPT or BHs), observers monitored a 360° area around the vessel. While underway (while the vessel was moving between geotechnical locations, or in transit to/from port), observations focused forward and to the sides of the vessel in an arc of ~180° from the bridge. PSOs also regularly scanned in a sweeping pattern for the presence of protected species astern of the vessel while the vessel was underway. Crew aboard the vessel watched for protected species (insofar as practical) and alerted the PSOs in the event of a sighting.

3.2.1 Unaided Eye (UE)

During daylight hours, PSOs systematically scanned around the vessel in a sweeping pattern primarily with the UE, occasionally sweeping with the RB (Fujinon™ 7 × 50). RB were used as possible to confirm species identification, distance to sighting, group composition/size, and behavior, by providing reticles and magnification stronger than possible with the UE (the trade-off for increased magnification using the RB was a narrower field of view than the UE). UE monitoring occurred during darkness when the vessel operating lights (i.e., artificial lights) lit up the water sufficiently to see protected species (as described in Section 3.2, above).

3.2.2 Night Vision Device (NVD)

Visual monitoring during darkness occurred using the UE, supplemented with a pair of PVS7 Generation III Armasight night vision device (NVD) binoculars used in conjunction with an

IR light-emitting diode spotlight. Observers positioned themselves in areas of the vessel where vessel floodlight interference with the NVD could be minimized, weather allowing (e.g., primarily on the bridge outside the wheelhouse, and occasionally the monkey deck or the bow). When using the NVD, PSOs systematically scanned around the vessel in a sweeping pattern, alternating scan sweeps between the UE and NVD. During *Phase 1* PSOs scanned with the NVDs approximately 5 min in every 30 min period and the remaining 25 min of UE scans (NVD effort shown in result tables for *Phase 1* reflects the total hours of cumulative from 5 min out of 30-min scans). During *Phase 2* PSOs scanned with the NVDs approximately 25 min out of every 30 min period and the remaining 5 min of UE scans (NVD effort shown in result tables for *Phase 2* reflects the total hours cumulative from 25 min out of 30-min scans). PSOs did not keep detailed notes of exact start and end times of UE versus NVD use, as the primary objective of observers was to detect and mitigate for protected species.

3.2.3 FLIR Infrared (IR) Device

Visual monitoring during darkness and some periods of daylight occurred with an IR system consisting of a FLIR Command hand-held bi-ocular IR device with attachable digital video recorder (DVR) for capturing images or video. Observers positioned themselves primarily on the bridge outside the wheelhouse (weather permitting), and occasionally the monkey deck or the bow. When using the IR device, PSOs systematically scanned around the vessel in a sweeping pattern, alternating scan sweeps between the UE and IR. During Phase 1 PSO scanned approximately 5 min in every 30 min period and the remaining 25 min of UE scans (IR effort shown in result tables for Phase 1 reflects the total hours of cumulative from 5 min out of 30-min scans). During Phase 2 PSOs scanned approximately 15 min out of every 30 min period and the remaining 5 min of UE scans (IR effort shown in result tables for Phase 2 reflects the total hours cumulative from 15 min out of 30-min scans). As with NVD use, PSOs did not keep detailed notes of exact start and end times of UE versus IR use in order to prioritize observing for protected species.

3.2.1 Mysticetus Observation Software

Mysticetus™ was used to record visual PSO data and integrate data in real time from all platforms (PAM, IR, NVD, Visual) into one database and shared map display. *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 PC screen immediately after data are entered by the user (www.mysticetus.com). *Mysticetus*™ also provided screen/map-sharing of detection occurrences, locations, and/or species, etc., between PSO visual detections (UE, NVD, IR) and PAM detections. This helped quickly cue in the PAM and visual teams to detections and identify shared detections. *Mysticetus*™ automatically plotted DMA polygons on the PSO maps, approved by Ørsted.

3.3 Passive Acoustic Monitoring Methods

PAM for marine mammals was conducted using a vertically deployed hydrophone array consisting of a wide-band acoustical recording and analysis system. This PAM system was designed to document vocalizations of all cetacean species ranging from low-frequency

baleen whale calls to ultra-sonic porpoise clicks. Real-time PAM for cetaceans during survey operations was conducted by deploying a 250-m vertical hydrophone array (MSeis® Night Hawk III) containing 4 wideband pre-amplified hydrophones with a flat frequency response from 6 hertz (Hz) to 180,000 Hz +/- 3 decibels (dB) and a sensitivity of -171 dB (re: 1 V/µPa) (Figure 3). The array also contained one depth sensor that provided real-time data via the array cable. Hydrophone spacing between the four sensors in the array was based on the following configuration:

a. 1.5 m between hydrophone 1 and hydrophone 2
b. 6 m between hydrophone 2 and 3
c. 1.5 m between hydrophone 3 and hydrophone 4

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

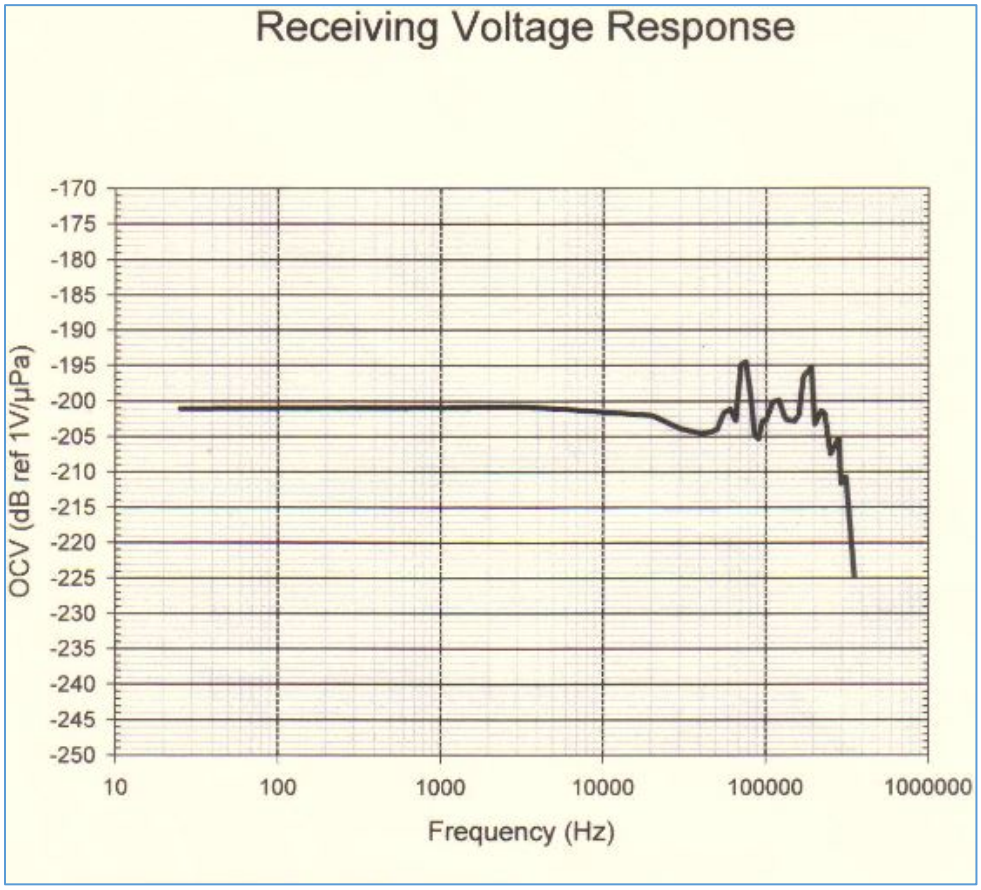


Figure 3. Receiving voltage response of passive acoustic monitoring (PAM) hydrophones with a flat frequency response from 6 Hz–180,000 Hz +/- 3 dB and a sensitivity of -201 dB (re: 1V/µPa) prior to 30 dB pre-amplification.

The PAM system was deployed from a mid-ships location on the vessel using a static, vertical array cable while the vessel was stationary "on station" to conduct geotechnical operations (involving DPT to maintain vessel position during CPTUs and borehole drilling). The vertical array deployment 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. Thus, in practice, distance estimation from the 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 (rudders, thrusters) while the vessel was stationary.

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

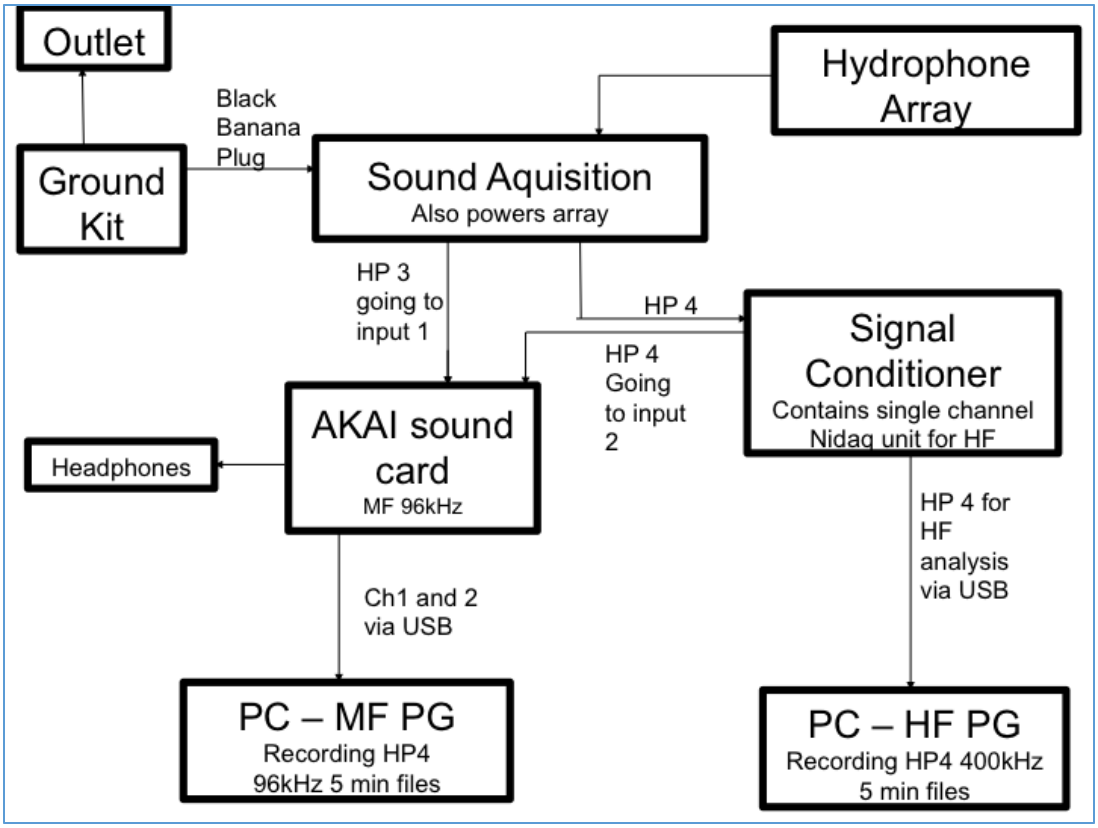


Figure 4. Passive acoustic monitoring (PAM) system set up diagram.

PAMGuard™ software was used to monitor, detect, and classify vocalizing marine mammals in near real-time via custom-designed routines for high frequency, mid-frequency, and low-frequency. 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 via the Akai EIE pro headphone output and visually using both manual and automated techniques (Figure 4). Trained acoustic technicians actively scanned three simultaneous, real-time scrolling spectrograms optimized for low, mid- and high frequencies (6 Hz–3 kHz, 3 kHz–48 kHz, and 48 kHz–200 kHz, respectively) for marine mammal vocalizations. 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 on duty. The lead PSO would attempt to visually confirm the acoustic detection and would also implement the necessary mitigation procedures.

3.4 Mitigation Measures

Distance to protected species and geotechnical operations and/or activity of the vessel determined the specific procedures to follow when protected species were visually sighted and/or acoustically detected. The following mitigation measures were implemented as feasible/safe to avoid causing injury, death, or significant disturbance of protected species as specified in the IHA and BOEM Lease.

3.4.1 DPT

The original MZ for DPT operations during the *OCW01 Geotechnical Investigation 1A (2017 & 2018),* was identified in the NMFS-issued IHA as a 500-m radius based on SSV tests conducted previously (described in the Ørsted NMFS IHA application for this project: https://beta.fisheries.noaa.gov/action/incidental-take-authorization-ocean-wind-marine-site-characterization-surveys-offshore-nj). However, results of the 2017 acoustic field verification test (i.e., SSV) for the *M/V Fugro Explorer* vessel DPT used for this project off New Jersey indicated that the NMFS-regulated 120-dB re 1 µPa (rms) isopleth distance for continuous sound relative to potential behavioral disturbance of marine mammals exceeded the original 500-m MZ. After Ørsted consultation with both BOEM and NMFS, including regarding the acoustic field verification results, it was recognized that powerdown or shutdown for the DPT was not feasible without endangering vessel crew and equipment safety. Thus, powerdown or shutdown of the DPT was not requested by the PSOs nor conducted after consultation with NMFS and BOEM after the SSV was conducted. However, NMFS and BOEM directed Ørsted to continue to monitor the numbers of marine mammals and sea turtles detected within view of the vessel during DPT operations, and to continue to implement the 60-min clearance period prior to start-up of the DPT any time the DPT had not been engaged (i.e., operating) for >20 min. The PSO team thus followed this protocol throughout the survey 24-h/day. PSOs also monitored and recorded the power level of the DPT.

DPT were operated while conducting CPTs, DCPT and sampling BH while the vessel was stationary on each station, as the DPT were used to maintain the vessel's position during these activities. However, the DPT were also operated on some occasions during transits between stations primarily inside the Lease Area to assist in vessel maneuvering and speed, and also during periods of inclement weather to help maintain the vessel's position relative to large waves/seas, predominant winds, etc.

3.4.2 Vessel Strike Avoidance

At all times when the vessel was underway, the vessel operator was required and advised by the PSOs on duty to maintain the following separation distances to avoid potential vessel strikes (as required by the BOEM Lease and the NMFS IHA):

- 500 m from any sighted North Atlantic Right Whale
- 100 m from non-delphinoid cetacean (i.e., mysticetes and sperm whales)
- 50 m from any delphinoid cetacean

If a delphinoid cetacean approached the vessel (for instance, bow riding), the vessel operator continued on course rather than attempting to change course.

3.4.3 North Atlantic Right Whale Measures

Mitigation measures specific to North Atlantic right whales were implemented during the survey as required by the BOEM Lease and Survey Plan and the NMFS IHA: (1) a 500-m separation distance (Section 3.4.2), and (2) Seasonal Operating Requirements.

Per the Seasonal Operating Requirements, PSOs regularly monitored for the presence of any Dynamic Management Areas (DMA) and the presence of North Atlantic right whales in or near the Lease Area. This was done by the lead PSO on duty at least every 4 h over each 24-h period and involved checking the NMFS North Atlantic right whale reporting systems (e.g., via the NMFS website and/or application Whale Alert). Had a DMA occurred in or near the Lease Area, the Lead PSO would immediately have informed the designated point of contact (POC) on the vessel, which would have notified Ørsted. Each time a DMA check was undertaken by the PSO, a column was marked with an "x" in the Mysticetus data entry form on the laptop, and was automatically associated with a date, time and GPS position and any relevant comments. Prior to survey start, it was determined that the nearest Seasonal Management Area (SMA) was located outside the area of operations/Lease Area for the survey vessel during geotechnical survey operations.

PSOs also requested and monitored that the *M/V Fugro Explorer* was operated at speeds of 10 knots or less to comply with seasonal restrictions for operation of vessels greater than 65 feet (19.8 m) in length in the region from November 1 through July 31 for the North Atlantic right whale.

In addition, PSOs on the vessel were directed to prepare a 1-page written summary of sighting details for any North Atlantic right whales detected from the vessel (including any photos), so that Ørsted could submit this information to NMFS. The lead PSO, when directed by Ørsted, also entered sighting data for any North Atlantic right whales seen from the vessel into the Whale Alert application or reported sightings to NMFS.

3.5 Effort, Sighting and Detection Rate Methods

The PSO data collection protocol included documenting all sightings and protected species monitoring effort (UE, NVD, IR, and PAM) during both survey and non-survey periods (for definitions see Table 3). All data identified in the project IHA and Lease were collected on a pre-determined data template on a laptop using *Mysticetus*™ (Table 1). Mysticetus automatically plotted sighting locations on a bathymetric map relative to the vessel and the MZ based on bearing and reticle or distance data input. Data on protected species sightings are presented to the species level whenever possible in species summary tables.

Table 3. Definitions of data collection and analysis terminology.

UE Effort	Periods when at least one PSO was visually monitoring with unaided eye and reticle binoculars
NVD Effort	Periods when at least one PSO was visually monitoring with the NVD: • *Phase 1* approximately 5 min in every 30 min period and the remaining 25 min of UE scans (NVD effort shown in result tables reflects the total hours of cumulative from 5 min out of 30-min scans) • *Phase 2* approximately 25 min out of every 30 min period and the

	remaining 5 min of UE scans (NVD effort shown in result tables reflects the total hours cumulative from 25 min out of 30-min scans)
PAM Effort	Periods when one PAM technician was acoustically monitoring.
IR Effort	Periods when at least one PSO was visually monitoring with the IR camera system: • *Phase 1* approximately 5 min in every 30 min period and the remaining 25 min of UE scans (IR effort shown in result tables reflects the total hours of cumulative from 5 min out of 30-min scans) • *Phase 2* approximately 15 min out of every 30 min period and the remaining 5 min of UE scans (IR effort shown in result tables reflects the total hours cumulative from 15 min out of 30-min scans)
DPT On Effort	Periods when at least one visual PSO or PAM occurred while DP thrusters were in operation.
DPT Off Effort	Periods when at least one PSO was visually or acoustically monitoring while DP thrusters were not in operation (i.e., during transit to/from port outside the Lease Area and between survey stations inside the Lease Area).
Inside Lease Area Effort	Periods when at least one PSO was visually or acoustically monitoring while within the OCS-A 0498 Lease Area
Outside Lease Area Effort	Periods when at least one PSO was visually or acoustically monitoring while outside the OCS-A 0498 Lease Area (i.e. transit to/from port)
Group (i.e., Sighting)	One or more individuals seen close together and coordinated in a similar manner (coordinated surfacing, orientation, behavior, etc.).
UE Sightings(s)	The number of protected species groups (or individuals) sighted through UE (or reticle binoculars).
NVD Sighting(s)	The number of protected species groups (or individuals) sighted through NVDs
IR Sighting(s)	The number of protected species groups (or individuals) sighted through 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 or IR-confirmed group size. Thus, default group size was considered 1.
UE Detection Rate	The number of protected species groups (or individuals) sighted through UE (or reticle binoculars) per hour of PSO UE effort.
NVD Detection Rate	The number of protected species groups (or individuals) visually sighted using the NVDs per hour of NVD effort.
IR Detection Rate	The number of protected species groups (or individuals) visually sighted using IR per hour of PSO IR effort.
PAM Detection Rate	The number of protected species groups (or individuals) acoustically detected (defined above) per hour of PAM effort.

Protected species movement relative to the vessel, as well as initial and secondary behavior states/events (Altmann 1974), were recorded for each protected species sighting based on pre-defined protocol and ethograms provided to the PSOs. Initial behavior states included mill, travel, surface-active mill, surface-active travel, rest, and unknown/other. Behavioral descriptions followed those described in numerous other 90-day reports associated with oil

and gas and geotechnical and geophysical (G&G) operations (e.g., Aerts et al. 2008; Blees et al. 2010; Lomac-MacNair et al. 2013).

The distribution of sightings relative to the source vessel was assessed using several variables including bearing and distance, initial and subsequent re-sight distances, and Closest (observed) Point of Approach (CPA) of the animal(s) to the source vessel.

Environmental variables were recorded every 30 min, when conditions changed, and during a protected species sighting. Environmental variables included all those identified in Table 1.

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 the unaided eye were feasible typically corresponded with the nautical twilight periods.

3.5.1 Detection Rates

A "detection" is defined as a group of one or more individuals detected visually (UE, NVD, IR) or acoustically by PAM. Detection rates of protected species were calculated as the number of groups visually observed or acoustically detected per hour of effort throughout the study period (as defined in Table 3). To maximize sample size, detection rates for all pooled detections (i.e., both inside and outside the Lease Area) were used to assess and compare effectiveness of the various equipment used to detect protected species, as required by the BOEM Lease and Alternative Monitoring Plan and by the NMFS IHA (see Appendix F). Hours were used for sighting rate analysis because distance (km) was not considered appropriate in this case, given that the vessel alternated between being stationary at survey stations and underway between survey stations and to/from port. A PAM detection that was not visually confirmed (including via IR or NVD) and thus group size was undetermined, was recorded as a minimum estimate of one individual.

3.5.2 Estimating Number of Exposures

NMFS considers exposures of cetaceans and pinnipeds to continuous anthropogenic received sound levels ≥ 120 dB (rms) and impulsive sound levels >160 dB (rms) to be a "take by harassment" (Level B harassment) that could potentially result in disturbance of these animals (NMFS 2005, 71 FR 50027).

Activities during the *OCW01 Geotechnical Investigation 1A (2017 & 2018)* included CPTs, borehole operations, and the use of DPT to maintain vessel position during CPTs and BH operations. In a letter to Ørsted dated 28 December 2017, NMFS advised that given the small size and energy footprint of CPTUs as well as the nature of the borehole operations, it is unlikely that noise from these activities would contribute significantly to the overall sounds emanating from the vessel (or DPT) or exceed the Level B harassment threshold for impulsive sounds at any appreciable distance.

Per the NMFS letter to Ørsted (see above), while NMFS has authorized take that could result from DPT in a few cases in the past, they have re-evaluated and are clarifying their recommendation in relation to this source type. Monitoring of past DPT projects has shown a lack of observed marine mammal responses. Sound produced through use of DPT is similar to that produced by transiting vessels. DPT are typically operated in a similarly predictable manner, either being used for short durations around stationary activities or being used to

maintain a slow steady speed for activities such as pipe-laying. Generally speaking, NMFS does not anticipate the need for an MMPA incidental take authorization for the use of DPT in the absence of activity-, location-, or species-specific circumstances that would cause greater concern (such as, potentially, activities proposed in an area known to be of critical importance and concentration for a species), or without associated activities that might result in take when combined with the DPT use, and neither of those circumstances was present during this *OCW01 Geotechnical Investigation 1A (2017 & 2018).*

The number of potential exposures to DPT during the *OCW01 Geotechnical Investigation 1A (2017 & 2018)* was based on direct observations/counts and separate acoustic detections of protected species within the distance categories of 1) <500 m, 2) 500-1000 m, and 3) >1000 m.

4 Results

4.1 Phase 1 Results

Phase 1 protected species monitoring effort, distribution, and sighting data inside and outside the Lease Area based on various conditions (e.g., darkness vs. daylight; DPT on vs. DPT off) is presented in Figures 5-17 and Tables 4-13. Results specific to requirements of the BOEM Alternative Monitoring Plan including detection rates are presented in Appendix D *Alternative Monitoring Plan Effectiveness Report* including Tables 14-18.

4.1.1 Phase 1 Monitoring Effort

All monitoring effort (pooled for areas inside and outside of the Lease Area) is summarized in Table 4 by night (darkness) and day periods based on the four monitoring methods: 1) UE, 2) IR, 3) NVD, and 4) PAM. A total of 2,303.2 h of monitoring effort occurred during the 42 days of survey using the four detection methods. Most of this time was overlapping/simultaneous, e.g., when PAM and visuals were concurrent, etc. Thus, to differentiate and compare detection methods, effort hours were totaled separately for each person on watch by type of monitoring method. Most effort (88 %) was conducted using visual methods (UE, IR or NVD) with the remaining 12 % conducted using PAM.

Of the 2,018.6 h of total visual effort, 1,829.3 h was conducted via UE during the day (610.5 h), and night (1,218.8 h) using UE in areas lit up by the vessel's operating lights. Monitoring during darkness occurred with UE, NVD, IR and PAM. Of the total 103.4 h of IR monitoring effort, 72 % occurred during darkness and 28 % occurred during the day. Of the total 284.7 h of PAM monitoring effort, 72 % occurred during darkness and 28 % during daylight (Table 4). Although a small amount of NVD effort (11 %) occurred during the day during twilight hours, most (89 %) occurred during darkness (Table 2).

Table 4. *Phase 1* total effort (hours) by monitoring method during night (darkness) and day.

Period	Visual				PAM	Total Effort (Visual & PAM)[1/ 2/]
	UE	IR	NVD	Visual Effort Total		
Night	1,218.8	74.5	76.1	1,369.4	204.4	**1,573.8**
Day	610.5	28.9	9.7	649.1	80.3	**729.4**
Total	**1,829.3**	**103.4**	**85.8**	**2,018.5**	**284.7**	**2,303.2**

[1/] Includes all effort (i.e. both outside and inside the Lease Area)
[2/] Effort includes simultaneously occurring effort, representing totals for each person on watch by method. (See *Methods* section.) UE = Unaided Eye (with occasional use of reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red, NVD = Night Vision Device, PAM = Passive Acoustic Monitoring

Monitoring effort is summarized in Table 5 by PSO effort occurring inside and outside the Lease Area based on the four monitoring methods: 1) UE, 2) IR, 3) NVD, and 4) PAM. Most (72 %) of the monitoring effort occurred inside the Lease Area, and the remaining 28 %

outside the Lease Area. Nearly all (95 %) of the PAM monitoring effort and most (68 %) of the Visual Effort (UE, IR and NVD combined) occurred inside the Lease Area. The remaining 5 % and 32 % of PAM and visual effort (respectively) occurred outside the Lease Area (Table 5).

Table 5. *Phase 1* total effort (hours) by monitoring method by inside and outside the Lease Area.

Region	Visual				PAM	Total Effort (Visual and PAM) [1/]
	UE	IR	NVD	Visual Effort Total		
Inside Lease Area	1,247.4	71.7	60.4	1,379.5	272.2	**1,651.7**
Outside Lease Area	581.9	31.8	25.5	639.2	12.6	**651.7**
Total	**1,829.3**	**103.5**	**85.9**	**2,018.7**	**284.7**	**2,303.4**

[1/] Effort includes simultaneously occurring effort, representing totals for each person on watch by method. (See *Methods* section.) UE = Unaided Eye (with occasional use of reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red, NVD = Night Vision Device, PAM = Passive Acoustic Monitoring

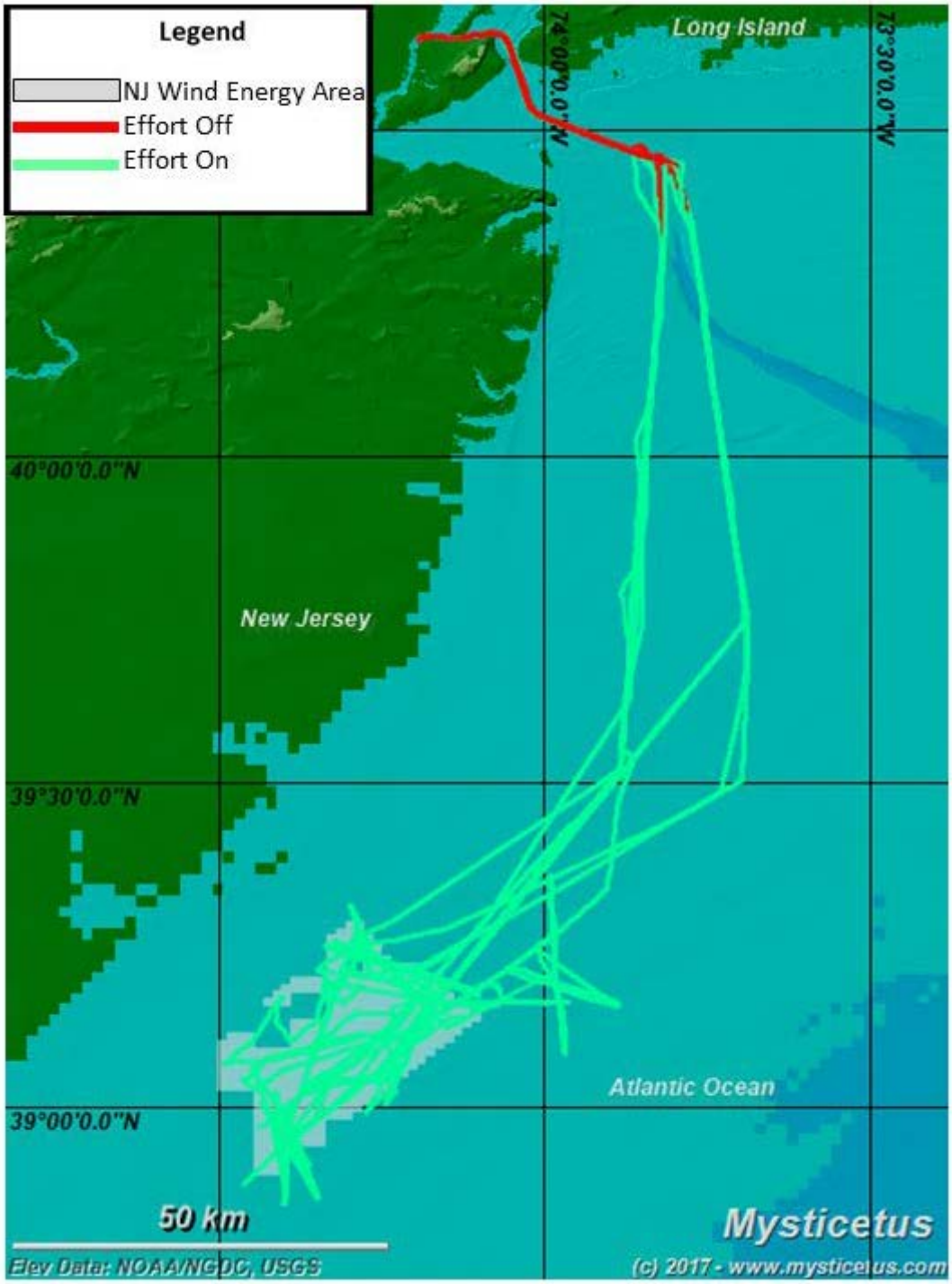


Figure 5. ***Phase 1*** **vessel tracklines with and without monitoring effort (visual and PAM) while underway and while at CPT/DCPT/BH stations inside and outside the Lease Area (i.e., NJ Wind Energy Area on map).**

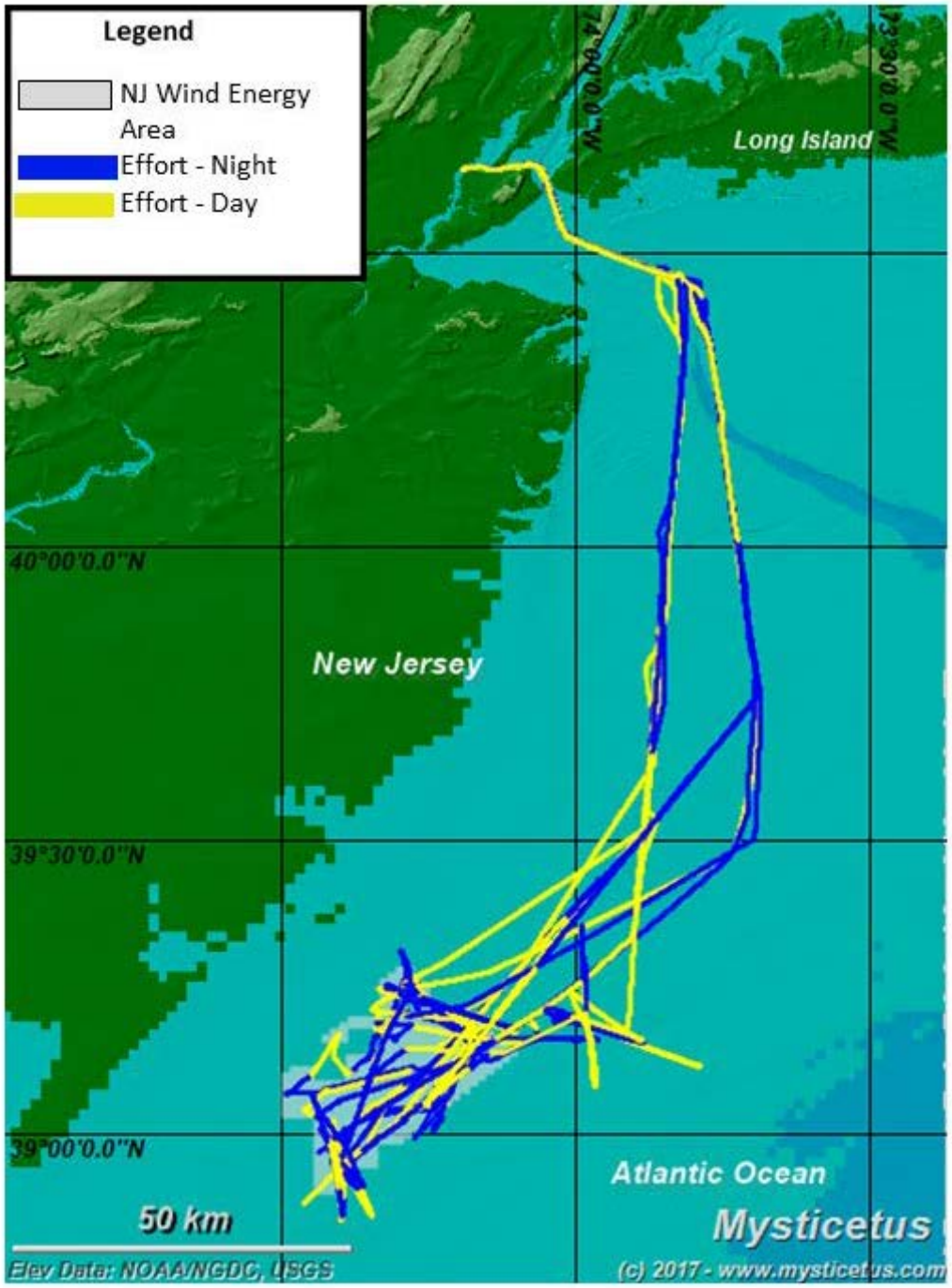


Figure 6. ***Phase 1*** **vessel tracklines and monitoring effort (visual and PAM) by night and day periods while underway and while at CPT/DCPT/BH stations inside and outside the Lease Area (indicated by gray polygon; note that tracklines near port closely overlap).**

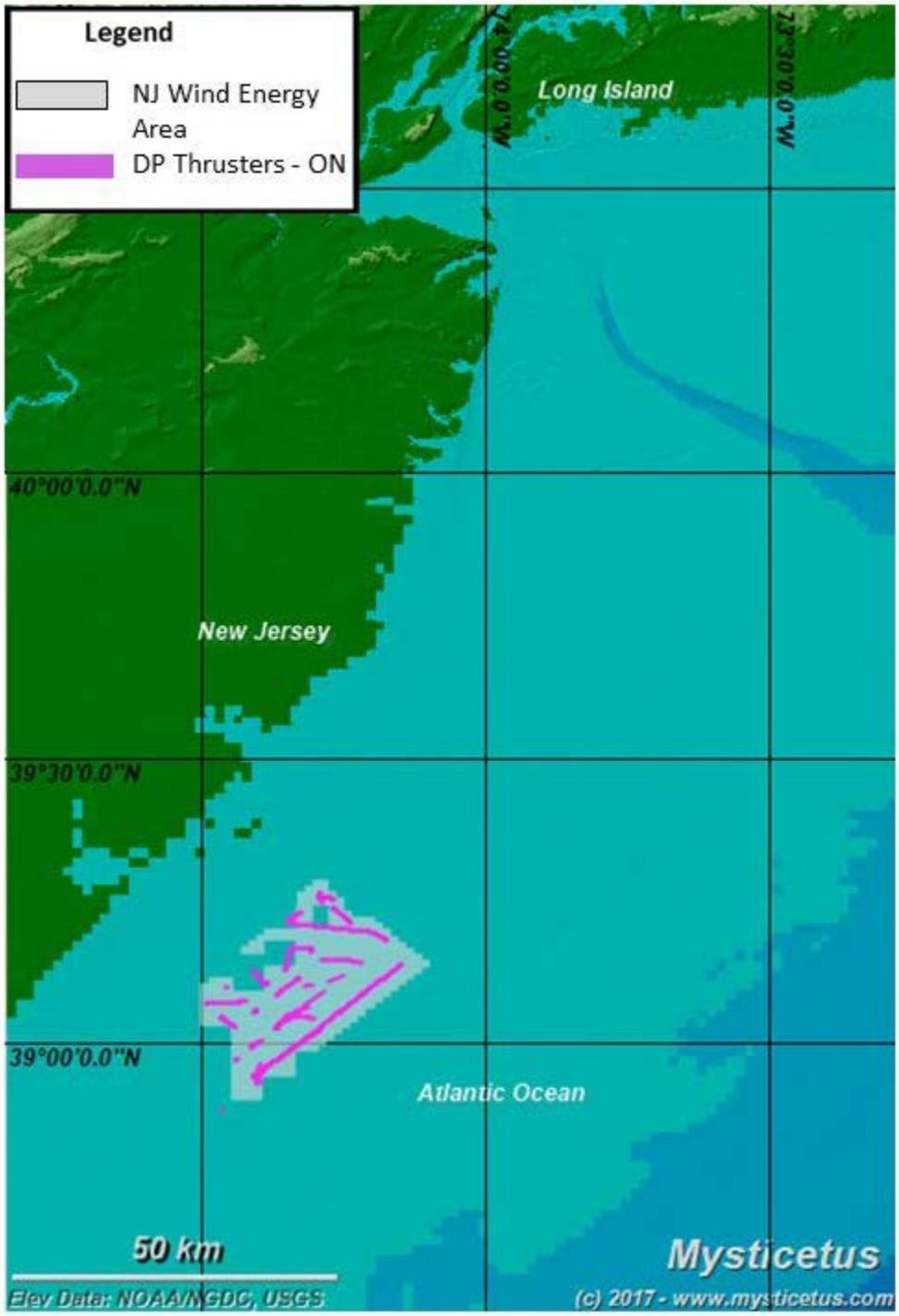


Figure 7. *Phase 1* monitoring effort (visual and PAM) during DPT On Effort (see Figure 1 for CPT/DCPT/BH station locations where DPT use was focused).

Figure 8. ***Phase 1*** **vessel tracklines and monitoring effort (visual and PAM) during DPT Off Effort inside and outside the Lease Area (indicated by gray polygon)**

4.1.1.1 Phase 1 Environmental Conditions

Overall, the environmental conditions inside and outside the Lease Area were conducive to appropriately monitor for marine mammals during survey operations using the four monitoring methods described in Section 3.2 (Figure 9). Bft ranged from 1-6 with an occasional Bft 7 and 8. PSO visual monitoring effort (UE, NVD and IR) occurred most often during Bft 4 (22 %) followed by Bft 5 (21 %) and Bft 6 (18 %). PAM monitoring effort occurred most frequently during Bft 4 (27 %) followed by Bft 5 (21 %) and Bft 6 (20 %).

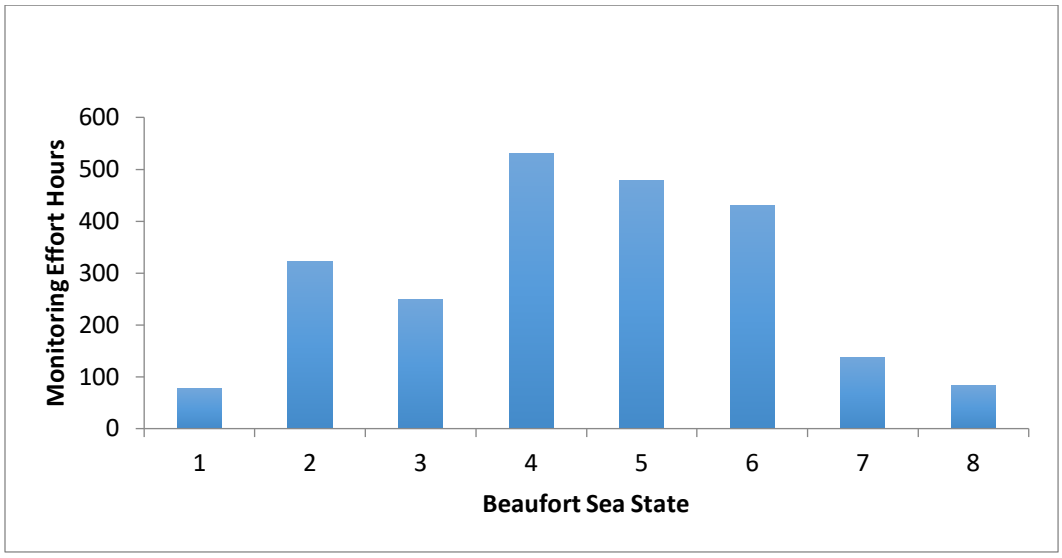


Figure 9. *Phase 1* monitoring effort (visual and PAM) during Beaufort Sea State (Bft) 1-8

4.1.2 *Phase 1* Protected Species Detections

During the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 1*, there were a total 60 protected species detections both inside and outside the Lease Area (comprised of 248 estimated individuals from 5 different species; Figures 10-13, Tables 6-9). No sea turtles or Atlantic sturgeon were sighted. Of the 60 detections, 47 % were identified to species while the remaining 53 % were identified only to taxonomic family level. The most commonly recorded species was the common dolphin (23 detections of 169 estimated individuals), followed by the humpback whale (3 detections of 3 individuals). There was a single sighting of two minke whales, a single fin whale, and a single North Atlantic right whale detected. Detections were classified as unidentified and counted as a minimum of a single individual when PAM detections were not visually confirmed (Table 3). A table of all protected species detections and details is provided in Appendix A.

Approximately equal numbers of detections were made outside (n = 29) vs. inside (n = 31) the Lease Area (Table 6). Similarly, approximately equal numbers of large whales were seen outside (n = 9) vs. inside (n = 7) the Lease Area. Only the humpback whale was identified to species outside the Lease Area. The total number of delphinid/porpoise detections was

also similar outside (n = 20) vs. inside (n= 24) the Lease Area; however, over three times more estimated such individuals were detected outside (n = 175) vs. inside the Lease Area (n = 54), attributed primarily to common dolphins (Table 6).

4.1.2.1 Phase 1 North Atlantic Right Whale Sighting

On 12 December 2017 one North Atlantic right whale was detected visually inside the Lease Area approximately 3 km from the *M/V Fugro Explorer* while the vessel DPT were off (operations were suspended for weather) (Figure 9). The average vessel speed was recorded at 3 knots; thus, no mitigation measures were required. The sighting information was reported to NOAA NMFS via the Whale Alert application as well as via email to NOAA on 12 December 2017 late afternoon to: Ne.RW.survey@NOAA.gov. Sighting details are presented in Appendix E.

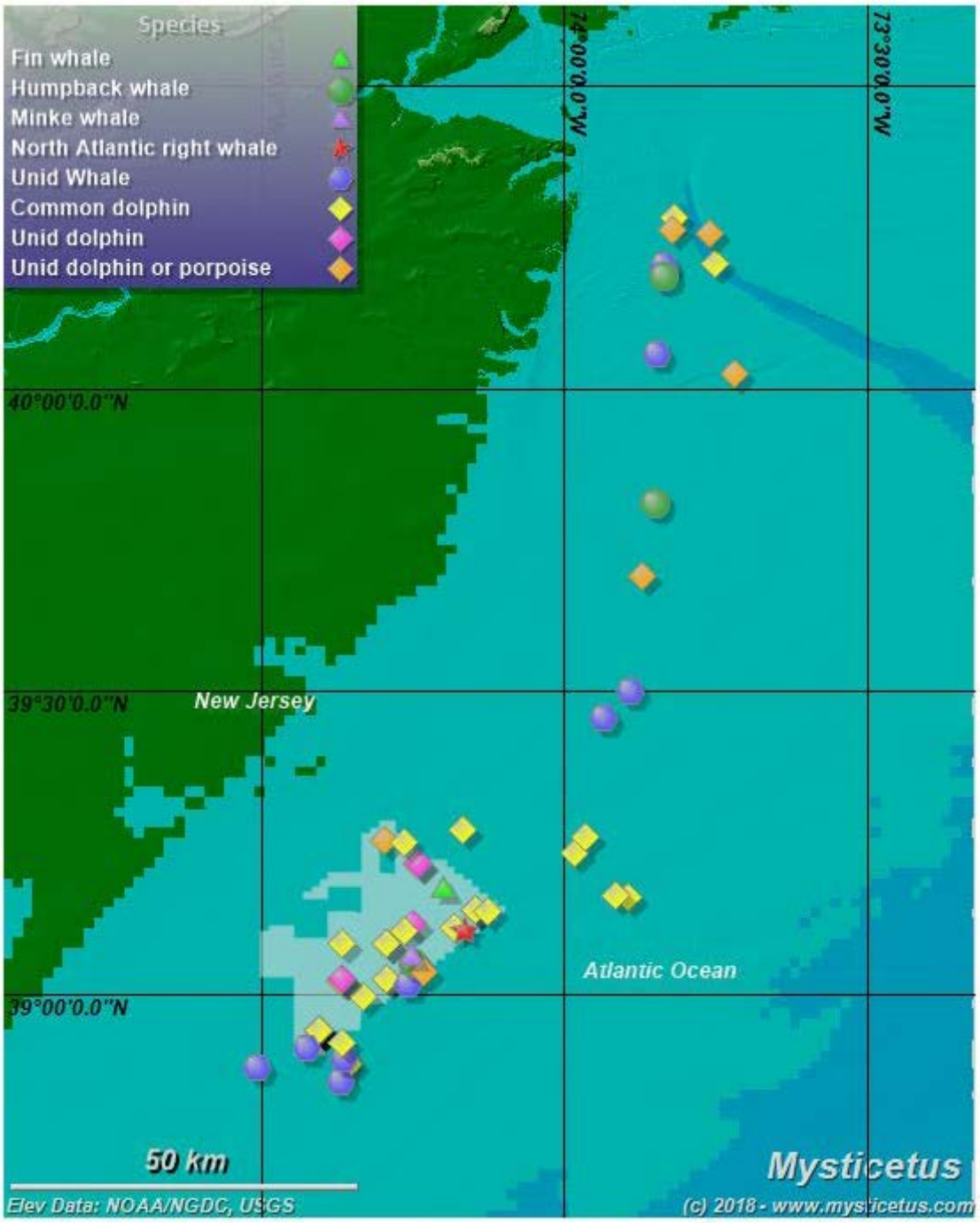


Figure 10. *Phase 1* sighting locations of all visual and PAM detections of protected species outside and inside the Lease Area (indicated by gray polygon).

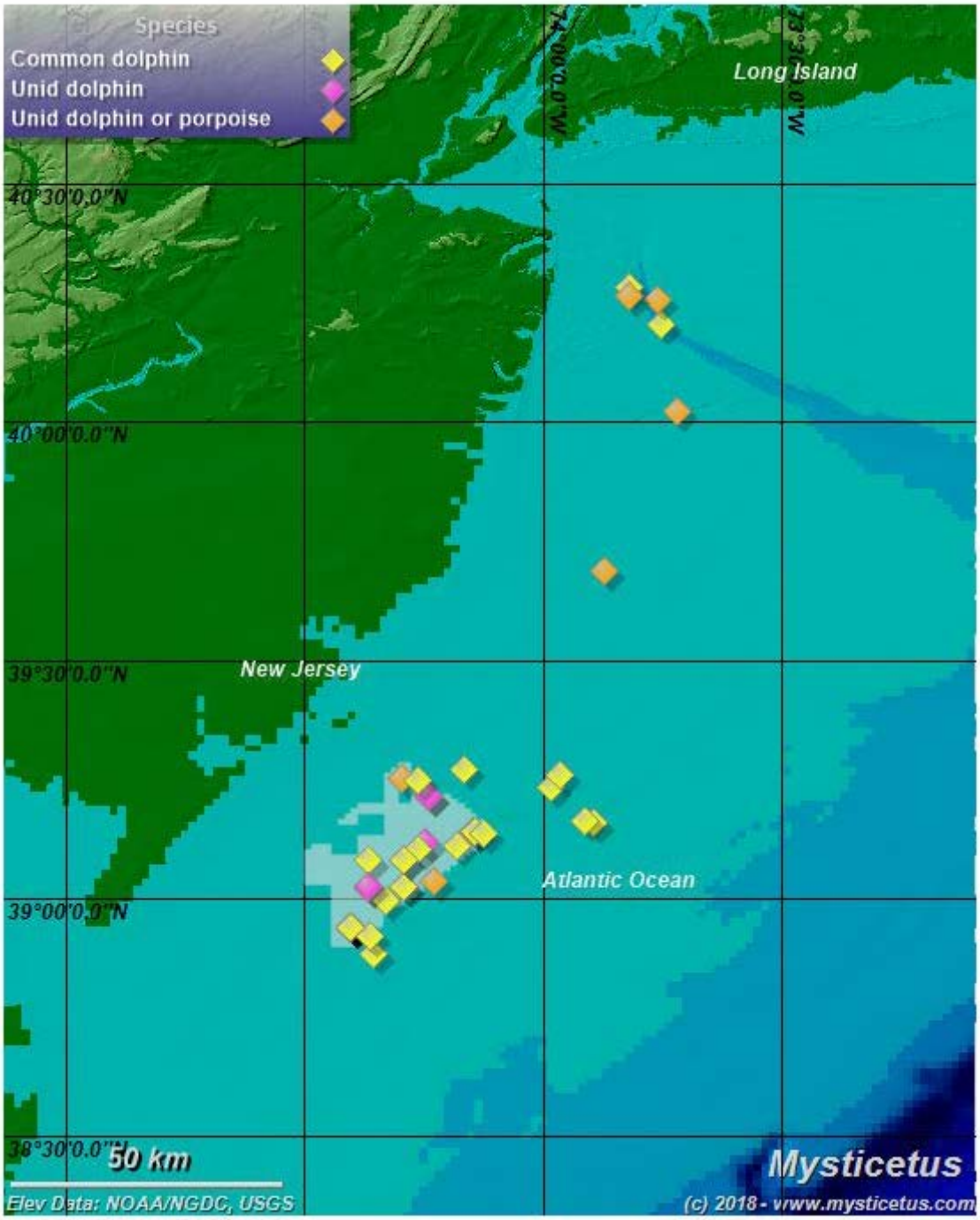


Figure 11. ***Phase 1*** **sighting locations of all dolphin or porpoise species (i.e., combined common dolphin, unidentified dolphin or porpoise) visual and PAM detections outside and inside the Lease Area (indicated by gray polygon).**

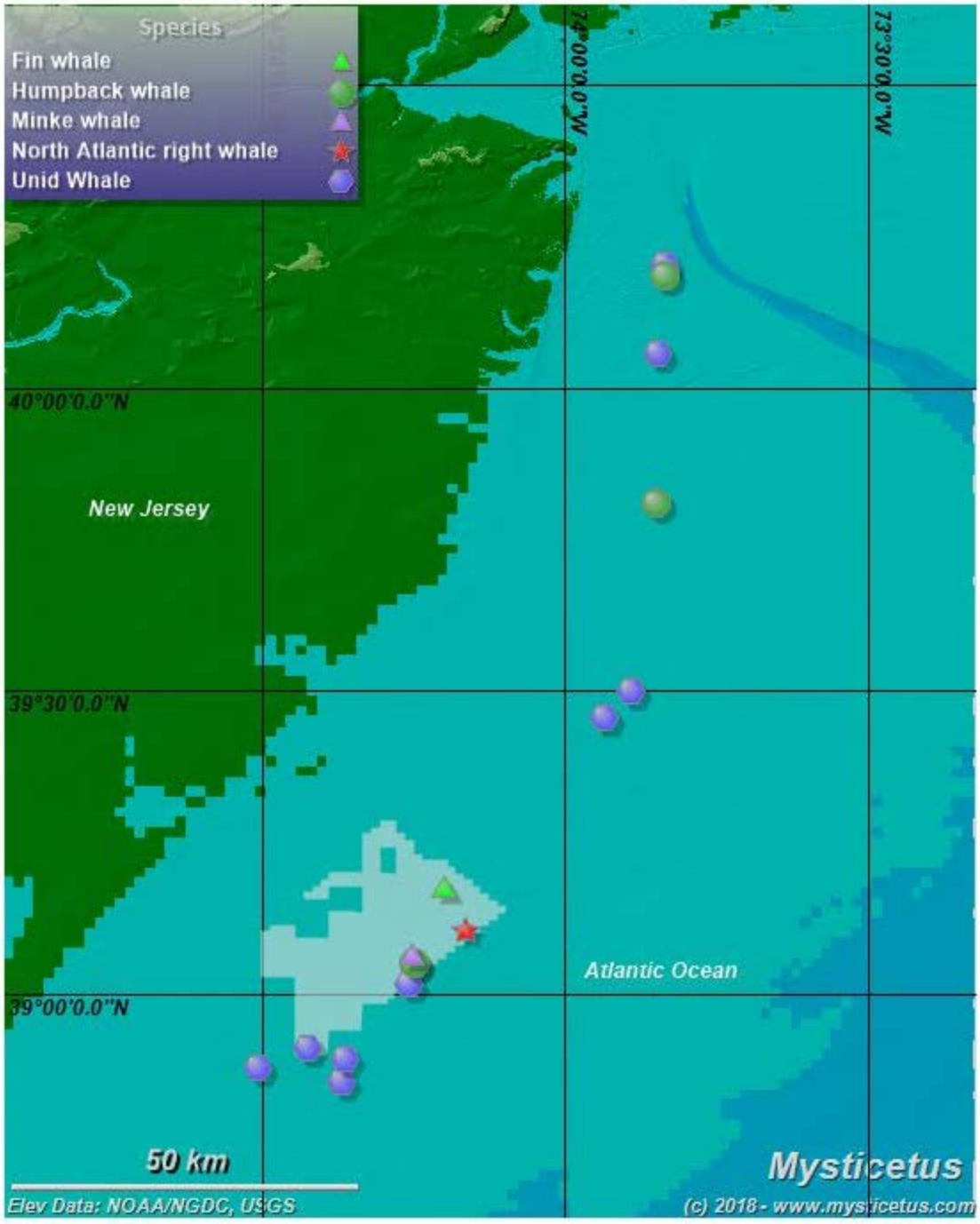


Figure 12. *Phase 1* sighting locations of all large whale species (i.e., combined humpback, fin, minke, North Atlantic right and unidentified whales) visual and PAM detections outside and inside the Lease Area (indicated by gray polygon).

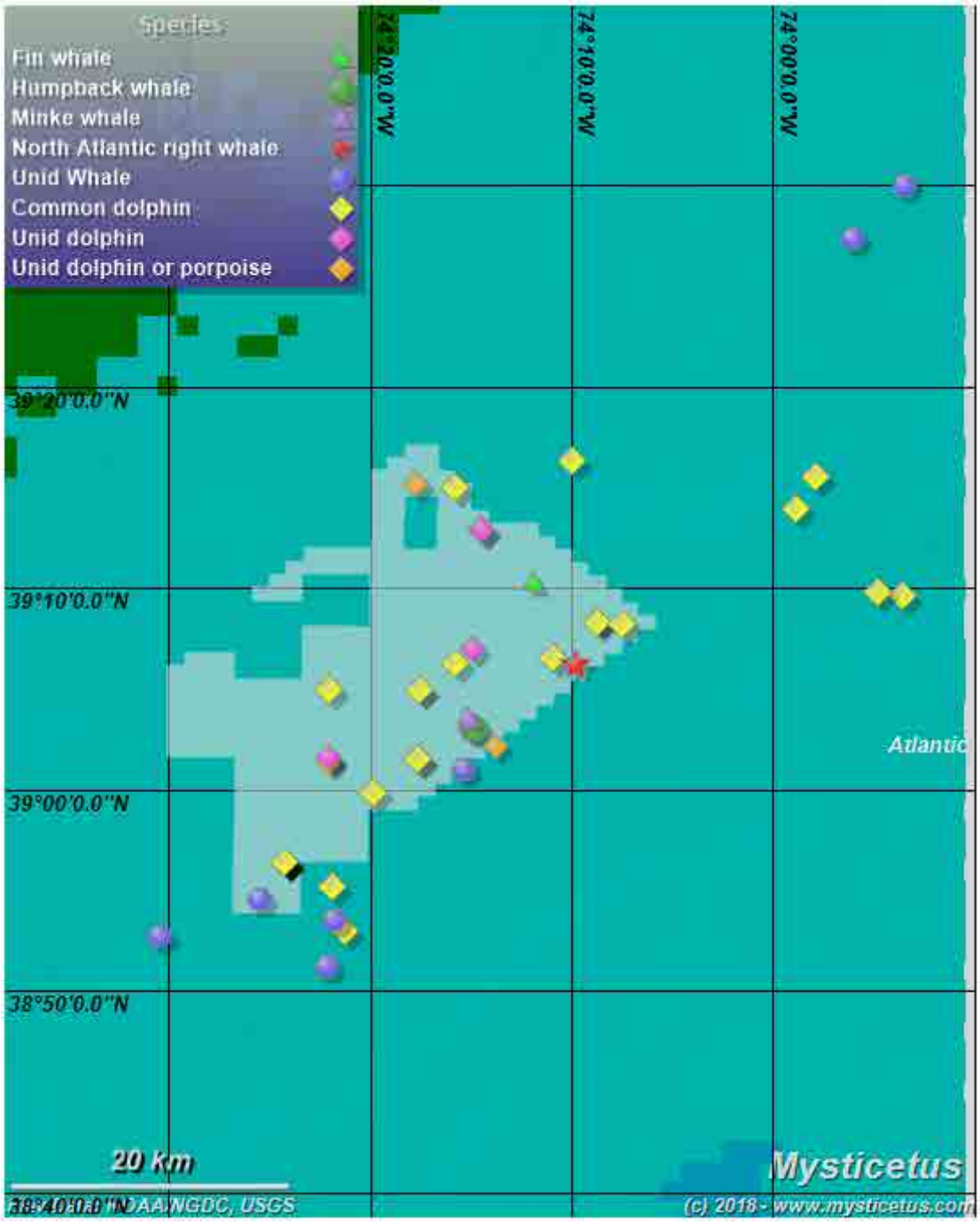


Figure 13. ***Phase 1*** **sighting locations of all visual and PAM detections of protected species focused on those inside the Lease Area indicated by the gray polygon (zoomed in to differentiate closely-spaced detections).**

Table 6. Total number of marine mammal detections and estimated number of individuals visually or passive acoustically detected during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 1* outside and inside the Lease Area.

		Outside Lease Area		Inside Lease Area		Total	
Species Common Name	**Species Scientific Name**	**No. Detections[1/]**	**No. Est. Individuals[2/]**	**No. Detections[1/]**	**No. Est. Individuals[2/]**	**No. Detections[1/]**	**No. Est. Individuals[2/]**
Fin Whale	*Balaenoptera physalus*			1	1	1	1
Humpback Whale	*Megaptera novaeangliae*	2	2	1	1	3	3
Minke Whale	*Balaenoptera acutorostrata*			1	2	1	2
North Atlantic Right Whale	*Eubalaena glacialis*			1	1	1	1
Common Dolphin	*Delphinus delphis*	13	134	10	35	23	169
Unidentified Dolphin or Porpoise		7	41	14	19	21	60
Unidentified Whale		7	8	3	4	10	12
Total		29	185	31	63	**60**	**248**

[1/] A detection is defined as a group of one or more individuals detected visually using the unaided eye (with occasional use of reticle binoculars, primarily to confirm sightings, species, etc., as needed), infra-red bi-oculars, night vision device, or detected acoustically using passive acoustic monitoring

[2/] Estimated Individuals = estimated number of individuals within each detection (separate group/sighting)

Table 7. Total number of marine mammal detections during DPT Off and DPT On periods outside the Lease Area during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 1.*

Outside Lease Area						
Species	**DPT Off[1/]**		**DPT On[2/]**		**Total**	
	No. Detection[3/]	**No. Est. Individual[4/]**	**No. Detection[3/]**	**No. Est. Individual[4/]**	**No. Detection[3/]**	**No. Est. Individual[4/]**
Fin Whale	0	0	0	0	0	0
Humpback Whale	2	2	0	0	2	2
Minke Whale	0	0	0	0	0	0
North Atlantic Right Whale	0	0	0	0	0	0
Common Dolphin	10	126	3	8	13	134
Unidentified Dolphin or Porpoise	6	39	1	2	7	41
Unidentified Whale	6	7	1	1	7	8
Total	24	174	5	11	**29**	**185**

1/ DPT Off = while DP thrusters are not in operation
2/ DPT On = while DP thrusters are in operation
3/ A detection is defined as a group of one or more individuals detected visually using the unaided eye (with occasional use of reticle binoculars, primarily to confirm sightings, species, etc., as needed), infra-red bi-oculars, night vision device, or detected acoustically using passive acoustic monitoring
4/ Estimated Individuals = estimated number of individuals within each detection (separate group/sighting)

Table 8. Total number of marine mammal detections during DPT Off and DPT On periods inside the Lease Area during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 1.*

Inside Lease Area						
Species	**DPT Off[1/]**		**DPT On[2/]**		**Total**	
	No. Detection[3/]	**No. Est. Indiv.[4/]**	**No. Detection[3/]**	**No. Est. Indiv.[4/]**	**No. Detection[3/]**	**No. Est. Indiv.[4/]**
Fin Whale	1	1	0	0	1	1
Humpback Whale	0	0	1	1	1	1
Minke Whale	0	0	1	2	1	2
North Atlantic Right Whale	1	1	0	0	1	1
Common Dolphin	1	2	9	33	10	35
Unidentified Dolphin or Porpoise	1	1	13	18	14	19
Unidentified Whale	1	1	2	3	3	4
Total	5	6	26	57	**31**	**63**

1/ DPT Off = while DP thrusters are not in operation
2/ DPT On = while DP thrusters are in operation
3/ A detection is defined as a group of one or more individuals detected visually using the unaided eye (with occasional use of reticle binoculars, primarily to confirm sightings, species, etc., as needed), infra-red bi-oculars, night vision device, or detected acoustically using passive acoustic monitoring
4/ Estimated Individuals = estimated number of individuals within each detection (separate group/sighting)

Table 9. Total number of marine mammal detections during DPT Off and DPT On periods inside and outside the Lease Area during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 1.*

Species	DPT Off[1/]		DPT On[2/]		Total	
	No. Detection	No. Est. Indiv.	No. Detection	No. Est. Indiv.	No. Detection	No. Est. Indiv.
Fin Whale	1	1	0	0	1	1
Humpback Whale	2	2	1	1	3	3
Minke Whale	0	0	1	2	1	2
North Atlantic Right Whale	1	1	0	0	1	1
Common Dolphin	11	128	12	41	23	169
Unidentified Dolphin or Porpoise	7	40	14	20	21	60
Unidentified Whale	7	8	3	4	10	12
Total	29	180	31	68	**60**	**248**

1/ DPT Off = while DP thrusters are not in operation
2/ DPT On = while DP thrusters are in operation

Nearly half (48 %) of the total 60 detections occurred during DPT Off periods (i.e., when DPT were not operating) and the remaining 31 (52 %) of the detections occurred during DPT On periods (i.e., when DPT were operating) (Table 9). Delphinids had the highest numbers of detections during DPT On periods. Of the 23 common dolphin detections, 12 were made during DPT On, and 11 during DPT Off periods. Of the three total humpback whale detections, two occurred during DPT Off periods and one during DPT On. The one North Atlantic right whale sighting occurred during a DPT Off period, as did the only fin whale sighting (Table 9).

4.1.2.2 Phase 1 Protected Species Behavior

To maximize sample size, behavior data were pooled for all detections both inside and outside the Lease Area. Behavior state was recorded for 46 of the total 60 detections (Table 10); behavior state was unknown for 14 detections because they were only acoustically detected (n=12; no visual confirmation of behavior), were too far away, or were observed only briefly. Behavior was recorded most often for common dolphins (23 detections), with 48 % exhibiting surface-active travel behavior followed by travel (30 %) (Figures 14 and 15, Table 10). For the 16 detections of large whales, travel was the most commonly (69 %) observed behavior state.

There was no apparent difference between behavior states observed when DPT were on vs. off for the combined common dolphin and unidentified dolphin or porpoise detections. Surface-active travel and travel were the most commonly observed behavior states when DPT were on (50 %) vs. off (78 %) (Figure 14). Though small sample size was small, there was also no apparent difference between behavior states observed by periods with DPT on vs. off for the combined large whale species (i.e., all humpback, fin, minke, North Atlantic right and unidentified whale) (Figure 15).

Table 10. *Phase 1* Behavior states observed for all protected species detections.

Species	Mill	Surface-Active Mill	Surface-Active Travel	Travel	Unknown	Unknown - PAM	Total
Fin Whale	0	0	0	1	0	0	1
Humpback Whale	0	0	1	2	0	0	3
Minke Whale	0	1	0	0	0	0	1
North Atlantic Right Whale	0	0	1	0	0	0	1
Common Dolphin	0	4	11	7	0	1	23
Unidentified Dolphin or Porpoise	1	0	2	7	0	11	21
Unidentified Whale	0	0	0	8	2	0	10
Total	1	5	15	25	2	**12**	**60**

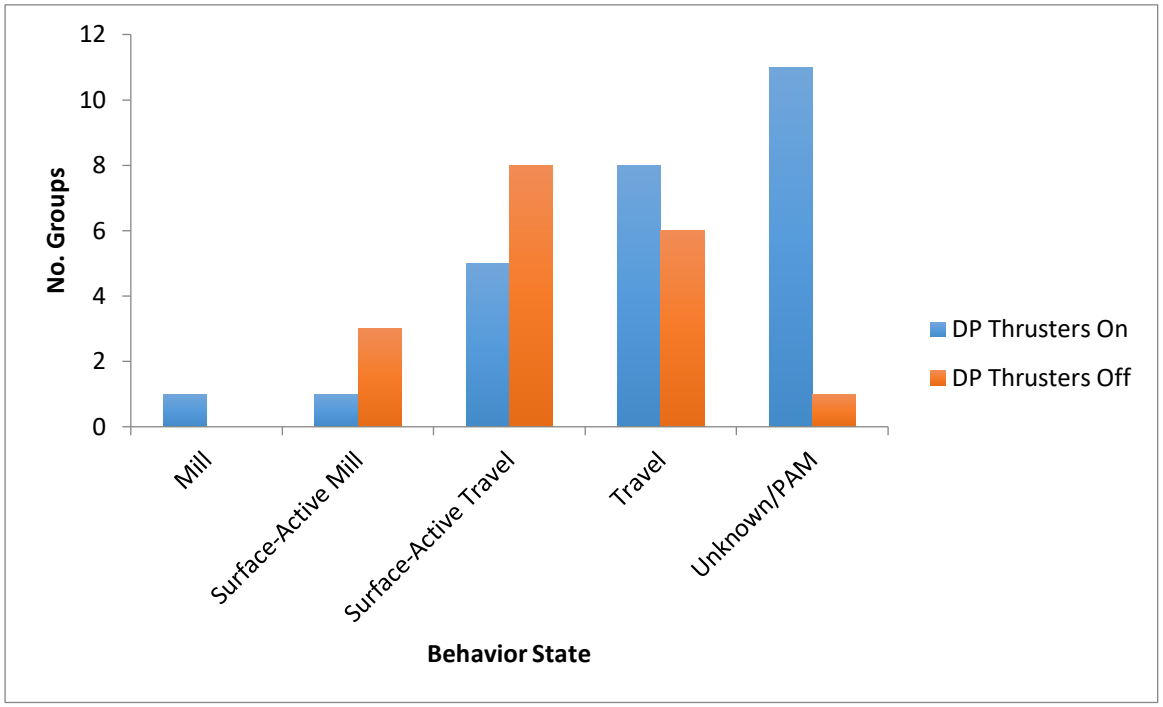


Figure 14. Behavior states for all dolphin or porpoise species (i.e., combined common dolphin, unidentified dolphin or porpoise) observed during DPT Off and DPT On periods *Phase 1.*

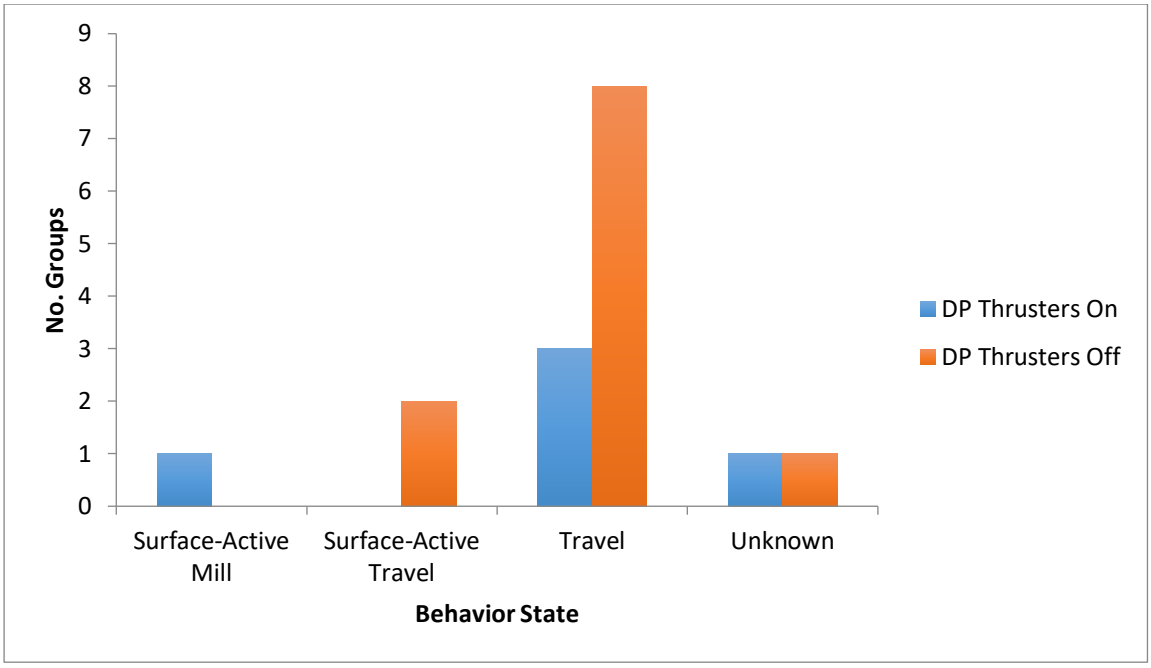


Figure 15. Behavior states for all large whale species (i.e., combined humpback, fin, minke, North Atlantic right and unidentified whales) observed during DPT Off and DPT On periods during *Phase 1.*

4.1.2.3 Phase 1 Closest Point of Observed Approach (CPA)

To maximize sample size, CPA data were pooled and calculated for all protected species detections (i.e., pooling detections made inside and outside the Lease Area) (Figures 16 and 17). CPA is presented for each sighting in Appendix A. There were 12 PAM detections that did not have visual (UE, NVD or IR) confirmation, thus distance to vessel was unknown. All PAM detections with unknown distance from the vessel were for delphinid species.

- Of the 44 total dolphin detections with recorded CPA (Figure 16):
  - 26 occurred during DPT On periods and 18 occurred during DPT Off periods
  - The most frequent CPA during DPT On periods was ≤50 m (30 %) followed by 51–100 m (19 %) and 201–500 m (8 %)
  - The most frequent CPA during DPT Off periods was ≤50 m (50 %) followed by 201–500 m (17 %) and 501-1000 m (17 %)
- Of the 16 total large whale detections with recorded CPA (Figure 17):
  - Five occurred during DPT On periods and 11 occurred during DPT Off periods
  - The most frequent CPA during DPT On periods was 501-1000 m (80 %) followed by > 3000 m (19 %) and 201–500 m (20 %)
  - The most frequent CPA during DPT Off periods was 501-1000 m (55 %) followed by 2001–3000 m (18 %) and > 3000 m (18 %)

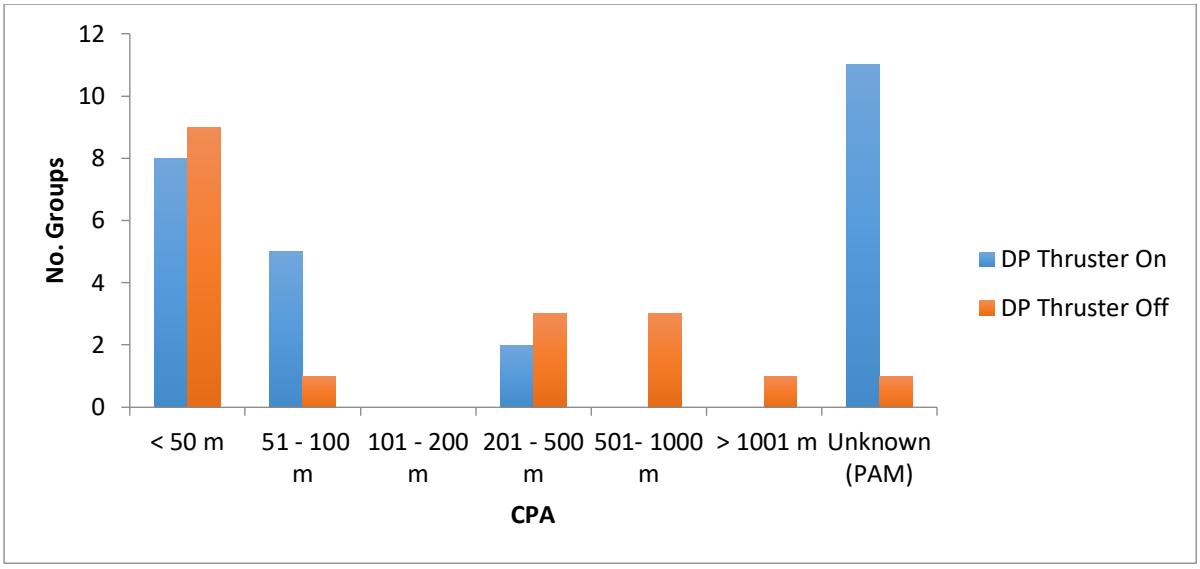


Figure 16**. Closest Point of observed Approach (CPA) for all dolphin or porpoise species (i.e., combined common dolphin, unidentified dolphin or porpoise) observed during DPT Off and DPT On periods during *Phase 1.***

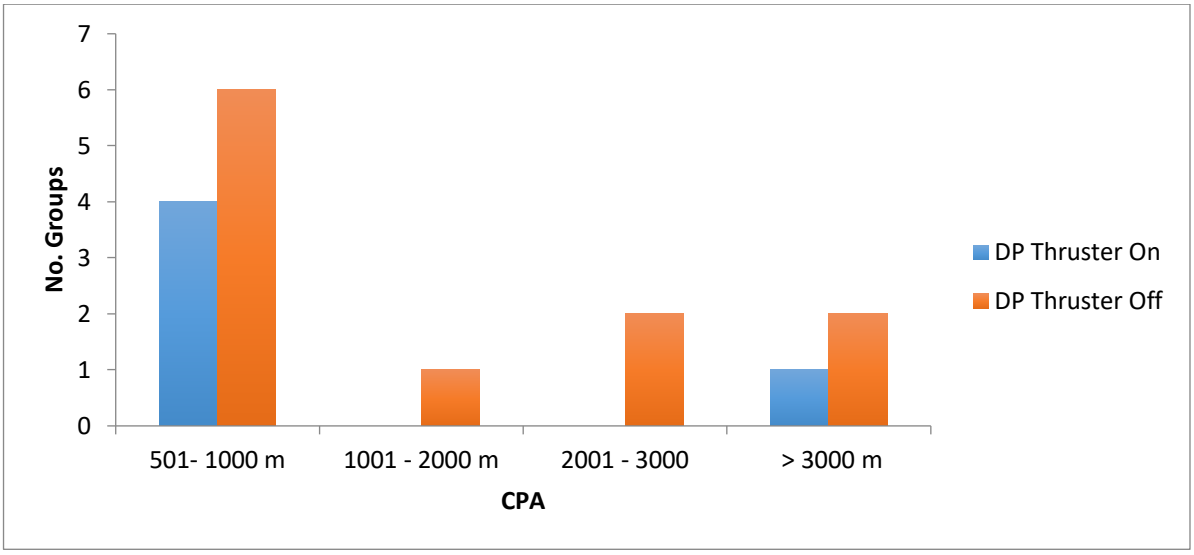


Figure 17. Closest Point of observed Approach (CPA) for all large whale species (i.e., combined humpback, fin, minke, North Atlantic right and unidentified whales) observed during DPT Off and DPT On periods *Phase 1.*

4.1.3 *Phase 1* Protected Species Exposures

The number of potential exposures was based on direct observations/counts or acoustic detections of protected species while the DPT were operating. Exposures were categorized based on distance from the vessel/DPT: 1) < 500 m, 2) 500-1000 m, and 3) > 1000 m (Table 11).

A total of 31 groups and an estimated minimum total of 68 individual marine mammals were visually observed or acoustically detected while the DPT were operating (Table 8). Of these 31 detections, 15 (~50 individuals) were detected within the 500-m MZ, 4 (~5

individuals) were within the 500-1000 m MZ, and 1 (~2 individuals) was detected > 1000 m away. Eleven PAM detections that were not visually confirmed, thus distances from the vessel were unknown. However, these were considered "potential exposures" for reporting purposes (Table 11).

Changes in individual behaviors were observed only during DPT Off periods while the vessel was underway, all of which consisted of dolphins (n=11 detections) approaching the vessel to bowride (Table 12). No obvious changes in behavior were observed during DPT On Periods (while the vessel was stationary/on station conducting geotechnical operations; Table 12).

Per the MMPA, the definition of a take is defined as an animal that shows a "disruption of natural behavioral patterns (i.e., migration, surfacing, nursing, breeding, feeding, or sheltering) to a point where such behavioral patterns are abandoned or significantly altered." No such adverse behavioral disruptions were observed or acoustically detected during the *OCW01 Geotechnical Investigation 1A (2017 & 2018)* that met this definition of take (Table 3).

4.1.4 *Phase 1* Protected Species Incident Reports

There were no marine mammal deaths, carcasses or strandings recorded during *OCW01 Geotechnical Investigation 1A (2017 & 2018).* Thus, no Protected Species Injury or Mortality reports were necessary/completed during the survey (as described in Appendix A of the BOEM project Lease).

Table 11. Summary table of number of minimum estimated potential exposures by distance categories during DP thruster operations during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 1.*

	Visual (UE/IR/NVD)[1/] Detections and PAM Detections with Visual Confirmation						PAM[2/] Detections without Visual Confirmation		Total Potential Exposures[4/]	
	<500 m		500-1000 m		>1000 m		Distance Estimation Undetermined[3/]			
Species	No. Groups	Est. No. Individuals	No. Groups	Est. No. Individuals	No. Groups	Est. No. Individuals	No. Groups	Est. No. Individuals[4/]	No. Groups	Est. No. Individuals
Fin Whale	0	0	0	0	0	0	0	0	0	0
Humpback Whale	0	0	1	1	0	0	0	0	1	1
Minke Whale	0	0	1	2	0	0	0	0	1	1
North Atlantic Right Whale	0	0	0	0	0	0	0	0	0	0
Common Dolphin	12	41	0	0	0	0	0	0	12	41
Unidentified Dolphin or Porpoise	3	9	0	0	0	0	11	11	14	20
Unidentified Whale	0	0	2	2	1	2	0	0	3	4
Total	**15**	**50**	**4**	**5**	**1**	**2**	**11**	**11**	**31**	**68**

[1/]UE = Unaided Eye (with occasional use of reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red, NVD = Night Vision Device.
[2/]PAM = Passive Acoustic Monitoring.
[3/]Distance from vessel for PAM detections could not be determined unless linked with a visual sighting.
[4/]A PAM detection that was not visually confirmed was recorded as a minimum estimate of one individual, as group size could not be determined using PAM methods alone.

Table 12. Number and behavioral changes of protected species detected during DPT Off and DPT On periods during *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 1.*

	No Exposure[1/] (DPT Off)				Yes Exposure[2/] (DPT On)			
	Detections		Behavioral Change		Detections		Behavioral Change	
Species	**No. Groups**	**Est. No. Indiv.**	**Type of Behavioral Change Observed**	**No. Indiv. Exhibiting Behavioral Change**	**No. Groups**	**Est. No. Indiv.**	**Type of Behavioral Change Observed**	**No. Indiv. Exhibiting Behavioral Change**
Fin Whale	1	1	None	N/A	0	0	None	N/A
Humpback Whale	2	2	None	N/A	1	1	None	N/A
Minke Whale	0		None	N/A	1	2	None	N/A
North Atlantic Right Whale	1	1	None	N/A	0	0	None	N/A
Common Dolphin	11	128	Approach/ Bow-ride	~25	12	41	None	N/A
Unidentified Dolphin or Porpoise	7	40	Approach/ Bow-ride	~6	14	20	None	N/A
Unidentified Whale	7	8	None	N/A	3	4	None	N/A
Total	**29**	**180**	**~31**		**31**	**68**		**N/A**

[1/]No Exposure = detected when DP thrusters were not in operation (i.e., underway) (i.e., during DPT Off period).
[2/]Yes Exposure = detected while DP thrusters were in operation (i.e., during DPT On period).

4.1.5 *Phase 1* Mitigation Measures

Mitigation measures requested and implemented during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 1* are summarized in Table 13 and presented for each visual and PAM detection in Appendix A.

Table 13. Summary table of mitigation measures implemented during the *OCW01 Geotechnical Investigation 1A (2017) Phase 1.*

Species	Vessel Course Change	Vessel Speed Reduction	Delay in Start of Survey Period	Power Down Requested (Denied Due to Safety)[1/]	None	Total
Fin Whale	0	1	0	0	0	1
Humpback Whale	0	0	0	0	3	3
Minke Whale	0	0	0	0	1	1
North Atlantic Right Whale	0	0	0	0	1	1
Common Dolphin	1	2	1	1	18	23
Unidentified Dolphin or Porpoise	0	0	0	2	19	21
Unidentified Whale	0	1	0	0	9	10
Total	1	4	1	3	51	60

[1/]Power downs for DP thruster operations were only requested by Protected Species Observers prior to the Sound Source Verification test, after which it was determined in consultation with the agencies that it was not safe to power down the DP thrusters. Thus, power downs were no longer requested (see Section 3.4.1 *DPT*).

4.2 Phase 2 Results

Phase 2 protected species monitoring effort, distribution, and sighting data inside and outside the Lease Area based on various conditions (e.g., darkness vs. daylight; DPT on vs. DPT off) are presented in Figures 18-21 and Tables 14-15. Results specific to requirements of the BOEM Alternative Monitoring Plan including detection rates are presented in Appendix D *Alternative Monitoring Plan Effectiveness Report* including Tables 28-30.

4.2.1 *Phase 2* Monitoring Effort

All monitoring effort (pooled for areas inside and outside of the Lease Area) is summarized in Table 14 by night (darkness) and day periods based on the four monitoring methods: 1) UE, 2) IR, 3) NVD, and 4) PAM. A total of 624.5 h of monitoring effort occurred during the 17 days of *Phase 2* of the survey using the four detection methods (Table 14). Most of this time was overlapping/simultaneous, e.g., when PAM and visuals were concurrent, etc. Thus, to differentiate and compare detection methods, effort hours were totaled separately for each person on watch by type of monitoring method. Most effort (71 %) was conducted using visual methods (UE, IR or NVD) with the remaining 29 % conducted using PAM.

Of the 445.3 total h of all visual effort, 106.6 was conducted via UE during the day and 240.8 hr using UE at night in areas lit up by the vessel's operating lights. Monitoring during

darkness occurred with UE, NVD, IR and PAM. Of the total 40.7 h of IR monitoring effort, most (69 %) occurred during darkness and 31 % occurred during daylight. Of the total 179.2 h of PAM monitoring effort, nearly half (49 %) occurred during darkness and 51 % during daylight. Although a small amount of NVD effort (3 %) occurred during the day during twilight hours, most (97 %) occurred during darkness (Table 14).

Table 14. *Phase 2* total effort[1/] (hours) by monitoring method during night (darkness) and day.[2/]

Period	Visual				PAM	All Effort Total
	UE	IR	NVD	Visual Effort Total		
Night	106.6	27.9	55.4	189.9	87.2	**277.1**
Day	240.8	12.8	1.7	255.3	92.1	**347.4**
Total	**347.4**	**40.7**	**57.1**	**445.2**	**179.2**	**624.4**

[1/] Includes all effort (i.e. both outside and inside the Lease Area)
[1/] Effort includes simultaneously occurring effort, representing totals for each person on watch by method. (See *Methods* section.) UE = Unaided Eye (with occasional use of reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red, NVD = Night Vision Device, PAM = Passive Acoustic Monitoring

Monitoring effort is summarized in Table 15 by PSO effort occurring inside and outside the Lease Area based on the four monitoring methods: 1) UE, 2) IR, 3) NVD, and 4) PAM. Most (96 %) of the monitoring effort occurred inside the Lease Area with the remaining 4 % outside the Lease Area. All (100 %) of the PAM monitoring effort and most (94 %) of the Visual Effort (UE, IR and NVD combined) occurred inside the Lease Area. The remaining 6 % of visual effort occurred outside the Lease Area (Table 15).

Table 15. *Phase 2* total effort (hours) by monitoring method by inside and outside the Lease Area.[1/]

Region	Visual				PAM	All Effort Total
	UE	IR	NVD	Visual Effort Total		
Inside Lease Area	322.5	40.5	55.7	418.7	179.2	**597.9**
Outside Lease Area	24.9	0.2	1.4	26.5	0.0	**26.5**
Total	**347.4**	**40.7**	**57.1**	**445.2**	**179.2**	**624.4**

[1/] Effort includes simultaneously occurring effort, representing totals for each person on watch by method. (See *Methods* section.) UE = Unaided Eye (with occasional use of reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red, NVD = Night Vision Device, PAM = Passive Acoustic Monitoring

Figure 18. *Phase 2* vessel tracklines with and without PSO monitoring effort (visual and PAM) while underway and while at CPT/DCPT/BH stations inside and outside the Lease Area (i.e., NJ Wind Energy Area on map).

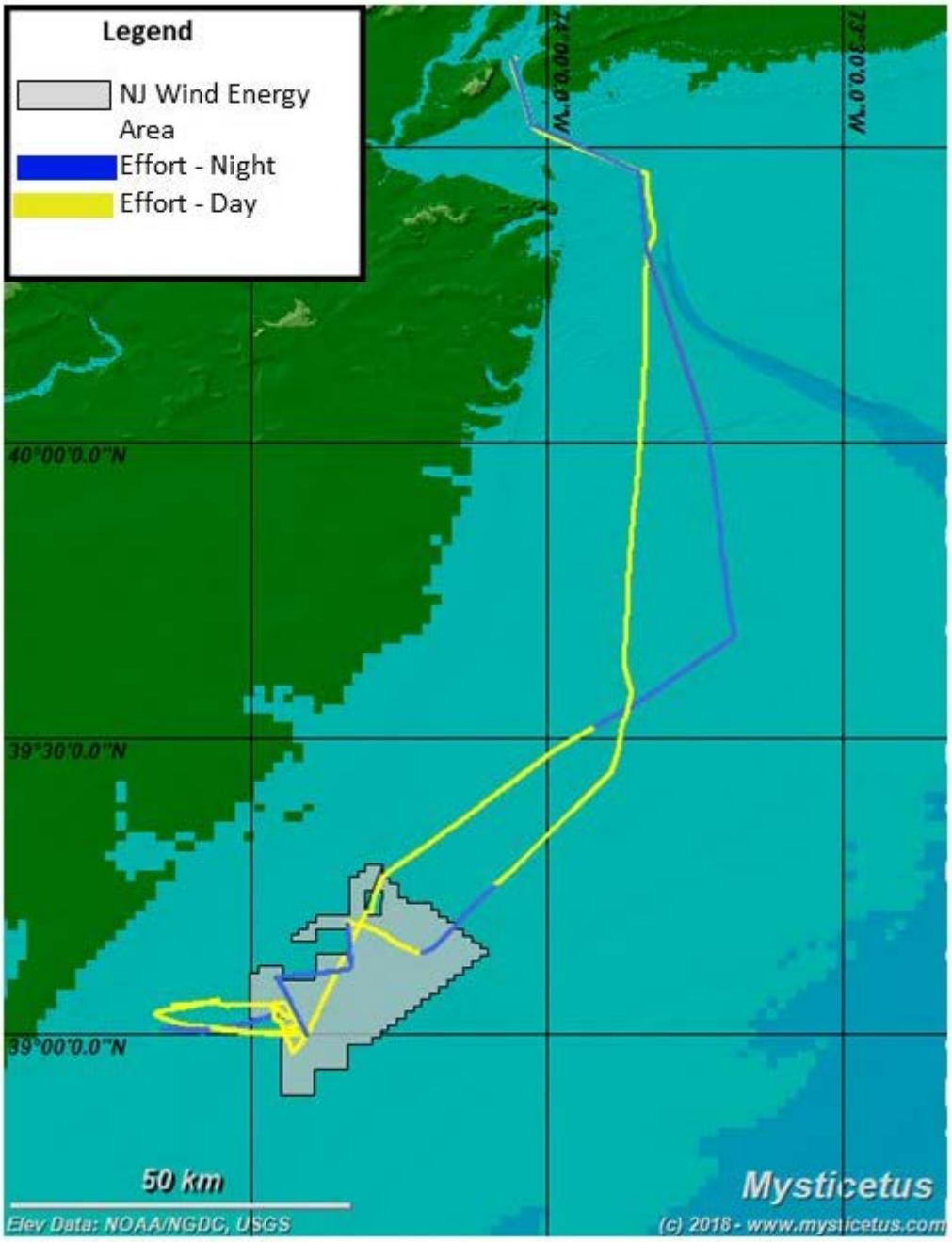


Figure 19. *Phase 2* vessel tracklines and PSO monitoring effort (visual and PAM) by night and day periods while underway and while at CPT/DCPT/BH stations inside and outside the Lease Area (indicated by gray polygon; note that tracklines near port closely overlap).

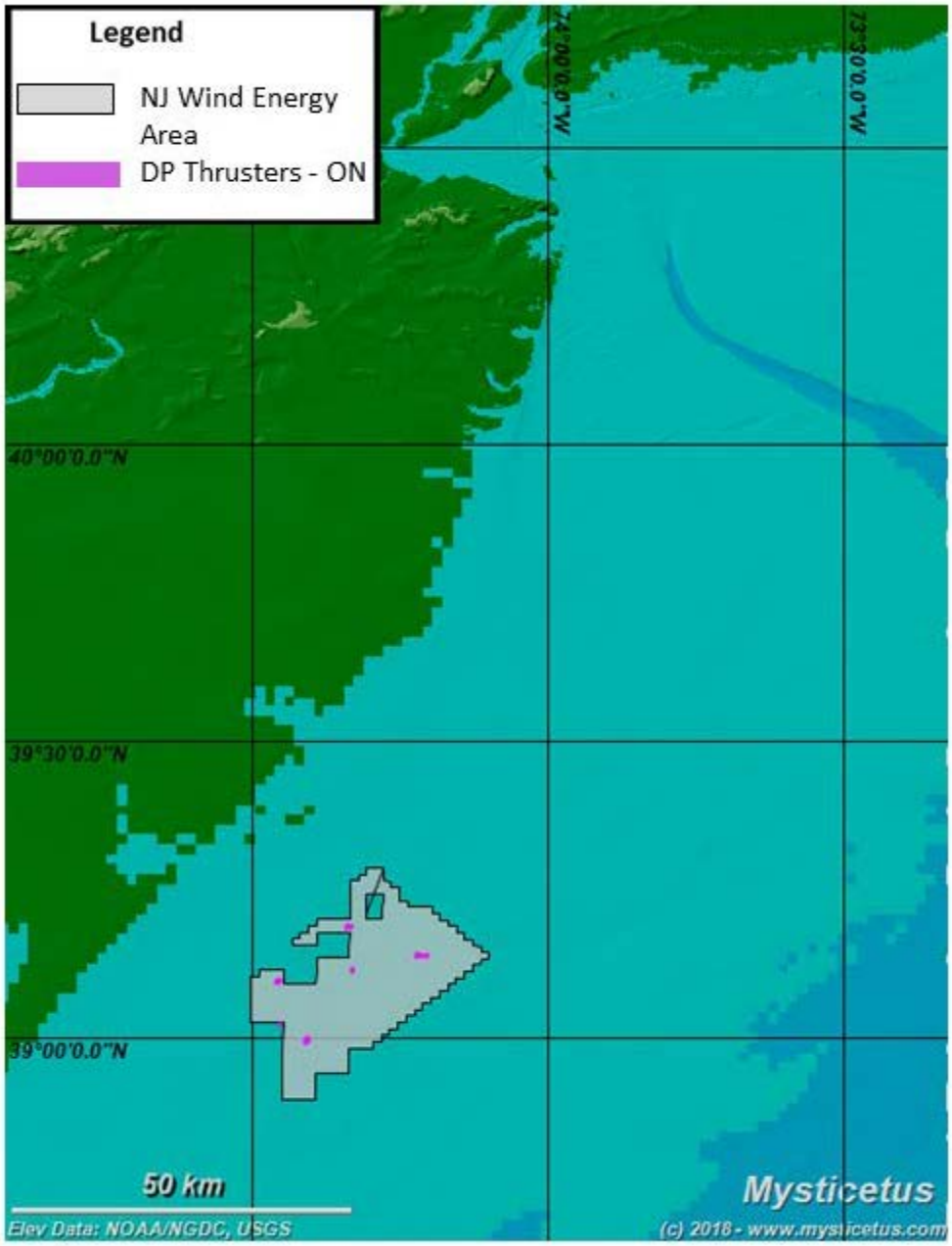


Figure 20. *Phase 2* PSO monitoring effort (visual and PAM) during DPT On Effort (see Figure 1 for CPT/DCPT/BH station locations where DPT use was focused).

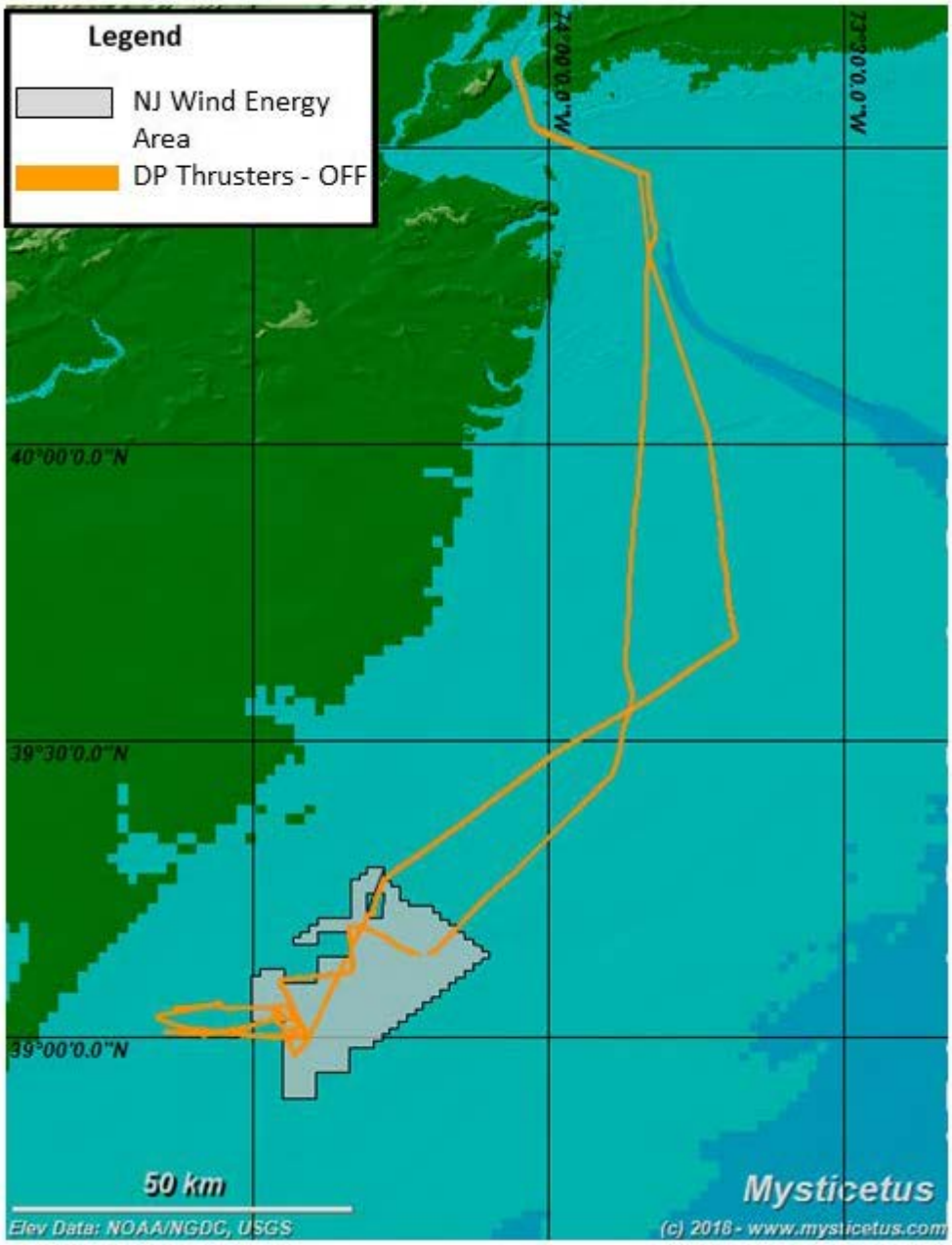


Figure 21. *Phase 2* vessel tracklines and PSO monitoring effort (visual and PAM) during DPT Off Effort inside and outside the Lease Area (indicated by gray polygon)

4.2.1.1 Phase 2 Environmental Conditions

Overall, the environmental conditions inside and outside the Lease Area were conducive to appropriately monitor marine mammals during survey operations using the four described monitoring methods (Figure 22). Bft ranged from 1-6 with an occasional Bft 7 and 8. PSO visual monitoring effort (UE, NVD and IR) occurred most often during Bft 5 (33 %) followed by Bft 4 (21 %) and Bft 6 (20 %). PAM monitoring effort occurred most frequently during Bft 4 (32 %) followed by Bft 3 (23 %) and Bft 2 (20 %).

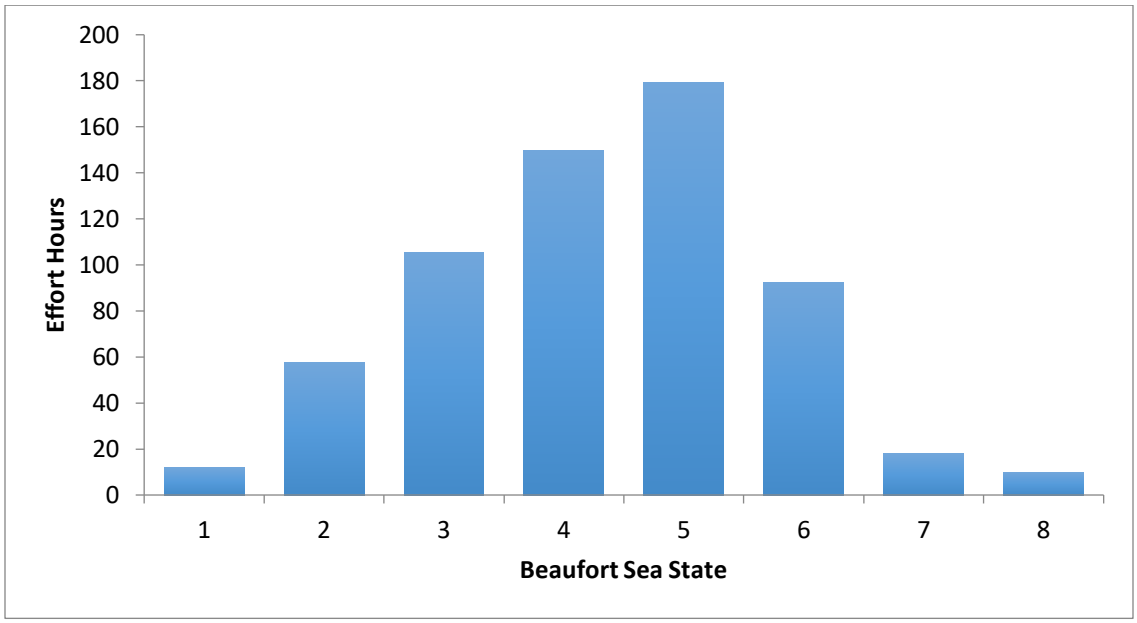


Figure 22. *Phase 2* PSO monitoring effort (visual and PAM) during Beaufort 1-8Protected Species Detections

4.2.1 *Phase 2* Protected Species Detections

During the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2*, there were a total 25 protected species detections both inside and outside the Lease Area (comprised of 81 estimated individuals from 5 different species; Figures 23-26 Tables 16-19). Of the 60 detections, 56 % were identified to species while the remaining 44 % were identified only to taxonomic family level. The most commonly recorded species was the unidentified dolphin (6 detections of 10 estimated individuals). There were 3 detections (51 estimated individuals) of bottlenose dolphin. Large whale detections included humpback whales (3 detections of 5 individuals), fin whales (3 detections of 4 individuals), minke whales (3 detections of 3 individuals) and unidentified whales (3 detections of 4 individuals). A total of four sea turtles were recorded; 2 loggerhead sea turtles and 2 unidentified sea turtles. No Atlantic sturgeon was sighted. A table of all protected species detections and details is provided in Appendix B.

More detections occurred inside (n = 20) vs. outside (n = 5) the Lease Area (Table 16). Similarly, most large whales were seen inside (n = 9) vs. outside (n = 1) the Lease Area. Only the humpback whale was identified to species outside the Lease Area. All sea turtle detections occurred inside the Lease Area (Table 16).

4.2.1.1 Phase 2 North Atlantic Right Whale Sighting

There were no North Atlantic right whale (*Balaena glacialis*) detections recorded during *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2*. Thus, NARW reports were not necessary/completed during Phase 2 of the survey (as described in Appendix B of the BOEM project Lease).

Figure 23. ***Phase 2*** **sighting locations of all visual and PAM detections of protected species outside and inside the Lease Area (indicated by gray polygon).**

Figure 24. ***Phase 2*** **sighting locations of all dolphin or porpoise species (i.e., combined bottlenose and unidentified dolphin or porpoise) visual and PAM detections outside and inside the Lease Area (indicated by gray polygon).**

Figure 25. ***Phase 2*** **sighting locations of all large whale species (i.e., combined humpback, fin and minke) visual and PAM detections outside and inside the Lease Area (indicated by gray polygon).**

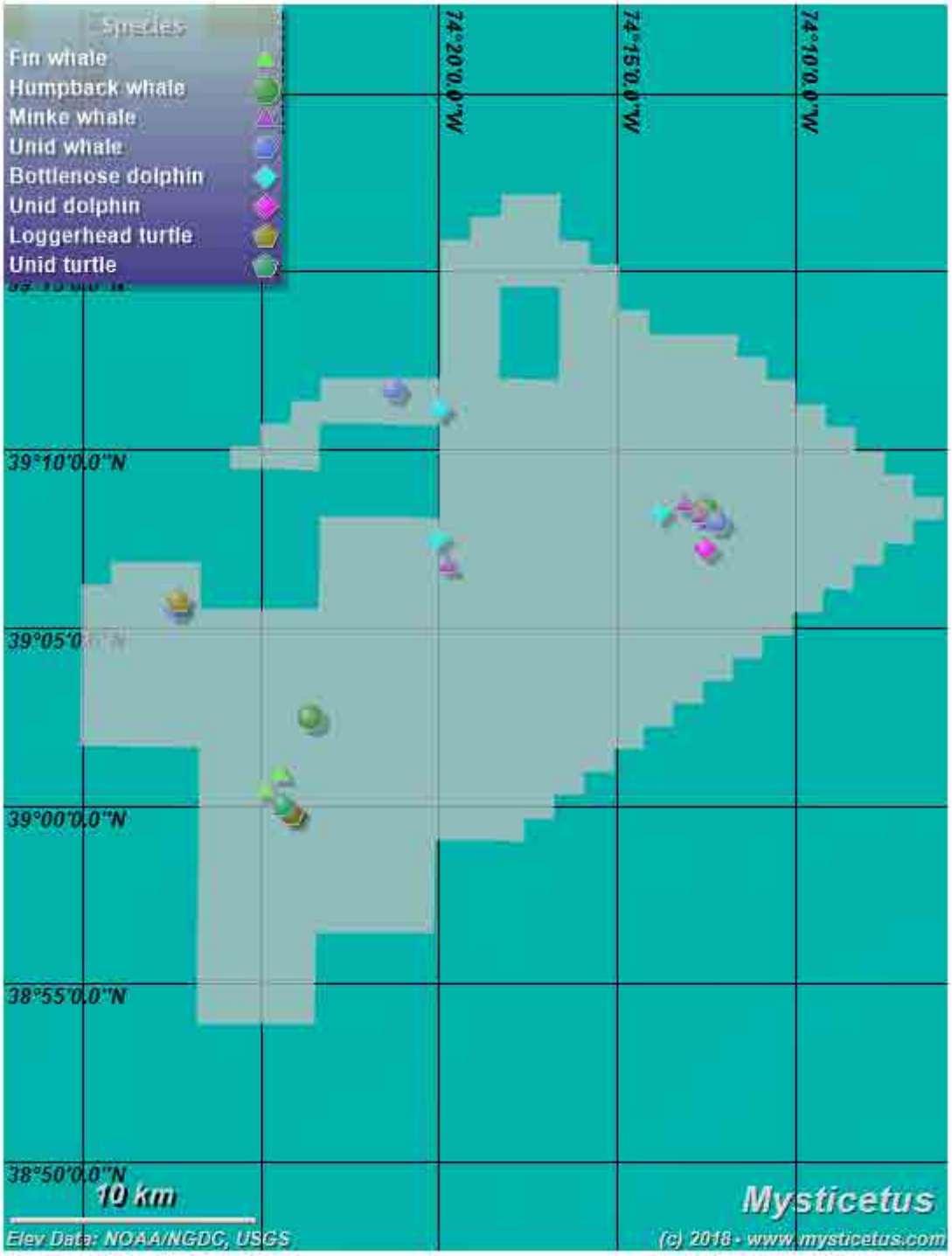


Figure 26. ***Phase 2*** **sighting locations of all visual and PAM detections of protected species focused on those inside the Lease Area indicated by the gray polygon (zoomed in to differentiate closely-spaced detections).**

Table 16. Total number of marine mammal detections and estimated number of individuals visually or passive acoustically detected during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2* outside and inside the Lease Area.

		Outside Lease Area		Inside Lease Area		Total	
Species Common Name	**Species Scientific Name**	**No. Detections[1]**	**No. Est. Individuals[2/]**	**No. Detections[1/]**	**No. Est. Individuals[2/]**	**No. Detections[1/]**	**No. Est. Individuals[2/]**
Marine Mammal Detections							
Bottlenose Dolphin	*Tursiops truncatus*	**0**	**0**	**3**	**51**	**3**	**51**
Fin Whale	*Balaenoptera physalus*	0	0	3	4	3	4
Humpback Whale	*Megaptera novaeangliae*	1	2	2	3	3	5
Minke Whale	*Balaenoptera acutorostrata*	0	0	3	3	3	3
Unidentified Dolphin or Porpoise		4	8	2	2	6	10
Unidentified Whale		0	0	3	4	3	4
Marine Mammal Total		**5**	**10**	**16**	**67**	**21**	**77**
Sea Turtle Detections							
Loggerhead Sea Turtle	*Caretta caretta*	0	0	2	2	2	2
Unidentified Sea Turtle		0	0	2	2	2	2
Sea Turtle Total		**0**	**0**	**4**	**4**	**4**	**4**
Overall Total		**5**	**10**	**20**	**71**	**25**	**81**

[1/] A detection is defined as a group of one or more individuals detected visually using the unaided eye (with occasional use of reticle binoculars, primarily to confirm sightings, species, etc., as needed), infra-red bi-oculars, night vision device, or detected acoustically using passive acoustic monitoring

[2/] Estimated Individuals = estimated number of individuals within each detection (separate group/sighting)

Table 17. Total number of marine mammal detections during DPT Off and DPT On periods outside the Lease Area during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2.*

Outside Lease Area						
Species	**DPT Off[1/]**		**DPT On[2/]**		**Total**	
	No. Detection[3/]	**No. Est. Individual[4/]**	**No. Detection[3/]**	**No. Est. Individual[4/]**	**No. Detection[3/]**	**No. Est. Individual[4/]**
Humpback Whale	1	2	0	0	1	2
Unidentified Dolphin or Porpoise	4	8	0	0	4	8
Total	5	10	0	0	**5**	**10**

1/ DPT Off = while DP thrusters are not in operation
2/ DPT On = while DP thrusters are in operation
3/ A detection is defined as a group of one or more individuals detected visually using the unaided eye (with occasional use of reticle binoculars, primarily to confirm sightings, species, etc., as needed), infra-red bi-oculars, night vision device, or detected acoustically using passive acoustic monitoring
4/ Estimated Individuals = estimated number of individuals within each detection (separate group/sighting)

Table 18. Total number of marine mammal detections during DPT Off and DPT On periods inside the Lease Area during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2.*

Inside Lease Area						
	DPT Off[1/]		**DPT On[2/]**		**Total**	
Species Common Name	**No. Detections[1/]**	**No. Est. Individuals[2/]**	**No. Detections[1/]**	**No. Est. Individuals[2/]**	**No. Detections[1/]**	**No. Est. Individuals[2/]**
Marine Mammal Detections						
Bottlenose Dolphin	0	0	3	51	3	51
Fin Whale	0	0	3	4	3	4
Humpback Whale	1	1	1	2	2	3
Minke Whale	0	0	3	3	3	3
Unidentified Dolphin or Porpoise	0	0	2	2	2	2
Unidentified Whale	0	0	3	4	3	4
Marine Mammal Total	**1**	**1**	**15**	**66**	**16**	**67**
Sea Turtle Detections						
Loggerhead Sea Turtle	0	0	2	2	2	2
Unidentified Sea Turtle	0	0	2	2	2	2
Sea Turtle Total	**0**	**0**	**4**	**4**	**4**	**4**
Overall Total	**1**	**1**	**19**	**70**	**20**	**71**

1/ DPT Off = while DP thrusters are not in operation
2/ DPT On = while DP thrusters are in operation
3/ A detection is defined as a group of one or more individuals detected visually using the unaided eye (with occasional use of reticle binoculars, primarily to confirm sightings, species, etc., as needed), infra-red bi-oculars, night vision device, or detected acoustically using passive acoustic monitoring
4/ Estimated Individuals = estimated number of individuals within each detection (separate group/sighting)

Table 19. Total number of marine mammal detections during DPT Off and DPT On periods inside and outside the Lease Area during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2.*

	DPT Off[1/]		DPT On[2/]		Total	
Species Common Name	**No. Detections[1]**	**No. Est. Individuals[2/]**	**No. Detections[1/]**	**No. Est. Individuals[2/]**	**No. Detections[1/]**	**No. Est. Individuals[2/]**
Marine Mammal Detections						
Bottlenose Dolphin	0	0	3	51	3	51
Fin Whale	0	0	3	4	3	4
Humpback Whale	2	3	1	2	3	5
Minke Whale	0	0	3	3	3	3
Unidentified Dolphin or Porpoise	4	8	2	2	6	10
Unidentified Whale	0	0	3	4	3	4
Marine Mammal Total	**6**	**11**	**15**	**66**	**21**	**77**
Sea Turtle Detections						
Loggerhead Sea Turtle	0	0	2	2	2	2
Unidentified Sea Turtle	0	0	2	2	2	2
Sea Turtle Total	**0**	**0**	**4**	**4**	**4**	**4**
Overall Total	**6**	**11**	**19**	**70**	**25**	**81**

1/ DPT Off = while DP thrusters are not in operation
2/ DPT On = while DP thrusters are in operation

Most (76 %) of the total 25 detections occurred during DPT On periods (i.e., when DPT were operating) and the remaining (24 %) detections occurred during DPT Off periods (i.e., when DPT were not operating) (Table 19). The only detections that occurred during periods of DPT Off were two (3 individuals) of humpback whales and 4 detections (8 individuals) of unidentified dolphin or porpoise. All other detections occurred during DPT On periods.

4.2.1.2 Phase 2 Protected Species Behavior

To maximize sample size, behavior data were pooled for all detections both inside and outside the Lease Area. Behavior state was recorded for 18 of the total 25 detections; and was unknown for the other 7 detections because they were too far away, or were observed only briefly. For the 12 detections of large whales, travel was the most commonly (69 %) observed behavior state.

There was no apparent difference between behavior states observed when DPT were on vs. off for the combined bottlenose dolphin and unidentified dolphin or porpoise detections. Surface-active travel and travel were the most commonly observed behavior states when DPT were on (50 %) vs. off (78 %) (Figure 27). Though sample size was small, there was also no apparent difference between behavior states observed by periods with DPT on vs. off for the combined large whale species (i.e., all humpback, fin, minke and unidentified whale) (Figure 28).

Table 20. *Phase 2* Behavior states observed for all protected species detections.

Species Common Name	Mill	Rest	Surface-Active Mill	Surface-Active Travel	Travel	Unknown	Total
Marine Mammal Detections							
Bottlenose Dolphin	0	0	0	3	0	0	3
Fin Whale	0	1	0	0	0	2	3
Humpback Whale	0	0	0	0	2	1	3
Minke Whale	0	0	0	0	3	0	3
Unidentified Dolphin or Porpoise	0	0	1	1	3	1	6
Unidentified Whale	0	0	0	0	1	2	3
Sea Turtle Detections							
Loggerhead Sea Turtle	0	0	0	0	1	1	2
Unidentified Sea Turtle	2	0	0	0	0	0	2
Overall Total	**2**	**1**	**1**	**4**	**10**	**7**	25

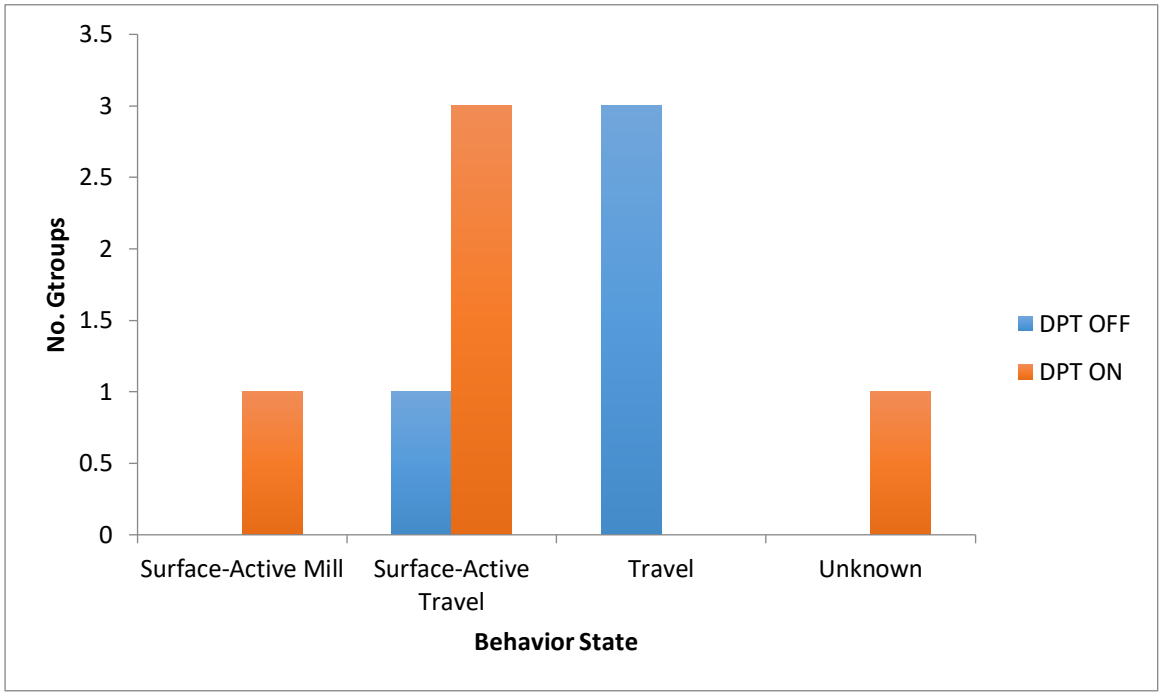


Figure 27. Behavior states for all dolphin or porpoise species (i.e., bottlenose dolphin and unidentified dolphin or porpoise) observed during DPT Off and DPT On periods during *Phase 2.*

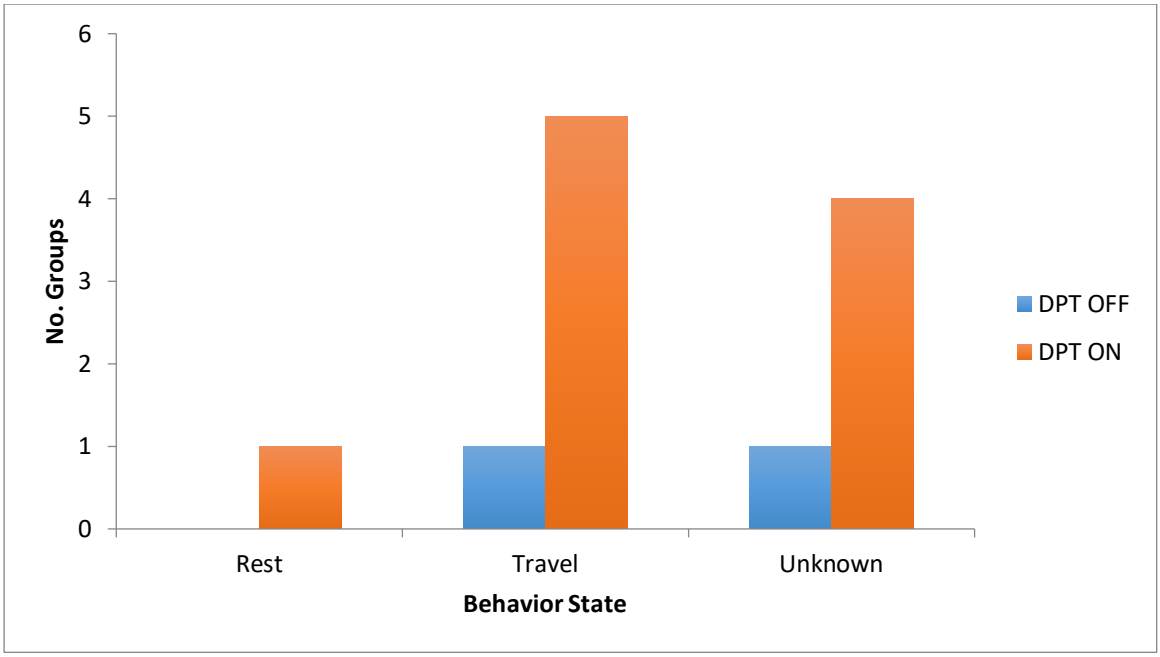


Figure 28. Behavior states for all large whale species (i.e., combined humpback, fin, minke and unidentified whales) observed during DPT Off and DPT On periods during *Phase 2.*

4.2.1.3 Phase 2 Closest Point of Observed Approach (CPA)

To maximize sample size, CPA data were pooled and calculated for all protected species detections (i.e., pooling detections made inside and outside the Lease Area) (Figures 29 and 30). CPA is presented for each sighting in Appendix A.

- Of the 9 total dolphin detections with recorded CPA (Figure 29):
  - Five occurred during DPT On periods and 4 occurred during DPT Off periods
  - The most frequent CPA during DPT On periods was 1001-2000 m (40 %)
  - The most frequent CPA during DPT Off periods 501-1000 m (50 %)
- Of the 16 total large whale detections with recorded CPA (Figure 30):
  - Eleven occurred during DPT On periods and 2 occurred during DPT Off periods
  - The most frequent CPA during DPT On periods was 1001-2000 m (36 %) followed by 501-1000 m (27 %)
  - CPA during DPT Off periods was 201-300 m (50 %) and > 2000 m (50 %)

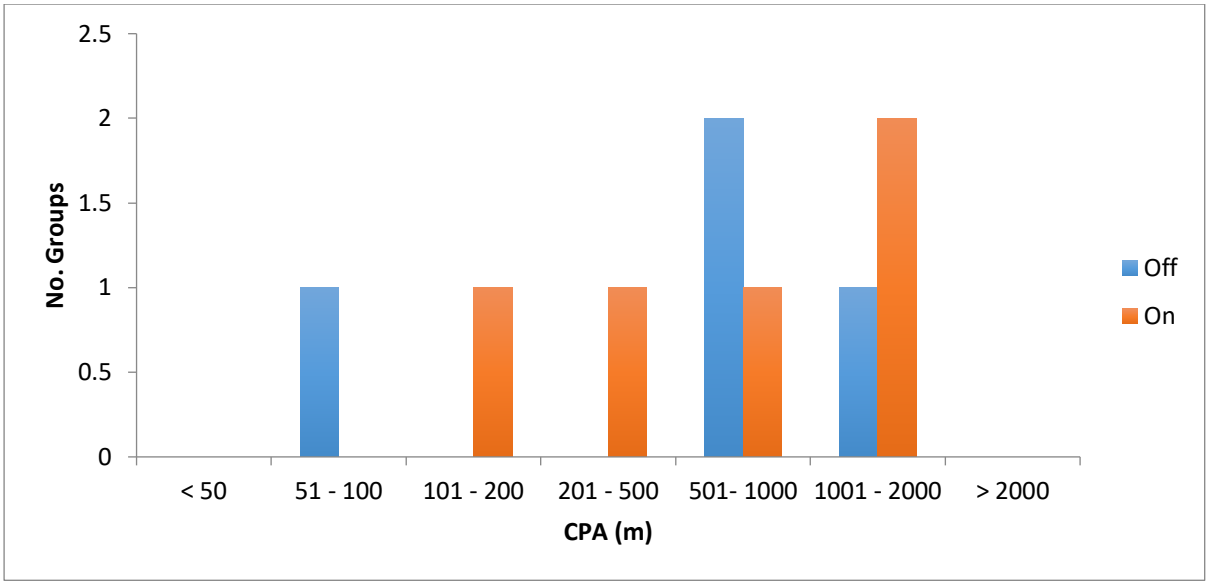


Figure 29. Closest Point of observed Approach (CPA) for all dolphin or porpoise species (i.e., combined bottlenose dolphin and unidentified dolphin or porpoise) observed during DPT Off and DPT On periods during *Phase 2.*

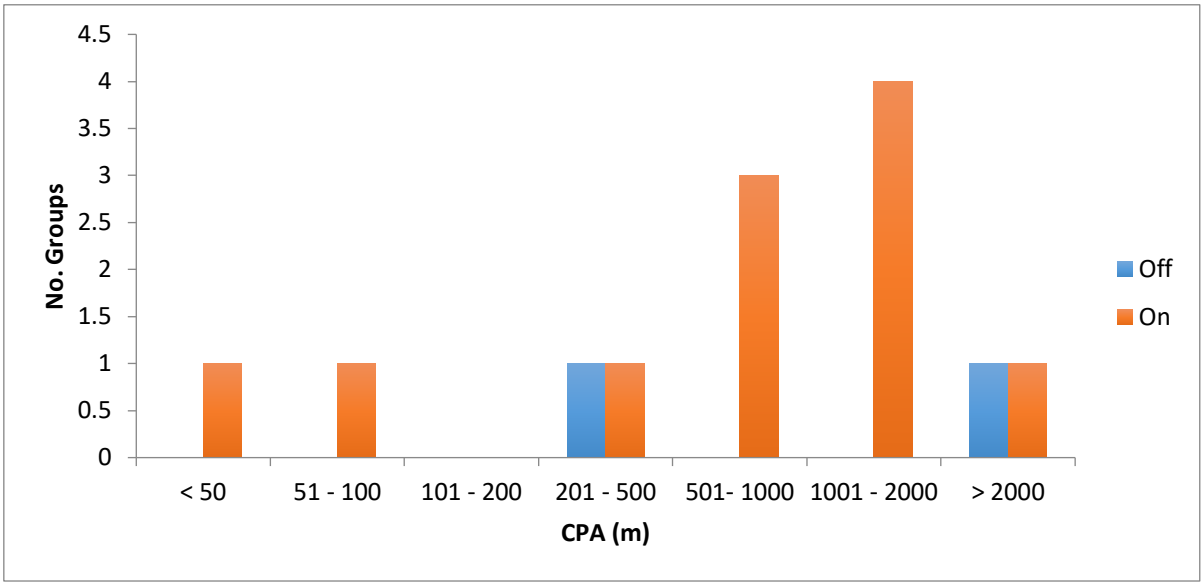


Figure 30. Closest Point of observed Approach (CPA) for all large whale species (i.e., combined humpback, fin, minke and unidentified whales) observed during DPT Off and DPT On periods *Phase 2.*

4.2.2 *Phase 2* Protected Species Exposures

The number of potential exposures was based on direct observations/counts or acoustic detections of protected species while the DPT were operating. Exposures were categorized based on distance from the vessel/DPT: 1) < 500 m, 2) 500-1000 m, and 3) > 1000 m (Table 21).

A total of 19 groups and an estimated minimum total of 70 individual marine mammals were visually observed or acoustically detected while the DPT were operating (Table 21). Of these 19 detections, 9 (~18 individuals) were detected within the 500-m MZ, 4 (~11 individuals) were within the 500-1000 m MZ, and 6 (~41 individuals) were detected > 1000 m away. All detections were made visually (i.e. no PAM detections) therefore all detections had an associated estimated distance (Table 21).

Changes in individual behaviors were observed during both DPT On and DPT Off periods. During DPT Off a humpback whale was recorded with a behavioral change of "dive". During DPT On two loggerhead sea turtles were recorded with behavioral changes of "dive". Both were considered normal behaviors for these species (Table 22). Per the MMPA, the definition of a take is defined as an animal that shows a "disruption of natural behavioral patterns (i.e., migration, surfacing, nursing, breeding, feeding, or sheltering) to a point where such behavioral patterns are abandoned or significantly altered." No such adverse behavioral disruptions were observed or acoustically detected during the *OCW01 Geotechnical Investigation 1A (2017)* that met this definition of take (Table 23).

4.2.3 *Phase 2* Protected Species Incident Reports

There were no marine mammal deaths, carcasses or strandings recorded during *OCW01 Geotechnical Investigation 1A (2017 & 2018).* Thus, no Protected Species Injury or Mortality reports were necessary/completed during the survey (as described in Appendix B of the BOEM project Lease).

Table 21. Summary table of number of minimum estimated potential exposures by distance categories during DP thruster operations during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2.*

Visual (UE/IR/NVD)[1/] Detections								
Species Common Name	**<500 m**		**500-1000 m**		**>1000 m**		**Total Potential Exposures**	
	No. Groups	Est. No. Individuals	No. Groups	Est. No. Individuals	No. Groups	Est. No. Individuals	No. Groups	Est. No. Individuals
Marine Mammal Detections								
Bottlenose Dolphin	1	9	1	7	1	35	3	51
Fin Whale	0	0	1	1	2	3	3	4
Humpback Whale	0	0	1	2	0	0	1	2
Minke Whale	2	2	1	1	0	0	3	3
Unidentified Dolphin or Porpoise	1	1	0	0	1	1	2	2
Unidentified Whale	1	2	0	0	2	2	3	4
Marine Mammal Total	**5**	**14**	**4**	**11**	**6**	**41**	**15**	**66**
Sea Turtle Detections								
Loggerhead Sea Turtle	2	2	0	0	0	0	2	2
Unidentified Sea Turtle	2	2	0	0	0	0	2	2
Sea Turtle Total	**4**	**4**	**0**	**0**	**0**	**0**	**4**	**4**
Overall Total	**9**	**18**	**4**	**11**	**6**	**41**	**19**	**70**

[1/]UE = Unaided Eye (with occasional use of reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red, NVD = Night Vision Device.

Table 22. Number and behavioral changes of protected species detected during DPT Off and DPT On periods during *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2.*

	No Exposure DPT Off[1/]				Yes Exposure DPT On[2/]			
Species Common Name	**No. Detections[1]**	**No. Est. Individuals[2/]**	**Type of Behavioral Change Observed**	**No. Indiv. Exhibiting Behavioral Change**	**No. Detections[1/]**	**No. Est. Individuals[2/]**	**Type of Behavioral Change Observed**	**No. Indiv. Exhibiting Behavioral Change**
Marine Mammal Detections								
Bottlenose Dolphin	**0**	**0**	None	N/A	**3**	**51**	None	N/A
Fin Whale	0	0	None	N/A	3	4	None	N/A
Humpback Whale	2	3	Dive	1	1	2	None	N/A
Minke Whale	0	0	None	N/A	3	3	None	N/A
Unidentified Dolphin or Porpoise	4	8	None	N/A	2	2	None	N/A
Unidentified Whale	0	0	None	N/A	3	4	None	N/A
Marine Mammal Total	**6**	**11**			**15**	**66**		
Sea Turtle Detections								
Loggerhead Sea Turtle	0	0	None	N/A	2	2	None	N/A
Unidentified Sea Turtle	0	0	None	N/A	2	2	Dive	2
Sea Turtle Total	**0**	**0**			**4**	**4**		
Overall Total	**6**	**11**			**19**	**70**		

[1/]No Exposure = detected when DP thrusters were not in operation (i.e., underway) (i.e., during DPT Off period).
[2/]Yes Exposure = detected while DP thrusters were in operation (i.e., during DPT On period).

4.2.4 *Phase 2* Mitigation Measures

Mitigation measures requested and implemented during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2* are summarized in Table 23 and presented for each visual and PAM detection in Appendix B.

Table 23. Summary table of mitigation measures implemented during the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2.*

Species	Vessel Course Change	Power Down Requested (Denied Due to Safety)[1/]	None	Total
Bottlenose Dolphin	0	1	2	3
Fin Whale	0	0	3	3
Humpback Whale	1	1	1	3
Minke Whale	0	1	2	3
Unidentified Dolphin or Porpoise	0	0	6	6
Unidentified Whale	0	0	3	3
Loggerhead Sea Turtle	0	2		2
Unidentified Sea Turtle	0	0	2	2
Total	**1**	**5**	**19**	**25**

5 Literature Cited

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Appendix A *Phase 1* Detections Summary Table

Date/Time (EST)	Species	Initial Detection Method[1/]	CPA (m)	No. Est. Individuals	Behavior State	DP Thrusters On vs. Off	Mitigation Measure	Behavioral Change	PAM Call
2017-12-02T13:01:14.2	Humpback Whale	UE	1000	1	Travel	Off	None	None	
2017-12-03T02:26:50.5	Common Dolphin	UE	300	2	Surface-Active Travel	Off	None	None	
2017-12-03T09:11:11.7	Common Dolphin	UE	50	10	Travel	Off	Speed Reduction	None	
2017-12-03T14:59:12.1	Unidentified Dolphin or Porpoise	UE	1000	23	Travel	Off	None	None	
2017-12-03T15:55:49.3	Common Dolphin	UE	2892	50	Surface-Active Mill	Off	None	None	
2017-12-05T08:18:58.6	Common Dolphin	UE	50	6	Surface-Active Travel	Off	None	None	
2017-12-05T08:42:00.0	Common Dolphin	UE	50	20	Surface-Active Travel	Off	Delay	Bow-riding/Approach	
2017-12-06T07:52:05.1	Common Dolphin	UE	500	4	Surface-Active Travel	Off	Course Change	None	
2017-12-06T14:41:01.7	Common Dolphin	UE	500	10	Surface-Active Mill	Off	None	None	
2017-12-06T16:57:51.2	Common Dolphin	UE	300	3	Travel	On	Powerdown (Denied - Safety)	None	
2017-12-06T19:48:17.7	Unidentified Dolphin or Porpoise	NVD	10	4	Travel	On	Powerdown (Denied - Safety)	None	
2017-12-06T20:11:22.5	Unidentified Dolphin or Porpoise	NVD	50	3	Mill	On	Powerdown (Denied - Safety)	None	
2017-12-07T00:30:13.2	Common Dolphin	PAM	60	7	Surface-Active Mill	On	None	None	Clicks
2017-12-07T02:47:30.6	Common Dolphin	IR	50	3	Surface-Active Travel	On	None	None	
2017-12-07T20:26:08.2	Common Dolphin	NVD	50	4	Surface-Active Travel	On	None	None	
2017-12-07T21:55:32.2	Common Dolphin	PAM	30	3	Surface-Active Travel	On	None	None	Clicks
2017-12-08T01:43:40.9	Common Dolphin	UE	50	3	Surface-Active Travel	On	None	None	
2017-12-08T22:27:02.0	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks
2017-12-08T22:56:35.0	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks
2017-12-08T23:54:02.0	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks

2017-12-09T00:31:33.6	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks
2017-12-09T05:45:55.7	Unidentified Dolphin or Porpoise	UE	20	2	Travel	Off	None	None	
2017-12-09T09:13:32.1	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks
2017-12-10T10:08:32.1	Fin Whale	UE	633	1	Travel	Off	Speed Reduction	None	
2017-12-10T16:34:46.7	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks
2017-12-10T18:11:54.5	Common Dolphin	NVD	50	3	Travel	On	None	None	
2017-12-10T18:50:27.5	Common Dolphin	UE	35	5	Surface-Active Travel	Off	None	Bow-riding/Approach	
2017-12-10T19:57:17.0	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	Off	None	None	Clicks
2017-12-11T01:57:06.3	Common Dolphin	UE	100	3	Travel	On	None	None	
2017-12-12T01:16:28.4	Common Dolphin	UE	50	2	Surface-Active Travel	On	None	None	
2017-12-12T02:18:19.7	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Travel	On	None	None	Clicks
2017-12-12T15:47:59.8	North Atlantic Right Whale	UE	2892	1	Surface-Active Travel	Off	None	None	
2017-12-12T20:36:20.5	Unidentified Dolphin or Porpoise	UE	30	1	Surface-Active Travel	Off	None	None	
2017-12-18T10:41:00.9	Common Dolphin	UE	700	9	Surface-Active Mill	Off	Speed Reduction	None	
2017-12-18T11:12:46.7	Unidentified Whale	UE	727	1	Travel	Off	None	None	
2017-12-18T11:19:40.1	Humpback Whale	UE	633	1	Surface-Active Travel	Off	None	None	
2017-12-18T14:22:01.3	Unidentified Dolphin or Porpoise	UE	561	2	Travel	Off	None	None	
2017-12-21T03:09:51.1	Unidentified Dolphin or Porpoise	NVD	50	5	Travel	Off	None	None	
2017-12-21T08:11:10.9	Unidentified Whale	UE	6175	1	Unknown	Off	None	None	
2017-12-22T07:20:38.6	Unidentified Dolphin or Porpoise	UE	400	2	Travel	On	None	None	
2017-12-28T03:12:21.3	Common Dolphin	PAM	100	1	Unknown - PAM	On	None	None	Clicks
2017-12-28T05:03:26.1	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks
2017-12-28T05:20:32.7	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks
2017-12-28T15:30:39.8	Unidentified Whale	UE	600	1	Unknown	On	None	None	
2017-12-29T00:06:28.7	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks
2017-12-29T00:41:32.6	Unidentified Dolphin or Porpoise	PAM	NA - PAM	1	Unknown - PAM	On	None	None	Clicks
2017-12-29T02:10:06.7	Common Dolphin	PAM	100	3	Travel	On	None	None	Clicks
2017-12-29T03:02:43.6	Common Dolphin	PAM	100	6	Travel	On	None	None	Clicks

2017-12-31T04:15:32.1	Common Dolphin	UE	30	4	Surface-Active Travel	Off	None	None	
2018-01-01T14:29:34.3	Unidentified Whale	UE	727	1	Travel	Off	Speed Reduction	None	
2018-01-01T14:43:02.2	Common Dolphin	UE	50	8	Travel	Off	None	None	
2018-01-01T15:33:00.0	Unidentified Whale	UE	2892	2	Travel	Off	None	None	
2018-01-01T16:35:32.5	Unidentified Whale	UE	3873	1	Travel	Off	None	None	
2018-01-09T03:46:17.3	Unidentified Dolphin or Porpoise	NVD	100	6	Surface-Active Travel	Off	None	Bow-riding/Approach	
2018-01-09T10:57:10.5	Unidentified Whale	UE	800	1	Travel	Off	None	None	
2018-01-09T14:41:59.3	Unidentified Whale	UE	1312	1	Travel	Off	None	None	
2018-01-11T11:11:44.9	Humpback Whale	UE	854	1	Travel	On	None	None	
2018-01-11T11:24:22.0	Unidentified Whale	UE	4247	2	Travel	On	None	None	
2018-01-11T13:02:45.7	Unidentified Whale	UE	727	1	Travel	On	None	None	
2018-01-11T14:48:35.0	Minke Whale	UE	633	2	Surface-Active Mill	On	None	None	

[1/]UE = Unaided Eye (with occasional use of reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red, NVD = Night Vision Device, PAM = Passive Acoustic Monitoring.

Appendix B *Phase 2* Detections Summary Table

Date/Time (EST)	Species	Initial Detection Method[1/]	CPA (m)	No. Est. Individuals	Behavior State	DP Thrusters (On/Off)	Mitigation Measure	Behavioral Change
2018-05-22T13:42:00.8	Unidentified Dolphin	UE	1500	4	Travel	Off	None	None
2018-05-22T14:52:35.6	Unidentified Dolphin	UE	1000	2	Travel	Off	None	None
2018-05-22T15:24:29.4	Unidentified Dolphin	UE	600	1	Travel	Off	None	None
2018-05-22T19:07:02.6	Humpback Whale	UE	500	2	Travel	Off	Course Change	None
2018-05-23T15:28:11.1	Unidentified Whale	UE	1500	1	Travel	On	None	None
2018-05-23T16:37:03.2	Minke Whale	UE	800	1	Travel	On	None	None
2018-05-23T18:03:16.5	Minke Whale	UE	100	1	Travel	On	None	None
2018-05-24T09:48:35.9	Bottlenose Dolphin	UE	1000	7	Surface-Active Travel	On	None	None
2018-05-24T10:13:56.3	Humpback Whale	UE	800	2	Travel	On	Powerdown (Denied - Safety)	None
2018-05-24T19:15:42.2	Unidentified Dolphin	UE	2000	1	Surface-Active Mill	On	None	None
2018-05-28T09:03:29.8	Unidentified Whale	UE	1800	1	Unknown	On	None	None
2018-05-28T09:23:46.6	Bottlenose Dolphin	UE	300	9	Surface-Active Travel	On	Powerdown (Denied - Safety)	None
2018-05-29T11:04:12.0	Minke Whale	UE	50	1	Travel	On	Powerdown (Denied - Safety)	None
2018-05-29T12:31:39.3	Bottlenose Dolphin	UE	1500	35	Surface-Active Travel	On	None	None
2018-05-31T06:50:02.3	Unidentified Whale	UE	400	2	Unknown	On	None	None
2018-06-01T10:18:18.3	Loggerhead Turtle	UE	60	1	Travel	On	Powerdown (Denied - Safety)	None
2018-06-04T07:31:01.7	Unid turtle	UE	5	1	Mill	On	None	Dive
2018-06-05T08:10:34.9	Fin Whale	UE	1000	1	Rest	On	None	None
2018-06-05T14:51:32.7	Fin Whale	UE	2000	1	Unknown	On	None	None
2018-06-05T16:17:25.5	Fin Whale	UE	1500	2	Unknown	On	None	None
2018-06-06T05:05:13.3	Unidentified Dolphin	UE	150	1	Unknown	On	None	None
2018-06-06T07:57:26.2	Unidentified Sea Turtle	UE	350	1	Mill	On	None	Dive
2018-06-06T15:09:19.6	Loggerhead turtle	UE	200	1	Unknown	On	Powerdown (Denied - Safety)	None

2018-06-06T17:25:55.6	Humpback Whale	UE	2500	1	Unknown	Off	None	Dive
2018-06-06T20:23:53.1	Unidentified Dolphin	UE	100	1	Surface-Active Travel	Off	None	None

[1/]UE = Unaided Eye (with occasional use of reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red, NVD = Night Vision Device, PAM = Passive Acoustic Monitoring.

Appendix C Ocean Wind NMFS-issued IHA

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

Incidental Harassment Authorization

Ocean Wind, LLC (Ocean Wind) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107, to harass marine mammals incidental to high-resolution geophysical (HRG) and geotechnical survey investigations associated with marine site characterization activities off the coast of New Jersey in the area of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0498) (the Lease Area).

1. This Authorization is valid from June 8, 2017 through June 7, 2018.
2. This Authorization is valid only for HRG and geotechnical survey investigations associated with marine site characterization activities, as described in the Incidental Harassment Authorization (IHA) application.
3. The holder of this authorization (Holder) is hereby authorized to take, by Level B harassment only, 32 short-beaked common dolphins (*Delphinus delphis*), 286 bottlenose dolphin (*Tursiops truncatus*), 4 harbor porpoise (*Phocoena phocoena*), 5 fin whale (*Balaenoptera physalus*), and 1 harbor seal (*Phoca vitulina*) incidental to HRG survey activities and dynamic positioning (DP) vessel thruster use during geotechnical activities.
4. The taking of any marine mammal in a manner prohibited under this IHA must be reported immediately to NMFS' Greater Atlantic Regional Fisheries Office (GARFO) at 978-281-9300.

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5. The Holder or designees must notify NMFS GARFO and Office of Protected Resources (OPR) at 301-427-8401 at least 24 hours prior to the commencement of the specified activity.
6. The holder of this Authorization must notify the Chief of the Permits and Conservation Division, Office of Protected Resources, or her designee at least 24 hours prior to the start of survey activities (unless constrained by the date of issuance of this Authorization in which case notification shall be made as soon as possible) at 301-427-8401 or to *laura.mccue@noaa.gov*.
7. Mitigation Requirements

The Holder is required to abide by the following mitigation conditions listed in 7(a)-(f). Failure to comply with these conditions may result in the modification, suspension, or revocation of this IHA.

(a) *Marine Mammal Exclusion Zones:* Protected species observers (PSOs) shall monitor the following zones for the presence of marine mammals:

- A 200-m exclusion zone during HRG surveys is in operation.
- A 500-m monitoring zone during the use of DP thrusters during geotechnical survey.
- At all times, the vessel operator shall maintain a separation distance of 500 m from any sighted North Atlantic right whale as stipulated in the *Vessel Strike Avoidance* procedures described below.

Visual monitoring of the established exclusion zone(s) shall be performed by qualified and NMFS-approved protected species observers (PSOs). An observer team composed of a minimum of four NMFS-approved PSOs and two certified Passive Acoustic Monitoring (PAM) operators, operating in shifts, shall be stationed aboard either the survey vessel or a dedicated PSO-vessel.

PSOs shall be equipped with binoculars and have the ability to estimate distances to marine mammals located in proximity to the vessel and/or exclusion zone using range finders. Reticulated binoculars will also be available to PSOs for use as appropriate based on conditions and visibility to support the siting and monitoring of marine species. Digital single-lens reflex camera equipment shall be used to record sightings and verify species identification. During night operations, PAM (see *Passive Acoustic Monitoring* requirements below) and night-vision equipment in combination with infrared video monitoring shall be used. The PSOs shall begin observation of the exclusion zone(s) at least 60 minutes prior to ramp-up of HRG survey equipment. Use of noise-producing equipment shall not begin until the exclusion zone is clear of all marine mammals for at least 60 minutes. If a marine mammal is seen approaching or entering the 200-m exclusion zones during the HRG survey, or the 500-m monitoring zone during DP thrusters use, the vessel operator shall adhere to the shutdown/powerdown procedures described below to minimize noise impacts on the animals.

(b) *Ramp-Up:* A ramp-up procedure shall be used for HRG survey equipment capable of adjusting energy levels at the start or re-start of HRG survey activities. The ramp-up procedure shall not be initiated during daytime, night time, or periods of inclement weather if the exclusion zone cannot be adequately monitored by the PSOs using the appropriate visual technology (*e.g.*, reticulated binoculars, night vision equipment) and/or PAM for a 60-minute period. A ramp-up shall begin with the power of the smallest acoustic HRG equipment at its lowest practical power output appropriate for the survey. The power shall then be gradually turned up and other acoustic sources added such that the source level would increase in steps not exceeding 6 dB per 5-minute period. If a marine mammal is sighted within the HRG survey exclusion zone prior to or during

the ramp-up, activities shall be delayed until the animal(s) has moved outside the monitoring zone and no marine mammals are sighted for a period of 60 minutes.

(c) *Shutdown and Powerdown*

HRG Survey - The exclusion zone(s) around the noise-producing activities HRG survey equipment will be monitored, as previously described, by PSOs and at night by PAM operators for the presence of marine mammals before, during, and after any noise-producing activity. The vessel operator must comply immediately with any call for shutdown by the Lead PSO. If a non-delphinoid (*i.e.*, mysticetes and sperm whales) cetacean is detected at or within the established exclusion zone (200-m exclusion zone during HRG surveys), an immediate shutdown of the HRG survey equipment is required. Subsequent restart of the electromechanical survey equipment must use the ramp-up procedures described above and may only occur following clearance of the exclusion zone for 60 minutes. If a delphinoid cetacean or pinniped is detected at or within the exclusion zone, the HRG survey equipment must be powered down to the lowest power output that is technically feasible. Subsequent power up of the survey equipment must use the ramp-up procedures described above and may occur after (1) the exclusion zone is clear of a delphinoid cetacean and/or pinniped for 60 minutes or (2) a determination by the PSO after a minimum of 10 minutes of observation that the delphinoid cetacean or pinniped is approaching the vessel or towed equipment at a speed and vector that indicates voluntary approach to bow-ride or chase towed equipment. If the HRG sound source shuts down for reasons other than encroachment into the exclusion zone by a marine mammal including but not limited to a mechanical or electronic failure, resulting in the cessation of sound source for a period greater than 20 minutes, a restart for the HRG survey equipment is required using the full ramp-up procedures and clearance of the exclusion zone of all cetaceans and pinnipeds for 60 minutes. If

the pause is less than 20 minutes, the equipment may be restarted as soon as practicable at its operational level as long as visual surveys were continued diligently throughout the silent period and the exclusion zone remained clear of cetaceans and pinnipeds. If the visual surveys were not continued diligently during the pause of 20 minutes or less, a restart of the HRG survey equipment is required using the full ramp-up procedures and clearance of the exclusion zone for all cetaceans and pinnipeds for 60 minutes.

Geotechnical Survey (DP Thrusters) - During geotechnical survey activities if marine mammals enter or approach the established 120 dB isopleth monitoring zone, the Holder shall reduce DP thruster to the maximum extent possible, except under circumstances when reducing DP thruster use would compromise safety (both human health and environmental) and/or the integrity of the equipment. After decreasing thruster energy, PSOs shall continue to monitor marine mammal behavior and determine if the animal(s) is moving towards or away from the established monitoring zone. If the animal(s) continues to move towards the sound source then DP thruster use shall remain at the reduced level. Normal use shall resume when PSOs report that the marine mammals have moved away from and remained clear of the monitoring zone for a minimum of 60 minutes since the last sighting.

(d) *Vessel Strike Avoidance:* The Holder shall ensure that vessel operators and crew maintain a vigilant watch for cetaceans and pinnipeds and slow down or stop their vessels to avoid striking these protected species. Survey vessel crew members responsible for navigation duties shall receive training on marine mammal sighting/reporting and vessel strike avoidance measures. Vessel strike avoidance measures shall include the following, per the Lease, except under extraordinary circumstances when complying with these requirements would put the safety of the vessel or crew at risk:

- All vessel operators shall comply with 10 knot (<18.5 km per hour (km/h)) speed restrictions in any Dynamic Management Area (DMA). In addition, all vessels greater than 65 feet operating from November 1 through July 31 shall operate at speeds of 10 knots (<18.5 km/h) or less.
- All survey vessels shall maintain a separation distance of 500 m or greater from any sighted North Atlantic right whale.
- If underway, vessels must steer a course away from any sited North Atlantic right whale at 10 knots (<18.5 km/h) or less until the 500 m minimum separation distance has been established. If a North Atlantic right whale is sited in a vessel's path, or within 100 m to an underway vessel, the underway vessel must reduce speed and shift the engine to neutral. Engines shall not be engaged until the North Atlantic right whale has moved outside of the vessel's path and beyond 100 m. If stationary, the vessel must not engage engines until the North Atlantic right whale has moved beyond 100 m.
- All vessels shall maintain a separation distance of 100 m or greater from any sighted non-delphinoid (*i.e.*, mysticetes and sperm whales) cetacean. If sighted, the vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the non-delphinoid cetacean has moved outside of the vessel's path and beyond 100 m. If a survey vessel is stationary, the vessel shall not engage engines until the non-delphinoid cetacean has moved out of the vessel's path and beyond 100 m.
- All vessels shall maintain a separation distance of 50 m or greater from any sighted delphinoid cetacean. Any vessel underway shall remain parallel to a

sighted delphinoid cetacean's course whenever possible, and avoid excessive speed or abrupt changes in direction. Any vessel underway shall reduce vessel speed to 10 knots or less when pods (including mother/calf pairs) or large assemblages of delphinoid cetaceans are observed. Vessels may not adjust course and speed until the delphinoid cetaceans have moved beyond 50 m and/or abeam of the underway vessel.

- All vessels shall maintain a separation distance of 50 m (164 ft) or greater from any sighted pinniped.

(e) *Seasonal Operating Requirements*: Between watch shifts members of the monitoring team shall consult the NMFS North Atlantic right whale reporting systems for the presence of North Atlantic right whales throughout survey operations. Throughout all survey operations, the Holder shall monitor the NMFS North Atlantic right whale reporting systems for the establishment of a DMA. If NMFS should establish a DMA in the Lease Area under survey, within 24 hours of the establishment of the DMA the Holder shall work with NMFS to shut down and/or alter the survey activities to avoid the DMA.

(f) *Passive Acoustic Monitoring*: To support 24-hour survey operations, the Holder shall include PAM as part of the project monitoring during the geophysical survey during nighttime operations, or as needed during periods when visual observations may be impaired. In addition, PAM systems shall be employed during daylight hours to support system calibration and PSO and PAM team coordination, as well as in support of efforts to evaluate the effectiveness of the various mitigation techniques (*i.e.*, visual observations during day and night, compared to the PAM detections/operations).

The PAM system shall consist of an array of hydrophones with both broadband (sampling mid-range frequencies of 2 kHz to 200 kHz) and at least one low-frequency hydrophone (sampling range frequencies of 75 Hz to 30 kHz). The PAM operator(s) shall monitor the hydrophone signals in real time both aurally (using headphones) and visually (via the monitor screen displays). PAM operators shall communicate detections/vocalizations to the Lead PSO on duty who shall ensure the implementation of the appropriate mitigation measure.

8. Monitoring Requirements

The Holder is required to abide by the following monitoring conditions listed in 8(a)-(b). Failure to comply with these conditions may result in the modification, suspension, or revocation of this IHA.

(a) *Visual Monitoring* – Protected species observers (refer to the PSO qualifications and requirements for *Marine Mammal Exclusion Zones* above) shall visually monitor the established Level B harassment zones (200-m radius during HRG surveys; 500-m radius during DP thruster use). The observers shall be stationed on the highest available vantage point on the associated operating platform. PSOs shall estimate distance to marine mammals visually, using laser range finders or by using reticulated binoculars during daylight hours. During night operations, PSOs shall use night-vision binoculars and infrared technology. Data on all PSO observations will be recorded based on standard PSO collection requirements. This will include dates and locations of survey operations; time of observation, location and weather; details of the sightings (*e.g.*, species, age classification (if known), numbers, behavior); and details of any observed "taking" (behavioral disturbances or injury/mortality). In addition, prior to initiation of survey work, all crew members shall undergo environmental training, a component of which will focus on the procedures for sighting and protection of marine mammals

(b) *Acoustic Field Verification* – Field verification of the exclusion/monitoring zones shall be conducted to determine whether the proposed zones correspond accurately to the relevant isopleths and are adequate to minimize impacts to marine mammals. The Holder shall conduct field verification of the exclusion/monitoring zone (the 160 dB isolpleth) for HRG survey equipment and the monitoring/powerdown zone (the 120 dB isopleth) for DP thruster use for all equipment operating below 200 kHz. The Holder shall take acoustic measurements at a minimum of two reference locations and in a manner that is sufficient to establish source level (peak at 1 meter) and distance to the 160 dB isopleth (the Level B harassment zones for HRG surveys) and 120 dB isopleth (the Level B harassment zone) for DP thruster use. Sound measurements shall be taken at the reference locations at two depths (*i.e.*, a depth at mid-water and a depth at approximately 1 meter (3.28 ft) above the seafloor). The Holder may use the results from its field-verification efforts to request modification of the exclusion/monitoring zones for the HRG or geotechnical surveys. Any new exclusion/monitoring zone radius proposed by the Holder shall be based on the most conservative measurements (*i.e.*, the largest safety zone configuration) of the target Level A or Level B harassment acoustic threshold zones. The modified zone shall be used for all subsequent use of field-verified equipment. The Holder shall obtain approval from NMFS and BOEM of any new exclusion/monitoring zone before it may be implemented and the IHA shall be modified accordingly.

9. Reporting Requirements

The Holder shall provide the following reports as necessary during survey activities:

(a) The Holder shall contact NMFS (301-427-8401) and BOEM (703-787-1300) within 24 hours of the commencement of survey activities and again within 24 hours of the completion of the activity.

(b) *Notification of Injured or Dead Marine Mammals*

(i) In the unanticipated event that the specified activities clearly causes the take of a marine mammal in a manner prohibited by the IHA, such as injury (Level A harassment), serious injury, or mortality), the Holder shall immediately cease the specified activities and report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, 301-427-8401, and the NOAA GARFO Stranding Coordinator, 978-281-9300. The report shall include the following information:

- Time, date, and location (latitude/longitude) of the incident;
- Name and type of vessel involved;
- Vessel's speed during and leading up to the incident;
- Description of the incident;
- Status of all sound source use in the 24 hours preceding the incident;
- Water depth;
- Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the event. NMFS would work with the Holder to minimize reoccurrence of such an event in the future. The Holder shall not resume activities until notified by NMFS.

(ii) In the event that the Holder discovers an injured or dead marine mammal and determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.*, in less than a moderate state of decomposition), the Holder shall immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, 301-427-8401, and the GARFO Stranding Coordinator, 978-281-9300. The report shall include the same information identified in the paragraph above. Activities would be able to continue while NMFS reviews the circumstances of the incident. NMFS would work with the Holder to determine if modifications in the activities are appropriate.

(iii) In the event that the Holder discovers an injured or dead marine mammal and determines that the injury or death is not associated with or related to the activities authorized in the IHA (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the Holder shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, 301-427-8401, and the NMFS GARFO Regional Stranding Coordinator, 978-281-9300, within 24 hours of the discovery. The Holder shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting.

(d) 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.

(e) In addition to the Holder's reporting requirements outlined above, the Holder 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. This shall be submitted as a draft to NMFS and BOEM 30 days after the completion of the HRG and geotechnical surveys and as a final version 60 days after completion of the surveys.

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

11. A copy of this Authorization and the Incidental Take Statement must be in the possession of each vessel operator taking marine mammals under the authority of this Incidental Harassment Authorization.

12. The Holder is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS' Biological Opinion.

Donna S. Wieting

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

JUN - 8 2017

Date

Appendix D Sound Source Verification Report

COMMERCIAL IN CONFIDENCE

Submitted to:

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Sound Source Verification - Fugro Explorer Dynamic Positioning System, Ocean Wind

Fergus Midforth, Tim Mason; Heidi Cocca

24 January 2018

Subacoustech Environmental Report No. P219R0201

Document No.	Date	Written	Approved	Distribution
P219R0101	01/24/2018	F Midforth	T Mason	Heidi Cocca (EPI Group)

This report is a controlled document. The report documentation page lists the version number, record of changes, referencing information, abstract and other documentation details.

COMMERCIAL IN CONFIDENCE

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1 Background

1.1 Project

Fugro Marine GeoServices Inc. (Fugro) was contracted by Ørsted to undertake a geotechnical survey of a proposed wind farm site off the east coast of the United States (USA). The site is located approximately 15 km east of Atlantic City, NJ.

The survey was undertaken by the Fugro Explorer, a geotechnical drilling vessel commissioned in 1999, with the following specifications.

Vessel Specifications	
Length	79.6 m
Breadth	16 m
Propulsion	2 x 4-blade Wärtsilä CP 74-ID
Bow Tunnel Thruster	2 x Kamewa 1650 Tunnel Thruster 800 HP
Stem Tunnel Thruster	1 x Kamewa 1650 Tunnel Thruster 800 HP

When dynamic positioning (DP) was in use, the vessel position and orientation was set, and the DP system controlled the power of the thrusters in order to maintain the position of the vessel. As such, the power output of the thrusters was continuously changing.

The Incidental Harassment Authorization (IHA) permit issued by the National Marine Fisheries Service (NMFS) required a Sound Source Verification (SSV) study to establish the underwater noise levels as a function of range caused by the operation of the DP system.

The initial results and preliminary findings were detailed in a summary report P219R0101 provided shortly after completion of the survey. These were indicative due to the rapid reporting requirement. This report details the procedure undertaken for the SSV study and the results following detailed analysis post-survey.

1.2 Objectives

The objective of the sound source verification study outlined in this report was to assess the underwater acoustic levels as a function of range from the operation of the dynamic positioning (DP) system on the Fugro Explorer as issued by National Marine Fisheries Service (NMFS) in the IHA Permit.

Acoustic recordings were collected on two autonomous recording hydrophones (Ocean Sonics icListen HF) at a fixed location while the Fugro Explorer held position in different orientations using DP at progressively increasing range from the measurement location.

The acoustic recordings were processed upon retrieval of the units in order to determine the RMS acoustic output of the vessel under DP conditions and to determine the 120 dB isopleth from field measurements. The 120 dB isopleth is the behavioural disturbance threshold for a non-impulsive source according to NMFS Acoustic Criteria (NMFS, 2016). The principle objectives are therefore to:

- To determine underwater noise levels from field measurements;
- Estimate from direct measurements the range to 120 dB RMS re 1 µPa.

2 Underwater Acoustics

2.1 Units of measurement

Sound measurements underwater are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound. A logarithmic scale is used because rather than equal increments of sound having an equal increase in effect, typically a constant ratio is required for this to be the case. That is, each doubling of sound level will cause a roughly equal increase in "loudness".

Any quantity expressed in this scale is termed a "level". If the unit is sound pressure, expressed on the dB scale, it will be termed a "Sound Pressure Level". The fundamental definition of the dB scale is given by:

$$Level = 10 \times \log_{10}\left(\frac{Q}{Q_{ref}}\right)$$

where Q is the quantity being expressed on the scale, and Q_{ref} is the reference quantity.

The dB scale represents a ratio and, for instance, 6 dB really means "twice as much as...". It is, therefore, used with a reference unit, which expresses the base from which the ratio is expressed. The reference quantity is conventionally smaller than the smallest value to be expressed on the scale, so that any level quoted is positive. For instance, a reference quantity of 20 µPa is used for sound in air, since this is the threshold of human hearing. A Pascal is equal to the pressure exerted by one Newton over one square metre; a micropascal equals one millionth of this.

A refinement is that the scale, when used with sound pressure, is applied to the pressure squared rather than the pressure. If this were not the case, when the acoustic power level of a source rose by 10 dB the Sound Pressure Level would rise by 20 dB. So that variations in the units agree, the sound pressure must be specified in units of root mean square (RMS) pressure squared. This is equivalent to expressing the sound as:

$$Sound\ Pressure\ Level = 20 \times \log_{10}\left(\frac{P_{RMS}}{P_{ref}}\right)$$

For underwater sound, typically a unit of one micropascal (1 µPa) is used as the reference unit. Where not defined, all noise levels in this report are referenced to 1 µPa.

2.2 Sound pressure level (SPL)

The sound pressure level (SPL) is normally used to characterise noise and vibration of a continuous nature such as drilling, boring, or background sea and river noise levels. To calculate the SPL, the variation in sound pressure is measured over a specific period to determine the Root Mean Square (RMS) level of the time varying sound. The SPL can therefore be considered a measure of the average unweighted level of sound over the measurement period.

Where RMS SPL is used to characterise transient pressure waves such as that from seismic airguns, underwater blasting or impact piling, it is critical that the period over which the RMS level is calculated is quoted. For instance, in the case of pile strike lasting, say, a tenth of a second, the mean taken over a tenth of a second will be ten times higher than the mean taken over one second. Often, transient sounds such as these are quantified using "peak" SPLs.

2.3 Peak sound pressure level (SPL_{peak})

Peak SPLs are often used to characterise sound transients from impulsive sources, such as percussive impact piling and seismic airgun sources. A peak SPL is calculated using the maximum variation of the

pressure from positive to zero within the wave. This represents the maximum change in positive pressure (differential pressure from positive to zero) as the transient pressure wave propagates.

A further variation of this is the peak-to-peak SPL where the maximum variation of the pressure from positive to negative within the wave is considered. Where the wave is symmetrically distributed in positive and negative pressure, the peak-to-peak level will be twice the peak level, equivalent to 6 dB higher than the peak.

2.4 Sound exposure level (SEL)

When assessing the noise from transient sources such as blast waves, impact piling or seismic airgun noise, the issue of the duration of the pressure wave is often addressed by measuring the total acoustic energy (energy flux density) of the wave. This form of analysis was used by Bebb and Wright (1953[1], 1954a[2], 1954b[3] and 1955[4]), and later by Rawlins (1987)[5] to explain the apparent discrepancies in the biological effect of short and long-range blast waves on human divers. More recently, this form of analysis has been used to develop criteria for assessing the injury range from fish for various noise sources (Popper *et al.*, 2014)[6].

The sound exposure level (SEL) sums the acoustic energy over a measurement period, and effectively takes account of both the SPL of the sound source and the duration the sound is present in the acoustic environment. Sound Exposure (SE) is defined by the equation:

$$SE = \int_0^T p^2(t)dt$$

where p is the acoustic pressure in Pascals, T is the duration of the sound in seconds, and t is the time in seconds. The SE is a measure of the acoustic energy and, therefore, has units of Pascal squared seconds (Pa^2s).

To express the SE on a logarithmic scale by means of a dB, it is compared with a reference acoustic energy level ($p^2{}_{ref}$) and a reference time (T_{ref}). The SEL is then defined by:

$$SEL = 10 \times \log_{10}\left(\frac{\int_0^T p^2(t)dt}{P^2{}_{ref}T_{ref}}\right)$$

By selecting a common reference pressure P_{ref} of 1 μPa for assessments of underwater noise, the SEL and SPL can be compared using the expression:

$$SEL = SPL + 10 \times \log_{10} T$$

where the SPL a measure of the average level of broadband noise, and the SEL sums the cumulative broadband noise energy. This means that, for continuous sounds of less than one second, the SEL will be lower than the SPL. For periods greater than one second, the SEL will be numerically greater than the SPL (i.e. for a sound of ten seconds duration, the SEL will be 10 dB higher than the SPL, for a sound of 100 seconds duration the SEL will be 20 dB higher than the SPL, and so on).

[1] Bebb A H, Wright H C (1953). Injury to animals from underwater explosions. Medical Research Council, Royal Navy Physiological Report 53/732, Underwater Blast Report 31, January 1953.
[2] Bebb A H, Wright H C (1954a). Lethal conditions from underwater explosion blast. RNP Report 51/654, RNPL 3/51, National archives reference ADM 298/109, March 1954.
[3] Bebb A H, Wright H C (1954b). Protection from underwater explosion blast. III. Animal experiments and physical measurements. RNP report 57/792, RNPL 2/54, March. 1954
[4] Bebb A H, Wright H C (1955). Underwater explosion blast data from the Royal Navy Physiological Labs. 1950/1955. Medical Research Council, April 1955.
[5] Rawlins J S P (1987). Problems in predicting safe ranges from underwater explosions. Journal of Naval Science, Volume 13, No. 4 pp. 235-246.
[6] Popper A N, Hawkins A D, Fay R R, Mann D A, Bartol S, Carlson T J, Coombs S, Ellison W T, Gentry R L, Halvorsen M B, Lokkeborg S, Rogers P H, Southall B L, Zeddies D G, Tavolga W N (2014). Sound exposure guidelines for Fishes and Sea Turtles. Springer Briefs in Oceanography. DOI 10.1007/978-3-319-06659-2.

3 Survey

3.1 Study Area

The SSV trial was undertaken off the coast of New Jersey in a location with bathymetry representative of the geotechnical survey area. The location of the survey is shown in Figure 3-1.

The SSV study was undertaken along a 2 km transect with a water depth of approximately 21 m. The variation in bathymetry over the site was negligible.

Figure 3-1 Map of the survey area

3.2 General Approach

A static two hydrophone array was deployed in a fixed location indicated in Figure 3-1. The trial was undertaken along a single transect. The transect comprised of measurements at increasing distances from the measurement position as shown in Figure 3-2. For each measurement, the vessel held position for a period of at least three minutes before rotating and repeating the measurement in the same location. Measurements were recorded with the vessel orientated beam on, bow on and stern on to the hydrophone array. The start and stop times and GPS coordinates of the vessel were recorded along with the approximate power level required to hold position.

The power output of the thrusters was controlled by the DP system to replicate the operating conditions expected during the survey. The thrusters continuously altered their power output to maintain specified

positions, even when wind or current conditions changed. This was within the normal operating parameters of the vessel and typical of the expected operations.

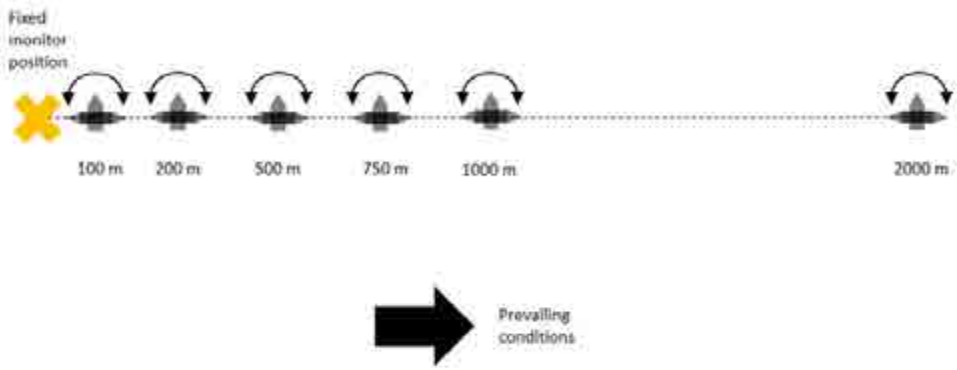


Figure 3-2 Diagram of the vessel transect, including vessel orientation

3.3 Equipment and Deployment

The hydrophone array was deployed at GPS position 39° 15.38" N, 74° 17.33" W. The configuration of the system is shown in Figure 3-3.

The array consisted of two Ocean Sonics icListen HF hydrophones in a vertical alignment. One hydrophone (s/n 1256) was deployed at a height of approximately 1 m from the seabed and the second (s/n 1433) at 11 m, approximately mid water.

The hydrophones were held vertical by a 15 litre subsurface buoy. The main marker buoy on the surface was a small low-drag spar buoy equipped with a strobe to enable visibility at night.

The instrumentation was configured to record continuously with a sampling rate of 100 kHz and data was stored as both audio (.wav) format and text based frequency (FFT) data files. The .wav files were analysed to determine relevant acoustic metrics.

The hydrophones have undergone a full calibration by the manufacturer within the last 12 months and the calibration was verified using a laboratory pistonphone (calibration traceable to international standards) immediately prior to mobilisation.

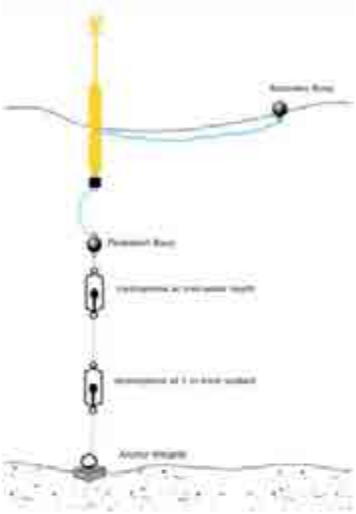


Figure 3-3 SSV trial measurement buoy configuration

3.4 Meteorological Conditions

The survey was undertaken on the night of December 2nd 2017. During the survey wind speeds ranged from 4.7 to 8.2 knots with a sea state between 1 and 2.

These conditions were ideal for the survey as wind and wave noise would have only a small influence on the ambient noise levels.

3.5 Array and Deployment Details

Hydrophones			
Ocean Sonics icListen HF #1256	1 m from seabed	Sampling Rate	100 kHz
Ocean Sonics icListen HF #1433	11 m from seabed	Sampling Rate	100 kHz
Deployment time	18:50 (EST) 2nd Dec 2017	Location	39° 15.38" N 74° 17.33" W
Recovery time	08:30 (EST) 3rd Dec 2017		

Table 3-1 – Survey overview data

3.6 Vessel Monitoring Locations

The range of the vessel from the monitoring array and its orientation is given in Table 3-2 below. The range is approximate and relevant to the centre of the vessel rather than its closest point. Therefore, the position of the thrusters and onboard noise sources will change relative to the vessel's orientation.

	Stern On		Beam On		Bow On	
Range (m)	Location	Heading	Location	Heading	Location	Heading
100	39° 15.3705 N 074° 17.2669 W	100°	39° 15.3696 N 074° 17.2669 W	188°	39° 15.3702 N 074° 17.2446 W	280°
200	39° 15.3584 N 074° 17.1727 W	100°	39° 15.3647 N 074° 17.2008 W	010°	39° 15.3608 N 074° 17.1699 W	290°
500	39° 15.3277 N 074° 16.9686 W	100°	39° 15.3338 N 074° 16.9983 W	011°	39° 15.3258 N 074° 16.9651 W	279°
750	39° 15.3013 N 074° 16.7993 W	100°	39° 15.3006 N 074° 16.8233 W	189°	39° 15.3022 N 074° 16.7991 W	280°
1000	39° 15.2732 N 074° 16.6307 W	100°	39° 15.2810 N 074° 16.6488	010°	39° 15.2744 N 074° 16.6288 W	280°
2000	039° 15.1691 N 074° 15.9465 W	100°	39° 15.1739 N 074° 15.9726 W	010°	39° 15.1693 N 074° 15.9467 W	280°

Table 3-2 – Coordinates and orientation of vessel at each measurement location

4 Analysis and Results

4.1 Initial Analysis and Reporting

The initial analysis and reporting was undertaken on board the vessel and was focused on assessing the level of noise from the vessel at each location and condition and the range to the 120 dB RMS isopleth. The maximum estimated ranges to this isopleth are summarised in Table 4-3.

The data files were downloaded for processing and analysis following the recovery of the equipment. The initial analysis used high pass filtering to remove the noise below 10 Hz in order to reduce the influence of ambient noise.

The initial report included results of the measurements at both the mid water and 1 m from the seabed. The filtered audio data was analysed using Subacoustech's software to calculate 1-minute RMS levels for position and orientation of the vessel during DP operation. The 1-minute sample period was selected to ensure it contained continuous DP operation.

Range	Beam on (dB re 1 µPa)		Stern on (dB re 1 µPa)		Bow on (dB re 1 µPa)	
	Mid Water	Seabed	Mid Water	Seabed	Mid Water	Seabed
100 m	143.7	147.7	142.8	147.4	138.7	140.6
200 m	140.8	144.4	140.1	144.2	135.5	138.0
500 m	136.4	139.5	135.6	138.7	131.5	134.7
750 m	134.7	136.9	132.4	135.5	128.3	132.0
1000 m	132.3	135.5	131.1	134.4	128.4	130.6
2000 m	128.5	130.2	127.9	128.8	126.9	124.4

Table 4-1 1-minute RMS levels for each vessel position

Vessel Orientation	Apparent Source Level, RMS @ 1 m (dB re 1 µPa)	
	Midwater	Seabed
Beam on	167	175
Stern on	167	176
Bow on	158	165

Table 4-2 Apparent RMS source level for each vessel orientation

Vessel Orientation	Estimated distance to 120 dB RMS (m)	
	Midwater	Seabed
Beam on	12000	14000
Stern on	9000	9000
Bow on	7500	6500

Table 4-3 Estimated distance to the 120 dB RMS isopleth

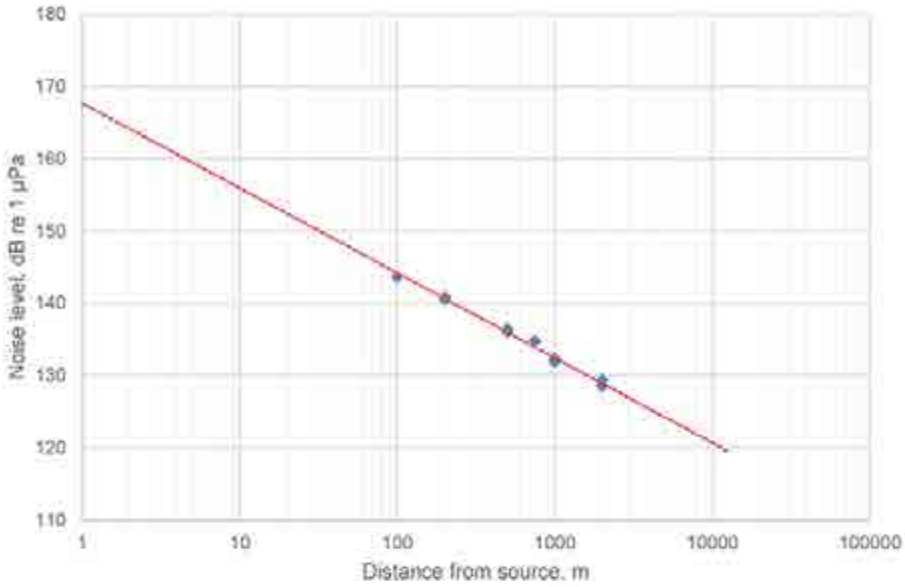


Figure 4-1 RMS SPL from mid water for positions on the beam transect

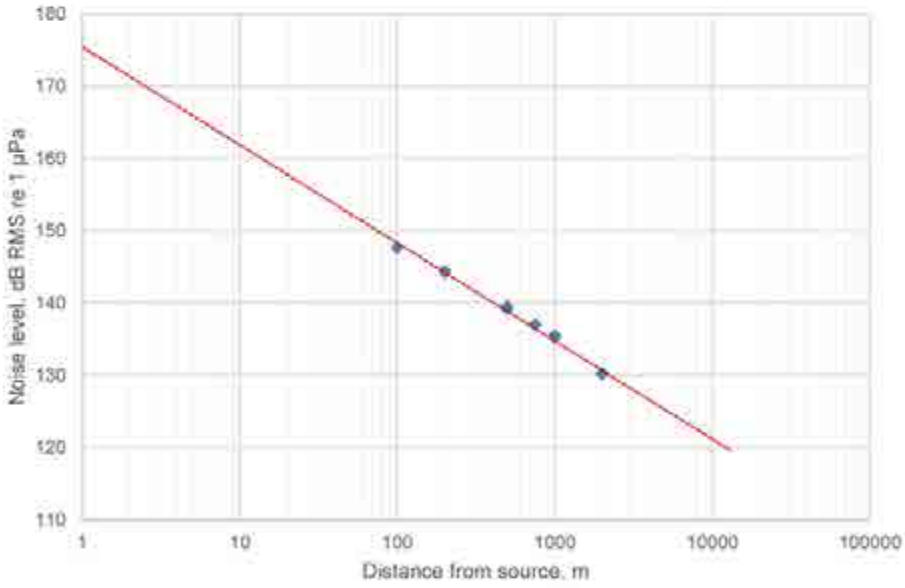


Figure 4-2 RMS SPL from 1 m above the seabed for positions on the beam transect

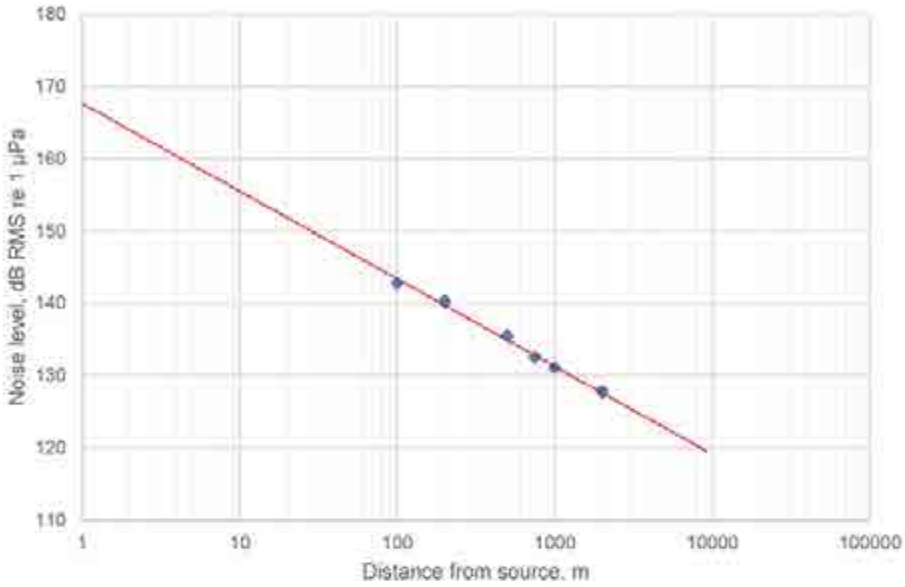


Figure 4-3 RMS SPL from mid water for positions on the stern transect

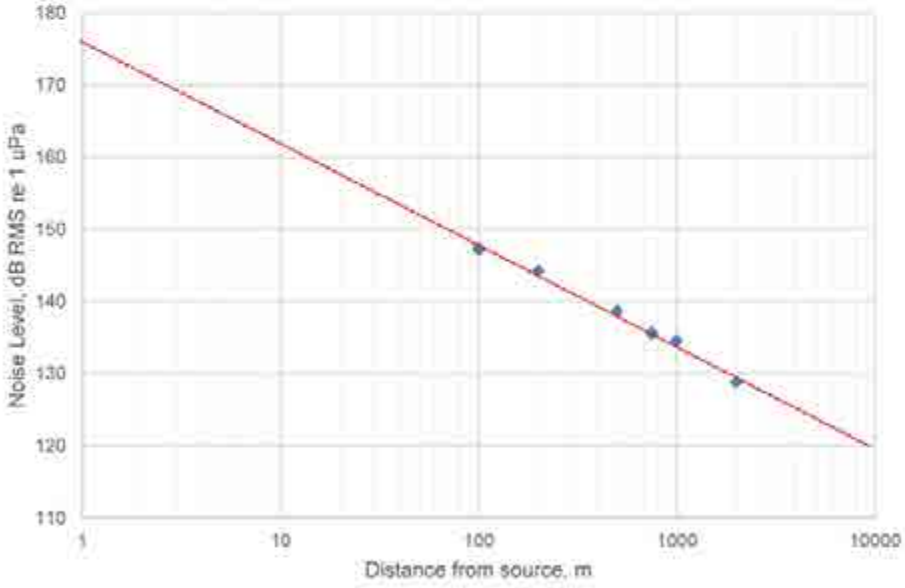


Figure 4-4 RMS SPL from 1 m above the seabed for positions on the stern transect

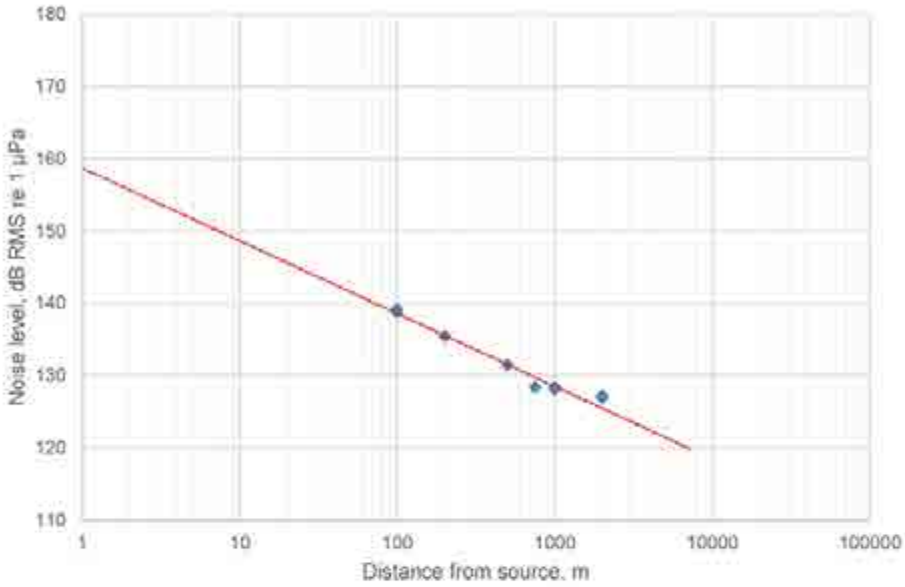


Figure 4-5 RMS SPL from mid water for positions on the bow transect

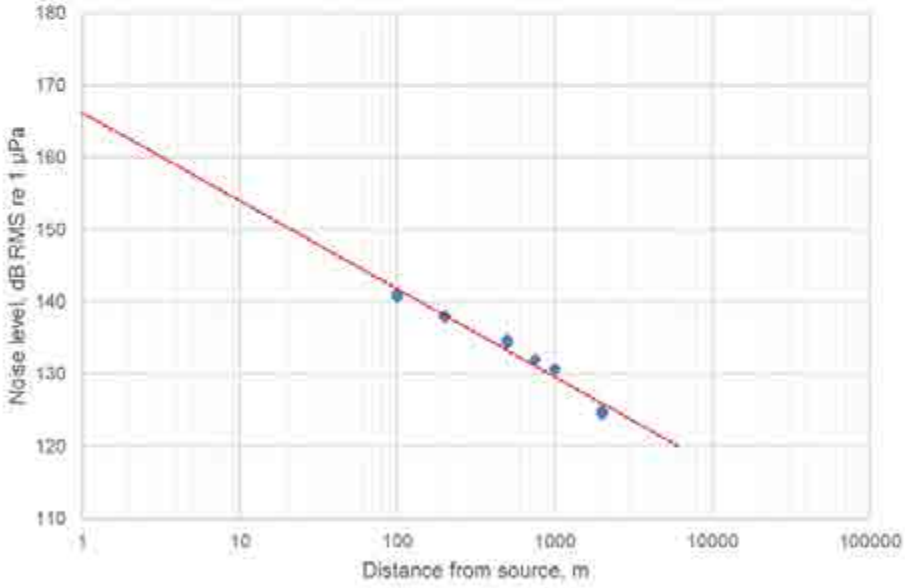


Figure 4-6 RMS SPL from 1 m above the seabed for positions on the bow transect

4.2 Further Analysis

Following demobilisation, the data was re-analysed in more detail than was possible for the initial report.

Table 4-4 shows the functional hearing range and PTS onset level for each marine mammal hearing group, as per NMFS 2016. The PTS onset level is a 24-hour cumulative SEL (cSEL) for exposure to non-impulsive (i.e. continuous) noise. The calculated 24-hour cSEL is reported in Table 4-5 for each range and orientation in the trial. These SEL values are derived from the previously reported 1-minute RMS values.

Functional Hearing Group	PTS Onset Non-Impulsive	Functional Hearing Range
Low-Frequency (LF) Cetaceans	199 dB re 1 μPa².s cSEL	7 Hz to 35 kHz
Mid-Frequency (MF) Cetaceans	198 dB re 1 μPa².s cSEL	150 Hz to 160 kHz
High-Frequency (HF) Cetaceans	173 dB re 1 μPa².s cSEL	275 Hz to 160 kHz
Phocid Pinnipeds (PW) (Underwater)	201 dB re 1 μPa².s cSEL	50 Hz to 86 kHz
Otariid Pinnipeds (OW) (Underwater)	219 dB re 1 μPa².s cSEL	60 Hz to 39 kHz

Table 4-4 Summary of relevant hearing group thresholds from NMFS 2016 guidance

Range	Beam-on cSEL (dB re 1 μPa².s)		Stern-on cSEL (dB re 1 μPa².s)		Bow-on cSEL (dB re 1 μPa².s)	
	Mid-Water	Seabed	Mid-Water	Seabed	Mid-Water	Seabed
100 m	193.1	197.1	188.0	189.9	192.1	196.7
200 m	190.2	193.8	184.8	187.3	189.4	193.5
500 m	185.8	188.9	180.8	184.0	184.9	188.0
750 m	184.1	186.3	177.6	181.3	181.7	184.8
1000 m	181.7	184.9	177.7	179.9	180.4	183.7
2000 m	177.9	179.6	176.2	173.7	177.2	178.1

Table 4-5 24-hour SEL derived from 1-minute RMS, unweighted

All calculated SEL levels shown in Figure 4-6, reported as unweighted levels, are below the PTS onset threshold for all hearing groups, with the exception of HF cetaceans. All absolute values will be reduced due to the hearing group weighting function and thus all hearing groups (with the exception of HF cetaceans) will have an impact range of less than 100 m. This means that a receptor in these hearing groups would have to remain within 100 m of the vessel on DP for a full 24 hours for there to be any risk of PTS. As noise should be shut down in the event LF cetaceans are detected within 500 m of the vessel during operation, this should minimize any risk to this species group.

It should be noted that most of the acoustical energy for all orientations is below 500 Hz, as shown in Figure 4-7. The majority of the acoustical energy is below the peak sensitivity of hearing in MF and HF cetaceans, and the weighting from these hearing groups will reduce the perceived received noise level by a minimum of 40 dB to the HF cetacean hearing group. Therefore, the risk to this species group of PTS onset can be reasonably considered negligible, especially due to the highly mobile nature of individuals in the HF cetacean group.

Peak sound pressure levels for the trial are reported in Table 4-6.

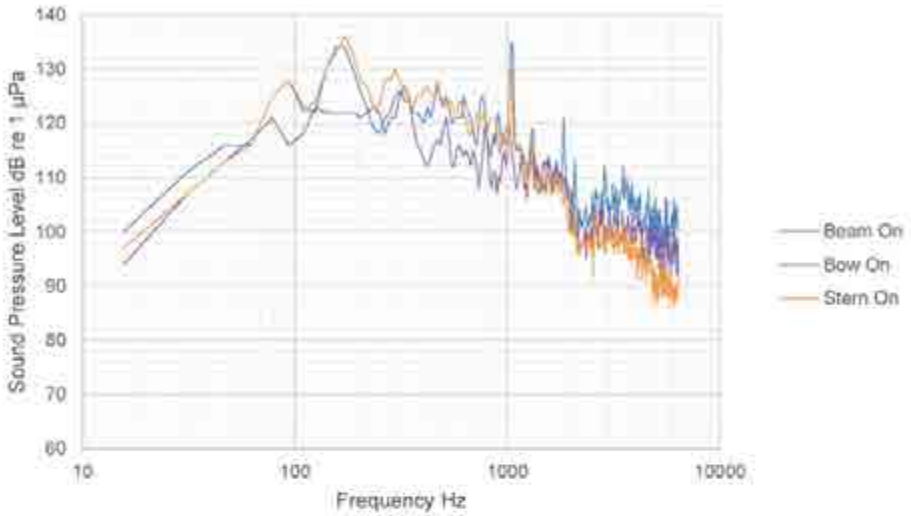


Figure 4-7 Frequency spectrum from 100m range measurements for each vessel orientation

Range	Beam on Peak SPL (dB re 1 µPa)		Stern on Peak SPL (dB re 1 µPa)		Bow on Peak SPL (dB re 1 µPa)	
	Mid Water	Seabed	Mid Water	Seabed	Mid Water	Seabed
100 m	158.3	161.6	155.8	160.6	155.7	157.0
200 m	155.2	158.5	154.7	159.6	154.6	151.6
500 m	152.2	153.0	152.4	153.4	152.1	148.1
750 m	148.5	152.3	149.6	148.5	148.2	145.0
1000 m	147.5	149.2	147.0	148.5	146.9	144.8
2000 m	154.8	145.1	151.4	142.6	154.1	141.2

Table 4-6 Peak SPL levels for each measured vessel position and orientation

There are no peak SPL PTS thresholds for continuous noise sources.

5 Conclusions

A sound source verification study was undertaken on December 2nd and 3rd 2017 onboard the Fugro Explorer.

Post processing was undertaken to remove low frequency ambient noise below 10 Hz form the recorded signals to reduce non-acoustic noise impacting the results of the trial.

Upon retrieval of the measurement equipment and initial analysis of the retrieved data, a field verification report was submitted to BOEM on December 3rd. This report focused on impact ranges for the 120 dB RMS re 1 µPa isopleth. The report identified that this threshold is likely to be reached between approximately 6,500 m and 14,000 m from the vessel, depending on position in the water column and orientation of the vessel relative to the receiver.

Following demobilisation, further analysis was undertaken to establish the 24-hour cSEL along with the distribution of energy in the frequency domain.

Assuming a receptor remained at 100 m from the vessel for 24 hours, this would lead to a noise exposure from the DP system of up to 197.1 dB cSEL re 1 µPa².s unweighted. This is below the PTS onset threshold for species in the LF, MF cetacean and pinniped hearing groups, and the HF cetacean group following appropriate frequency weighting. This means that an individual from any of these groups would have to remain within 100 m of the vessel operating under DP (from any vessel orientation) for 24-hours to receive the necessary exposure. In combination with PSO protocols, therefore, any risk of PTS to marine mammals is considered negligible.

Appendix A Calibration Certificates

Ocean Sonics

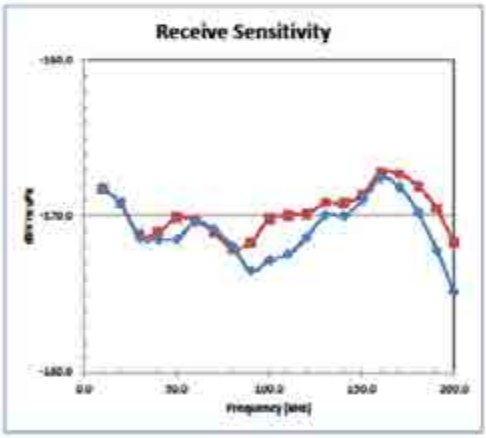
Certificate of Calibration

Ocean Sonics, Ltd.

Calibration Certificate Number: **C4191**

Test Result:	10 kHz to 100 kHz: -170.8 ± 2.7
	10 kHz to 200 kHz: -171.0 ± 3.8

Model Number	SB2-ETH	Projector Manufacturer	Ocean Sonics
Serial Number	1256	Projector Model	TH2-SER-4F
Manufacture Date	21-Jun-2017	Projector Serial	2210
Measurement Date	22-Jun-2017	Measurement Distance	1 m
Certificate Date	22-Jun-2017	Output Level	128.4 dB re uPa @ 1 m
Sensitivity @ 26 Hz	-168.2 dB re V / uPa	Tone Burst	8.0 ms / 300 ms
Case Type	Plastic	Reference Manufacturer	Ocean Sonics
Element Manufacturer	GeoSpectrum	Reference Model	RB9-ETH
Element Model	M24HF	Reference Serial	1452
Element Serial	C000590	Primary Calibration	22-Dec-2015
Preamp Model	04-300435-01	Preamp Manufacturer	Ocean Sonics
Calibrated By	S.MacLean	Preamp Model	04-300434-01
Work Order Number	W1554	Preamp Serial	473
Test Type	RX Sensitivity	Preamp Gain	36 dB
Test Procedure	Complex RMS	ADC Manufacturer	Ocean Sonics
Test Location	Tank #2, 1 m	ADC Model Number	04-300423-01
Water Temperature	18 °C	ADC Serial Number	473



Frequency	Sensitivity [dBV re µPa]	
kHz	0 deg	90 deg
10.0	-168.2	-168.2
20.1	-169.2	-169.2
30.1	-171.2	-171.4
40.2	-171.0	-171.5
50.2	-170.1	-171.5
60.2	-170.3	-170.4
70.3	-171.0	-170.8
80.3	-172.1	-171.9
90.4	-171.7	-173.5
100.4	-170.2	-172.8
110.4	-170.0	-172.5
120.5	-169.9	-171.4
130.5	-169.1	-170.0
140.5	-169.2	-170.0
150.6	-168.6	-169.0
160.6	-167.2	-167.6
170.7	-167.3	-168.2
180.7	-168.1	-169.8
190.7	-169.5	-172.2
200.0	-171.7	-174.8

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Ocean Sonics

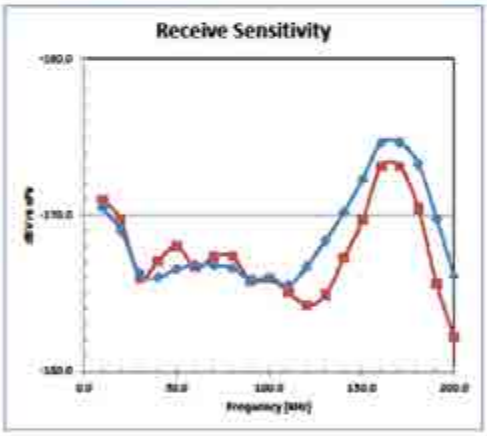
Certificate of Calibration

Ocean Sonics, Ltd.

Calibration Certificate Number: **C4192**

Test Result: 10 kHz to 100 kHz: -171.6 ± 2.6
10 kHz to 200 kHz: -171.6 ± 6.2

Model Number	SB2-ETH	Projector Manufacturer	Ocean Sonics
Serial Number	1433	Projector Model	TH2-SER-4F
Manufacture Date	21-Jun-2017	Projector Serial	2210
Measurement Date	22-Jun-2017	Measurement Distance	1 m
Certificate Date	22-Jun-2017	Output Level	128.4 dB re uPa @ 1 m
Sensitivity @ 26 Hz	-169.2 dB re V / uPa	Tone Burst	8.0 ms / 300 ms
Case Type	Plastic	Reference Manufacturer	Ocean Sonics
Element Manufacturer	GeoSpectrum	Reference Model	RS9-ETH
Element Model	M24HF	Reference Serial	1492
Element Serial	A002767	Primary Calibration	22-Dec-2015
Preamp Model	04-300435-01	Preamp Manufacturer	Ocean Sonics
Calibrated By	S.MacLean	Preamp Model	04-300434-01
Work Order Number	W1554	Preamp Serial	473
Test Type	RX Sensitivity	Preamp Gain	36 dB
Test Procedure	Complex RMS	ADC Manufacturer	Ocean Sonics
Test Location	Tank #2, 1 m	ADC Model Number	04-300423-01
Water Temperature	18 °C	ADC Serial Number	473



Frequency	Sensitivity (dBV re µPa)	
kHz	0 deg	90 deg
10.0	-169.0	-169.5
20.1	-170.5	-171.0
30.1	-174.0	-173.7
40.2	-172.9	-174.0
50.2	-172.0	-173.5
60.2	-173.3	-173.2
70.3	-172.7	-173.2
80.3	-172.7	-173.4
90.4	-174.2	-174.2
100.4	-174.1	-174.0
110.4	-174.9	-174.4
120.5	-175.7	-173.3
130.5	-175.1	-171.6
140.5	-172.7	-169.8
150.6	-170.3	-167.7
160.6	-168.9	-165.4
170.7	-168.9	-165.4
180.7	-169.6	-166.7
190.7	-174.4	-170.2
200.0	-177.8	-173.9

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Report documentation page

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Document No.	Draft	Date	Details of change
P219R0201	-	01/24/2018	Initial writing and internal review

Originator's current report number	P219R0201
Originator's name and location	T Mason; Subacoustech Environmental Ltd.
Contract number and period covered	P219; December 2017-January 2018
Sponsor's name and location	EPI, Smultea, Fugro
Report classification and caveats in use	COMMERCIAL IN CONFIDENCE
Date written	January 2018
Pagination	Cover + i + 17
References	
Report title	Sound Source Verification - Fugro Explorer Dynamic Positioning System, Ocean Wind
Translation/Conference details (if translation, give foreign title/if part of a conference, give conference particulars)	
Title classification	Unclassified
Author(s)	Fergus Midforth, Tim Mason; Heidi Cocca
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Abstract	
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Appendix E Phase 1 Alternative Monitoring Plan Effectiveness Report

During the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 1*, four different complementary methods were used to detect marine mammals and sea turtles, some of which were used simultaneously (see 3 *Methods*):

1) UE
    a. During daylight: UE (with occasional use/sweeps of reticle binoculars [RB])
    b. During darkness: UE via artificial illumination from the *M/V Fugro Explorer* vessel lights
2) NVD during darkness (and some periods of daylight at twilight)
3) IR during both daylight and darkness
4) PAM during both daylight and darkness.

In the field, we recorded which monitoring method first identified (detected) a marine mammal (i.e., initial detection method); we also recorded which methods subsequently made the same detection (confirming the initial detection, i.e., a re-sighting) (Table 24). To maximize sample size and robustness, we pooled all detections made during the survey both inside and outside the Lease Area, since the goal of this appendix report is to assess and compare effectiveness of monitoring methods. However, we also present detection rates for data collected only within the Lease Area.

- A total of 60 initial detections occurred along with an additional 7 subsequent resights from other monitoring methods for a grand total of 67 detections
- Most detections (57 %) were made using UE methods (36 initial and 2 subsequent), followed by PAM (17 initial and 1 subsequent), NVD (6 initial and 3 subsequent) and IR (1 initial and 1 subsequent).

Table 24. *Phase 1* initial and subsequent total number of detections for Unaided Eye (UE), Night Vision Device (NVD), Infra-red (IR) and Passive Acoustic Monitoring (PAM) methods inside and outside the Lease Area.

Detection Method	No. Initial Detections	Subsequent Confirmation Method (No.)
UE[1/]	36	None (0)
NVD	6	IR (1)
IR	1	PAM (1)
PAM	17	UE (2), NVD (3)
Total	**60**	**7**

[1/] During daylight, UE included occasional use of reticle binoculars; during darkness, only UE was used for this table category and only in waters artificially illuminated by the vessel's lights

Detections in Daylight vs. Darkness

During the *OCW01 Geotechnical Investigation 1A (2017),* the four complementary detection methods were used during periods of both daylight and darkness.

- Of the 60 initial visual detections, 53 % (32 detections) occurred during daytime and 47 % (28 detections) occurred during darkness.
- Of the 28 initial detections in darkness, over half (53 %) occurred from PAM, 6 were made using NVD, 6 occurred with the UE (where artificial illumination occurred from the *M/V Fugro Explorer* vessel lights), and a single detection occurred from the IR.

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 25. We further calculated detection rates based on periods of darkness and daylight in Table 26. Though sample sizes were small, for general comparative purposes, we also present detection rates by detection method for data collected only inside the Lease Area in Table 27.

- By species/grouping (Table 25):
    - Large whales were only observed during daylight and only with the UE.
    - Pooled delphinids/porpoises and pooled whales were seen at similar rates of detection using the UE (0.011 versus 0.009, respectively).
    - Pooled delphinids/porpoises were detected by NVD and PAM at similar rates (0.070 versus 0.060, respectively).
    - Common dolphins were detected using all four detection methods, most frequently with NVD (0.023) followed by PAM (0.014). Although this species was seen twice with IR, the IR was not useful for confirming species due to a blurry/fuzzy image (alternative methods were used to confirm species; Table 4).

- Overall (Table 25):
    - NVD resulted in the highest detection rate (0.070 detections/h of NVD effort) followed closely by PAM (0.060 detections/h of PAM effort).
    - UE resulted in 0.02 detections/h of effort.
    - IR detection rates were lower (0.01 detections/h of IR effort).

- During daylight (Table 26):
    - UE had the highest detection rate (0.049) and was nearly double that of PAM (0.025).
    - No IR or NVD detections were made. (The NVD was used during “daylight” only near twilight, as stronger daylight rendered them useless).

- During darkness (Table 26):
    - NVD (0.079) had the highest detection rate followed closely by PAM (0.073).
    - Although the NVD detection rate (0.079) was considerably higher than the UE

(0.005), 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, as long as there was some amount of low ambient light to help illuminate the view through the NVD.
- Although only 1 IR initial detection and one IR subsequent detection were made during the entire survey, the estimated detection rate for IR was higher (0.013) than UE (0.005) relative to the amount of effort expended using the two methods (Table 26).

Table 25. *Phase 1* detection rates (number of initial[1/] detections per hours of effort[2/]) for Unaided Eye (UE), Night Vision Device (NVD), Infra-red (IR) and Passive Acoustic Monitoring (PAM) methods by species and groupings (data pooled for inside and outside the Lease Area).

Species	No. UE Visual Detections	UE Detection Rate (No. UE Detections / 1829.3 UE Effort)	No. IR Detections	IR Detection Rate (No. IR Detection/ 103.4 h IR Effort)	No. NVD Detections	NVD Detection Rate (No. NVD Detection/ 85.9 h NVD Effort)	No. PAM Detection	PAM Detection Rate (No. PAM Detection/ 284.7 h PAM Effort)	Total
Fin Whale	1	0.001	-	-	-	-	-	-	1
Humpback Whale	3	0.002	-	-	-	-	-	-	3
Minke Whale	1	0.001	-	-	-	-	-	-	1
North Atlantic Right Whale	1	0.001	-	-	-	-	-	-	1
Common Dolphin	15	0.008	1	0.010	2	0.023	4	0.014	22
Unidentified Dolphin or Porpoise	5	0.003	-	-	4	0.046	13	0.046	22
Unidentified Whale	10	0.005	-	-	-	-	-	-	10
All Delphinids/ Porpoises (Pooled)	*(20)*	*(0.011)*	*(1)*	*(0.010)*	*(6)*	*(0.070)*	*17*	*0.060*	*44*
All Whales (Pooled)	*(16)*	*(0.009)*	-	-	-	-	-	-	*16*
Total[3/]	**36**	**0.020**	**1**	**0.010**	**6**	**0.070**	**17**	**0.060**	**60**

[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 = Infra-red bi-oculars, 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/] Total excludes pooled delphinids/porpoises and pooled whales

Table 26. *Phase 1* detection rates (number of initial[1/] detections per hours of effort[2/]) for Unaided Eye (UE), Night Vision Device (NVD), Infra-red (IR) and Passive Acoustic Monitoring (PAM) methods (data pooled for inside and outside the Lease Area).

Initial Detection Method	Daylight			Darkness			Overall		
	Effort Hours	No. Initial Detections	Detection Rate	Effort Hours	No. Initial Detections	Detection Rate	Effort Hours	No. Initial Detections	Detection Rate
UE	610.5	30	0.049	1,218.8	6	0.005	1,829.30	36	0.020
NVD	9.7	0	NA	76.1	6	0.079	85.9	6	0.070
IR	28.9	0	NA	74.5	1	0.013	103.4	1	0.010
PAM	80.3	2	0.025	204.4	15	0.073	284.7	17	0.060
Total	**729.4**	**32**	**0.044**	**1,573.8**	**28**	**0.018**	**2,303.30**	**60**	**0.026**

[1/] Detections presented are *initial* detections from each monitoring method. UE = Unaided Eye (with occasional use of 7 x 50 reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red bi-oculars, NVD = Night Vision Device (night vision binoculars), PAM = Passive Acoustic Monitoring.
[2/] During daylight, both UE and reticle binoculars were used; during darkness, only UE was used and only in waters artificially illuminated by the vessel's lights.

Table 27. *Phase 1* detection rates (number of initial[1/] detections per hours of effort[2/]) for Unaided Eye (UE), Night Vision Device (NVD), Infra-red (IR) and Passive Acoustic Monitoring (PAM) methods by species and groupings for all detections occurring Inside the Lease Area.

Species	No. UE Detection Inside Lease Area	No. UE Detection/ 1,247.4 h Visual effort	No IR Detection Inside Lease Area	No. IR Detection/ 71.7 h IR Effort	No. NVD Detection Inside Lease Area	No. NVD Detection/ 60.4 h NVD Effort	No. PAM Detection Inside Lease Area	No. PAM Detection/ 272.2 h PAM Effort	Total
Fin Whale	1	0.001	-	-	-	-	-	-	1
Humpback Whale	1	0.001	-	-	-	-	-	-	1
Minke Whale	1	0.001	-	-	-	-	-	-	1
North Atlantic Right Whale	1	0.001	-	-	-	-	-	-	1
Common Dolphin	2	0.002	1	0.014	2	0.033	5	0.018	10
Unidentified Dolphin or Porpoise	0	0.000	-	-	2	0.033	12	0.044	14
Unidentified Whale	3	0.002	-	-	-	-	-	-	3
Total	**9**	0.007	**1**	**0.014**	**4**	**0.066**	**17**	0.062	**31**

[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 = Infra-red bi-oculars, NVD = Night Vision Device (night vision binoculars)

[2/] Effort includes all periods (daylight and darkness) and simultaneously occurring effort occurring inside the Lease Area, representing totals for each person on watch by method. See *Methods* section

Unaided Eye Effectiveness

Over half (60 %) of the detections occurred by UE. Most (83 %) occurred during daylight and the remaining 6 (17 %) occurred during darkness. Of the 28 total detections that occurred in darkness, 6 occurred with UE (where artificial illumination occurred from the *M/V Fugro Explorer* vessel lights).

In general, during the day, PSOs considered the UE to be the most effective method for visually detecting the cetaceans observed during the survey. This was attributed to the wider field of view afforded by the UE within the 500-m MZ for North Atlantic right whales 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 (or unidentified porpoises) 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 limiting 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 (> 4)
- Darkness with no ambient light
- Fog

Environmental conditions and results of monitoring are discussed further in the body of this Technical Report and presented as associated with each detection in Appendix A, as required by BOEM and the NMFS IHA.

Night Vision Device Effectiveness

Of the 28 total detections in darkness, 6 were made using NVD. Detection distance with NVD ranged from 50-100 m (mean 61.7 m, S.D. 20.45). NVD resulted in the highest overall detection rate (0.069 detections/h of NVD effort). In general, NVDs were considered by the PSOs to be more effective at detecting cetaceans near the vessel than the IR device. 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 one initial detection made using IR during darkness was unidentified dolphins (due to a relatively fuzzy image) and could not be confirmed as common dolphin until an UE confirmation was made of these animals in an area illuminated by the vessel operating lights.

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 monkey deck and 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 (> 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.

IR Effectiveness

There was a single IR detection during darkness at a distance of 200 m. The sighting was confirmed by visual and PAM methods. There was a single subsequent IR detection after dolphins were detected through NVD. No IR detections occurred during daylight hours. Based on the one IR detection in darkness and previous use of IR for protected species monitoring from large vessels in the U.S. mid-Atlantic, the IR device appears to be able to detect cetaceans at farther distances than the NVD. However, the narrower field of view of the IR than the NVD is a limitation. 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 (Bf <4) and is otherwise compromised by increases in Bf due to its weight and hand-held nature.

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

- Reflectiveness of the windows inside the bridge: The FLIR IR had reduced effectiveness inside the bridge at night because the interior bridge lights reflecting in the bridge windows caused the image as seen through the IR to be compromised or interfered by other images.
- "Blacklight" was the relatively clearest setting available on the IR device, but even images on this setting were blurry compared to images seen through the NVD.
- The FLIR IR device can only take the external battery or the DVR at one time as there is only one port to connect either of them.
- The extremely cold temperatures during much of this survey (near freezing) resulted in relatively short battery life for the IR compared to manufacturer specifications. The external battery pack is rated to provide an operational time of up to 8 h with two rechargeable 3.0-volt batteries. However, in colder temperatures, the battery life of the external pack was closer to 4 h. These batteries took upwards of 2 h to completely recharge. In practice, the battery packs had to be recharged and replaced every ~45 min and the IR device could not be continuously turned on for more than 10-15 min without requiring a recharge. The manufacturer was contacted about this, but they offered no solution other than recharging the battery packs more frequently. Attaching an electrical cord from the IR device to a larger/heavier battery pack was considered; however, such cords were considered a potential safety/trip hazard and limited the PSO's ability to move very far from the bridge, which was

needed to allow a better 360-degree view.

- Beaufort > 4 and fog/precipitation/snow. In particular, the IR device was difficult to keep steady during rough Beaufort conditions given its narrow field of view and its relatively heavy weight.
- Visual quality in the field of view seemed to be most clear when set to 'White Hot' mode. Quality did deteriorate periodically, even when no settings were changed. This occurred in the form of vertical lines or darkness on the FLIR screen. Resetting the device to Factory Default in the Settings menu seemed to rectify this issue.
- Using the IR video recorder to record images quickly drained the device batteries. In addition, the IR device's external battery pack attachment had to be replaced with the video screen attachment. Thus, it is recommended that an IR device that takes photos would be more useful than a video recorder to document visual detections.

PAM Effectiveness

- Overall, PAM resulted in the second-highest detection rate (0.06 detections/h of PAM effort).
- There were 17 total initial PAM detections; most (88 %, 15 detections) occurred during darkness and 12 % (2 detections) occurred during daylight (Table 6).
- There were no 'low frequency' or 'high frequency' detections during the cruise. All detections contained signals characteristic of delphinid vocalizations, which are arbitrarily labeled as mid-frequency for the purposes of this report (Table 5).

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

- Environmental conditions: High Beaufort, waves, and precipitation introduce background noise into the environment with potential for reducing the PAM system effectiveness by masking 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 appeared negligible, as there was no apparent trend of decreasing PAM detections with increased Beaufort based on preliminary data.
- DPT system: The operation of the DPT introduced low-frequency background noise with potential to mask the energy of marine mammal calls occurring in an overlapping frequency range. In this specific case, the low-frequency energy (<2 kHz) emitted by the DP2 system had the potential to mask the low-frequency calls of baleen whales such as the North Atlantic right whale and the fin whale, unless their vocalizations were louder and/or at different frequencies. However, it is unlikely that mid-frequency vocalizations typical of the delphinid species would have been affected by the DP2 noise, and we detected them with PAM on multiple occasions.
- 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 versus 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 project area range from low-frequency (< 40 Hz) calling baleen whales to ultra-sonic frequency (>150,000 Hz) calling porpoises. Sound propagation loss models suggest that baleen whale calls may be audible for 10+ km under many circumstance. However, the highly directional and rapid propagation loss characteristic of ultra-sonic porpoise clicks

may limit their detection distance to < 500 m. Given that no 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.

Appendix F Phase 2 Alternative Monitoring Plan Effectiveness Report

During the *OCW01 Geotechnical Investigation 1A (2017 & 2018) Phase 2*, four different complementary methods were used to detect marine mammals and sea turtles, some of which were used simultaneously (see 3 *Methods*):

5) UE
    a. During daylight: UE (with occasional use/sweeps of reticle binoculars [RB])
    b. During darkness: UE via artificial illumination from the *M/V Fugro Explorer* vessel lights
6) NVD during darkness (and some periods of daylight at twilight)
7) IR during both daylight and darkness
8) PAM during both daylight and darkness.

In the field, we recorded which monitoring method first identified (detected) a marine mammal (i.e., initial detection method); we also recorded which methods subsequently made the same detection (confirming the initial detection, i.e., a re-sighting) (Table 28). To maximize sample size and robustness, we pooled all detections made during the survey both inside and outside the Lease Area, since the goal of this appendix report is to assess and compare effectiveness of monitoring methods. However, we also present detection rates for data collected only within the Lease Area.

- A total of 25 initial detections occurred with no additional subsequent resights from other monitoring methods
- All detections (100 %) were made using UE methods (25 initial)
- There were zero PAM, zero NVD and zero IR detections.

Table 28. *Phase 2* initial and subsequent total number of detections for Unaided Eye (UE), Night Vision Device (NVD), Infra-red (IR) and Passive Acoustic Monitoring (PAM) methods inside and outside the Lease Area.

Detection Method	No. Initial Detections	Subsequent Confirmation Method (No.)
UE[1/]	25	None (0)
NVD	0	None (0)
IR	0	None (0)
PAM	0	None (0)
Total	**25**	**0**

[1/] During daylight, UE included occasional use of reticle binoculars; during darkness, only UE was used for this table category and only in waters artificially illuminated by the vessel's lights

Detections in Daylight vs. Darkness

During the *OCW01 Geotechnical Investigation 1A (2017 & 2018),* the four complementary detection methods were used during periods of both daylight and darkness.

- Of the 25 visual detections, 100 % (25 detections) occurred during daytime and zero detections occurred during darkness.

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 29. We further calculated detection rates based on periods of darkness and daylight in Table 30.

- By species/grouping (Table 29):
    - All species were only detected by UE, no other (IR, NVD, PAM) monitoring methods resulted in detections.
    - Unidentified dolphin or porpoise had the highest UE detection rates (0.17) followed by pooled sea turtles (0.12).
    - All large whales (fin, humpback, minke and unidentified) all had the same detection rate (0.9) and all from UE methods.

- During daylight (Table 30):
    - UE had the highest detection rate (0.072).
    - No IR or NVD detections were made. (The NVD was used during "daylight" only near twilight, as stronger daylight rendered them useless).
    - No PAM detections were made.

- During darkness (Table 30):
    - No detections occurred during darkness
    - The pooled (all detections) detection rate was highest from UE methods during daylight (0.104).

Table 29. *Phase 2* detection rates (number of initial[1/] detections per hours of effort[2/]) for Unaided Eye (UE), Night Vision Device (NVD), Infra-red (IR) and Passive Acoustic Monitoring (PAM) methods by species and groupings (data pooled for inside and outside the Lease Area).

Species	No. UE Visual Detections	UE Detection Rate (No. UE Detections/ 347.4 UE Effort)	No. IR Detections	IR Detection Rate (No. IR Detections/ 40.7 IR Effort)	No. NVD Detections	NVD Detection Rate (No. NVD Detections/ 57.1 UE Effort)	No. PAM Detection	PAM Detection Rate (No. PAM Detections/ 179.2 PAM Effort)
Bottlenose Dolphin	**3**	0.009	-	NA	-	NA	-	NA
Fin Whale	3	0.009	-	NA	-	NA	-	NA
Humpback Whale	3	0.009	-	NA	-	NA	-	NA
Minke Whale	3	0.009	-	NA	-	NA	-	NA
Unidentified Dolphin or Porpoise	6	0.017	-	NA	-	NA	-	NA
Unidentified Whale	3	0.009	-	NA	-	NA	-	NA
Marine Mammal Total	**21**	0.060	-	NA	-	NA	-	NA
Loggerhead Sea Turtle	2	0.006	-	NA	-	NA	-	NA
Unidentified Sea Turtle	2	0.006	-	NA	-	NA	-	NA
Sea Turtle Total	**4**	0.012	**-**	NA	**-**	NA	**-**	NA
Overall Total	**25**	0.072	**-**	NA	**-**	NA	**-**	NA

[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 = Infra-red bi-oculars, 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/] Total excludes pooled delphinids/porpoises and pooled whales

Table 30. *Phase 2* detection rates (number of initial[1/] detections per hours of effort[2/]) for Unaided Eye (UE), Night Vision Device (NVD), Infra-red (IR) and Passive Acoustic Monitoring (PAM) methods (data pooled for inside and outside the Lease Area).

Initial Detection Method	Daylight			Darkness			Overall		
	Effort Hours	No. Initial Detections	Detection Rate	Effort Hours	No. Initial Detections	Detection Rate	Effort Hours	No. Initial Detections	Detection Rate
UE	240.8	25	0.104	106.6	0	NA	347.4	25	0.072
NVD	1.7	0	NA	55.5	0	NA	57.1	0	NA
IR	12.8	0	NA	27.9	0	NA	40.7	0	NA
PAM	92.1	0	NA	87.2	0	NA	179.2	0	NA
Total	**347.3**	**25**	**0.726**	**277.1**	**0**	**NA**	**624.4**	**25**	**0.040**

[1/] Detections presented are *initial* detections from each monitoring method. UE = Unaided Eye (with occasional use of 7 x 50 reticle binoculars primarily to confirm sightings, species, etc.), IR = Infra-red bi-oculars, NVD = Night Vision Device (night vision binoculars), PAM = Passive Acoustic Monitoring.

[2/] During daylight, both UE and reticle binoculars were used; during darkness, only UE was used and only in waters artificially illuminated by the vessel's lights.

Unaided Eye Effectiveness

All (100 %) of the detections occurred by UE and all (100 %) occurred during daylight. There were no detections made by other methods and no detections during periods of darkness. PSOs considered the UE to be the most effective method for visually detecting the cetaceans observed during the survey. This was attributed to the wider field of view afforded by the UE within the 500-m MZ for North Atlantic right whales 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.

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

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

Environmental conditions and results of monitoring are discussed further in the body of this Technical Report and presented as associated with each detection in Appendix A, as required by BOEM and the NMFS IHA.

Night Vision Device Effectiveness

There were no detections during *Phase 2* that occurred from NVD methods. During Phase 2 there was a total of 57.1 h of NVD effort, which was considerably less than the 85.9 h that occurred during *Phase 1*. See *Appendix E Night Vision Device Effectiveness* for details on conditions reported by PSOs to reduce effectiveness of the NVDs.

IR Effectiveness

There were no detections during *Phase 2* that occurred from IR methods. During Phase 2 there was a total of 40.7 h of IR effort, which was considerably less than the 103.4 h that occurred during Phase 1. See *Appendix E IR Effectiveness* for details on conditions reported by PSOs to reduce effectiveness of the IR system.

PAM Effectiveness

There were no detections during *Phase 2* that occurred from PAM methods. This was a change from Phase 1 where PAM resulted in the second-highest detection rate (0.06 detections/h of PAM effort). All detections during Phase 1 contained signals characteristic of delphinid vocalizations, which are arbitrarily labeled as mid-frequency for the purposes of this report (Table 5). During Phase 2 there were only 9 total delphinid visual detections (3 bottlenose and 6 unidentified dolphin or porpoise). Therefore it is possible that PAM detections did not occur due to the lower frequency of dolphin and/or porpoise. See *Appendix E PAM Effectiveness* for details on conditions reported by PSOs to reduce effectiveness of the PAM system.

Appendix G Monitoring Method Product Sheets

ARMASIGHT by FLIR COMMAND PRO

Thermal Imaging Bi-Ocular

FEATURES

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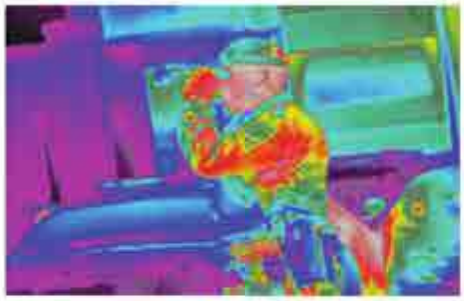
ARMASIGHT by FLIR

Figure 31. FLIR Infrared monitoring system specifications.

Specifications

	COMMAND PRO336 4-16x50	COMMAND PRO640 2-16x50	COMMAND PRO336 8-32x100	COMMAND PRO640 4-32x100
Sensor Specifications				
Detector type	336x256VOx Microbolometer	640x512VOx Microbolometer	336x256VOx Microbolometer	640x512VOx Microbolometer
Video frame rate	30Hz or 60Hz			
Start up	<3 seconds			
Image processing	User-adjustable image enhancement tools			
System Specifications				
Lens system	50mm, f/1.4		100mm, f/1.4	
Optical magnification (NTSC/PAL)	3.3x / 4x	1.8x / 2.1x	6.7x / 8x	3.5x / 4.2x
Field of view (H x V)	6.7° x 5°	12.5° x 10°	3.3° x 2.5°	6.2° x 5°
Digital zoom	1x, 2x, 4x	1x, 2x, 4x, 8x	1x, 2x, 4x	1x, 2x, 4x, 8x
Diopter adjustment range	-5 to +5 dpt			
Focusing range	5 to infinity			
Minimum Distance	10 to 7mm (26 to 3in)			
Display	800x600 AMOLED SVGA OLED			
Video output	PAL (768x576 pixels) / NTSC (640x480 pixels)			
Temperature imaging modes (image palettes)	White Hot, Black Hot, Sepia, Fusion, Rainbow, and Iron			
User Interface				
Control panel buttons	Configures operational settings: • Unit On/Off • Display brightness control • Image palette control • Digital zoom control • Choose menu navigation			
Focusing	Adjusts the objective lens focus			
Diopter adjustment ring	Adjusts the eyepiece diopter			
Remote control	Wireless button			
Interfacing				
Connector	Power in, analog video out (NTSC/PAL), digital video connector, laser range finder connections			
Power				
Battery type	Four CR123A 3V lithium batteries or four AA 1.5V			
Battery life (operating)	Up to 7hr (typical up to 14hr)			
Environmental				
Operating temperature range	-20 to +60°C (-4 to +122°F)			
Storage temperature range	-40 to +70°C (-40 to +140°F)			
Physical				
Weight	1.05kg (2.3lb)		1.4kg (3.1lb)	
Size	241x102x130mm (9.5x4.0x5.1in)		330x102x130mm (13x4.0x5.1in)	
Color (housing)	Black			
Country Of Origin	USA			
Packages Include				
	Thermal Hi-Color, Set of Batteries (4), Battery Cartridge for AA Batteries, Battery Box Extender Ring, Wireless Remote control, Quick Start Guide, Soft Carrying Case			



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Equipment described herein may require US Government authorization for export purposes. Diversion contrary to law is prohibited.

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FLIR

Figure 32. FLIR Infrared monitoring system specifications (page 2).

MSeis PAM SYSTEMS

Night Hawk III PAM System

Night Hawk III PAM System

Passive acoustic monitoring is fast becoming a necessity throughout the seismic industry in parts of the world where cetacean monitoring guidelines exist.

Improved performance of the Night Hawk III PAM system now makes detecting and localising mammals easier than before. Our balanced cables and upgraded preamplifiers give a greater signal to noise ratio allowing more effective detections.

Our Night Hawk III systems require 240V clean mains power, a double-desk monitoring station and a back deck location to site the reel.

Specifications

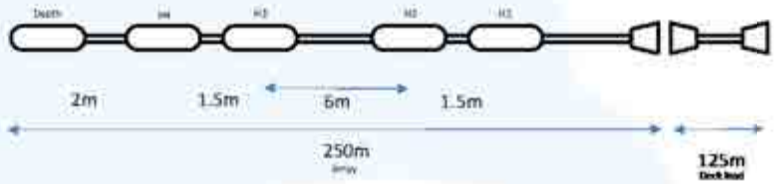
Hydrophone	Custom built -201 dBV re 1 microPa effective sensitivity. Near-flat response 0 to 180kHz, omni-directional. (tested at 50, 75 and 100kHz)
Cable	Custom length deck cable. In water cable to 300m.
Preamplifier	PA2 (MSeis in house design and build)
Channels	4
Depth Sensor	Pressure sensor 4-20mA
Construction	Hydrophone and preamplifier in polyurethane housing.
Connectors	19pin Cannon Military spec connectors, Souriau 12 pin underwater connectors, SOTB 16 pin.
Supply Voltage	240V AC
Operating Voltage	24V DC
Bandwidth	4Hz - 180kHz +/-3dB
Storage	CD, DVD, Hard disk, WAV files
Acquisition	NI DAQ card; sampling to 500KS/s External USB sound card; sampling to 192KS/s
Software & Data Logging	Pamguard

serving the energy sector

Figure 33. MSeis Night Hawk PAM system specifications.

3. Hydrophone Array

The hydrophone array consists of four sensor elements with integral pre-amp **and depth** sensor.



Mechanical Information

Length	*250m*		
Diameter	*16mm over cable*	*60mm over element*	*55mm over connector*
Weight	*70kg*		
Connector	*SD-16*		

Hydrophone elements

H1	*Broadband*	*4Hz – 180kHz*
H2	*Broadband*	*4Hz – 180kHz*
H3	*Broadband*	*4Hz – 180kHz*
H4	*Broadband*	*4Hz – 180kHz*

Filter roll off below 6kHz

Max depth 30m

H1-H2 Spacing	*1.5m*	*1ms*	*LF/HF*
H2-H3 Spacing	*6m*	*4ms*	*LF*
H3-H4 Spacing	*1.5m*	*1ms*	*LF/HF*

Deck Lead

Mechanical Information

Length	*125m*	
Diameter	*16mm over cable*	*55mm over connector*
Weight	*32kg*	
Connector	*SD-16/FP-19*	

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Warehouse: 43A Sandford Road, Weston-super-Mare, Somerset, BS23 3LX t: +44 (0)1934 622203
www.mseis.com Registered company number: 06078814 VAT Registration number: 969109532

Figure 34. MSeis Night Hawk PAM system specifications (page 2).

Figure 35. Mysticetus Observation Software.

ARMASIGHT by FLIR PVS-7

Night Vision Goggles

The Armasight by FLIR PVS-7 is the most widely recognized and dependable United States Military night vision goggle system available. The AN/PVS-7B/D system has proven itself in combat due to its rugged, ergonomic design.

The PVS-7 is equipped with Automatic Brightness Control (ABC), which automatically adjusts the brightness of the image tube to achieve the highest quality image resolution under varying light conditions, as well as a built-in infrared illuminator that allows the user to operate in total darkness. The PVS-7 also has an excessive light cut-off feature that protects the image tube from bright light sources, and a flip-up shut-off feature when used with the optional helmet mount assembly. The PVS-7 is equipped with two LED indicators: yellow for a low battery, and red to alert the operator that the IR illuminator is on. Both are displayed on the eyepiece screen. Lightweight, rugged, and versatile, the PVS-7 can be handheld, head mounted, and helmet mounted. The demounted goggle can also be used as an excellent long range viewer with optional afocal magnifier lenses.

FEATURES

- Compact, rugged design
- Waterproof
- Header helmet mountable for hands-free usage
- Ergonomic, simple, easy to operate controls
- Built-in Infrared illuminator and fl. coolers
- Limited two year warranty

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ARMASIGHT by FLIR

Figure 36. Armasight by FLIR PVS7 Generation 3.

Specifications

Overview	
Image intensifier tube	HDMG – Gen 2+, "Improved Definition" HDMG – Gen 2+, "High Definition" 3Bravo – Gen 3+ 3Alpha – Gen 3+, High Performance 3P – Gen 3, High Performance Thin Filmed Auto-Gated IIT
Magnification	1x standard, (2x, 3x optional)
Lens system	27mm, F/1.2
FOV	40°
Focus range	0.20m to infinity
Exit pupil	15mm
User Interface	
Function switch	On/Off unit and built-in IR illuminator
Focus ring	Focuses the objective lens
Diopter adjustment rings	Focuses the eyepieces
System Specifications	
Bright light cut-off	Yes
Automatic shut-off system	Yes
IR indicator	Yes
Low battery indicator	Yes
Infrared illuminator	Yes (built-in with 3 conditions)
Power	
Battery type	Two AA batteries
Battery life (operating)	Up to 30hrs
Environmental	
Operating temperature range	-40°C to +50°C (-40°F to +122°F)
Storage temperature range	-50°C to +70°C (-58°F to +158°F)
Physical	
Weight (without mount)	0.63kg (1.4lbs)
Size (with mount)	162 × 152 × 76 mm (6.4 × 6 × 3in)
Color (housing)	Black
Package Includes	
Night Vision Goggles, Lens Cap, Eyecup, Head Mount Assembly, Semi cut Window, Dovetail Shields, Shoulder Strap, Neck Cord, AA Batteries, Operation and Maintenance Manual, Soft Carrying Case	
Optional Accessories	
ANHM000005 – Nordic MIO Helmet Mount Assembly USA #107 ANHM000006 – Nordic PASGT Helmet Mount Assembly USA #108 ANAF300003 – 3x A Focal Mil-Spec Lens #99 ANAF300001 – 3x A Focal Lens #22 with Adapter #24/#25 ANAF500001 – 5x A Focal Lens with Adapter #24/#25 ANAMFR0003 – AFR53 – Advanced Range Finding Stadia for 3x A Focal Lens ANAMFR0005 – AFR55 – Advanced Range Finding Stadia for 5x A Focal Lens ANKXLR047 – BR09-XLR Detachable X Long Range Infrared Illuminator w/ Dovetail to Weaver Transfer Piece #21, Rechargeable Battery, and Charger ANHC000001 – Hard Shipping/ Storage Case #101	

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Figure 37. Armasight by FLIR PVS7 Generation 3 (page 2).

Appendix H North Atlantic Right Whale Sighting Report

12 December 2017
Wind farm lease area (OCS-A 0498)
RV Fugro Explorer
Felipe Triana (Lead Protected Species Observer), Smultea Sciences
North Atlantic Right Whale detection

Sighting Details
Position: 39°06'15.0''N 74°09'46.2''W
Time: 15:48 to 15:50 EST

One North Atlantic right whale (*Balaena glacialis*) was detected visually approximately 3000 meters off the portside of the *RV Fugro Explorer.* The sighting was initially made at 15:48 using 7 x 50 reticle binoculars that indicated a distance of 2890 m. The whale was initially seen partially breaching on its side exposing above the water surface a broad spatulate-shaped flipper characteristic of this species and a notched tail fluke (Figure 1). Four V-shaped blows were observed soon after (Figure 2), with a final side breach at 15:50 EST. The whale was heading to an orientation of 50° true (i.e., to the NE) moving in the opposite direction of the vessel. The vessel DP thrusters were off during this detection, as operations were down for weather, and the vessel was conducting weather patterns. Average vessel speed was recorded at 3 knots. This detection was 15 kilometers west of the project survey area. No mitigation measures were required.

Reporting Details

This detection was reported to NOAA NMFS via the Whale Alert application as well as via NOAA email on 12 December 2017 late afternoon to: Ne.RW.survey@NOAA.gov

Appendix F Figure 1. North Atlantic right whale (flipper & fluke) observed 12 December 2017.

Appendix F Figure 2. V-shaped blow of the North Atlantic right whale observed 12 December 2017.

Appendix I Photo Log

Figure 38. Common dolphins observed on 1 January 2018 during *OCW01 Geotechnical Investigation 1A (2017) Phase* 1. Photographer: Felipe Triana (Smultea Sciences).

Figure 39. Humpback whale observed on 12 December 2017 *OCW01 Geotechnical Investigation 1A (2017) Phase 1*. Photographer: Felipe Triana (Smultea Sciences).

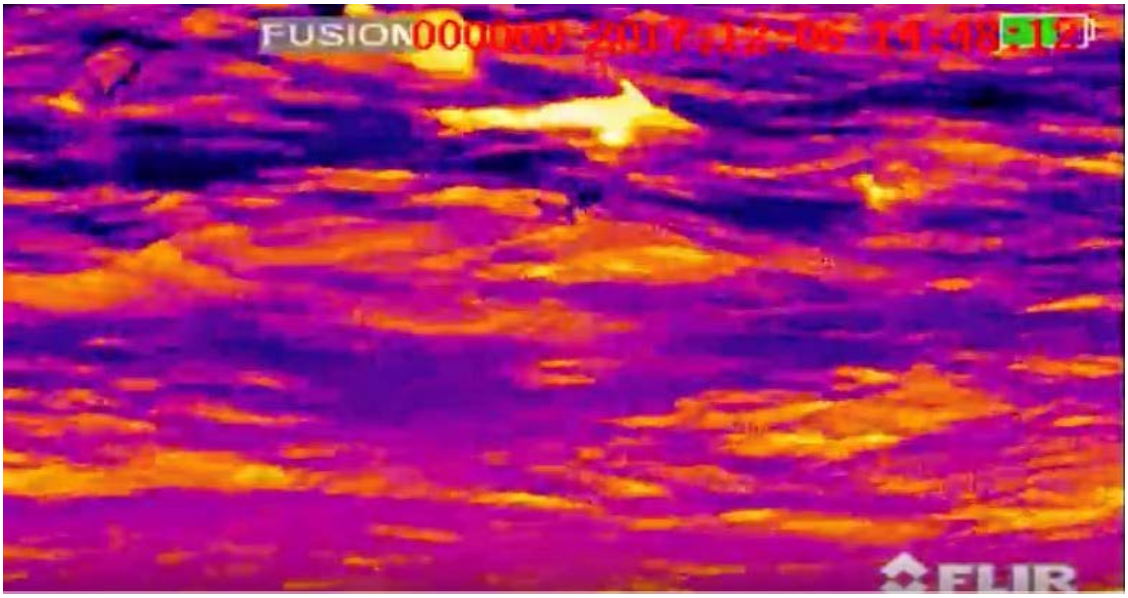

Figure 40. Common dolphin observed on 6 December 2017 through FLIR IR bi-ocular device during *OCW01 Geotechnical Investigation 1A (2017) Phase 1*. Species was confirmed with NVD.

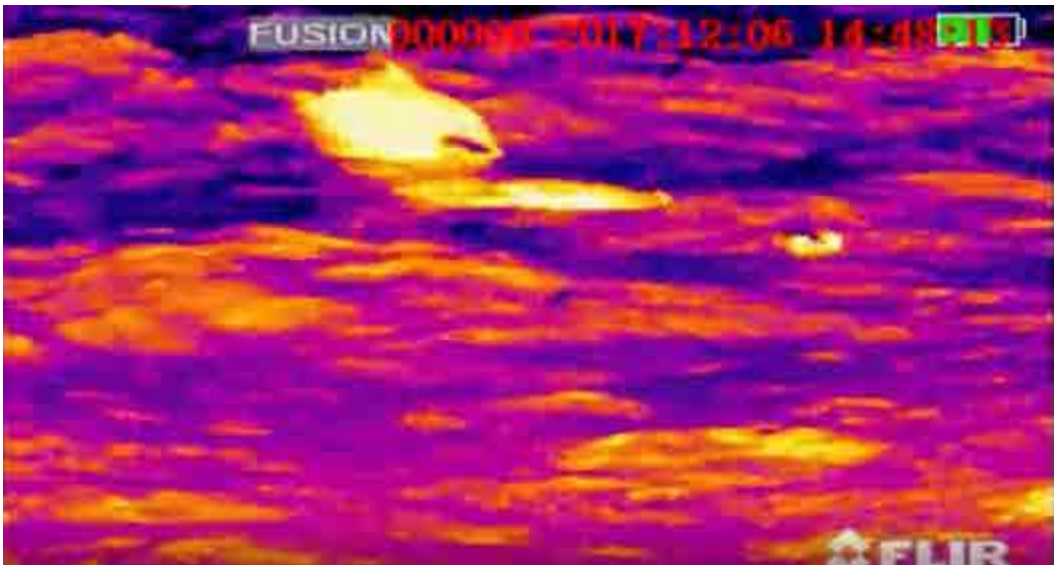

Figure 41. Common dolphin observed on 6 December 2017 through FLIR IR bi-ocular device during *OCW01 Geotechnical Investigation 1A (2017) Phase 1*. Species was confirmed via NVD.

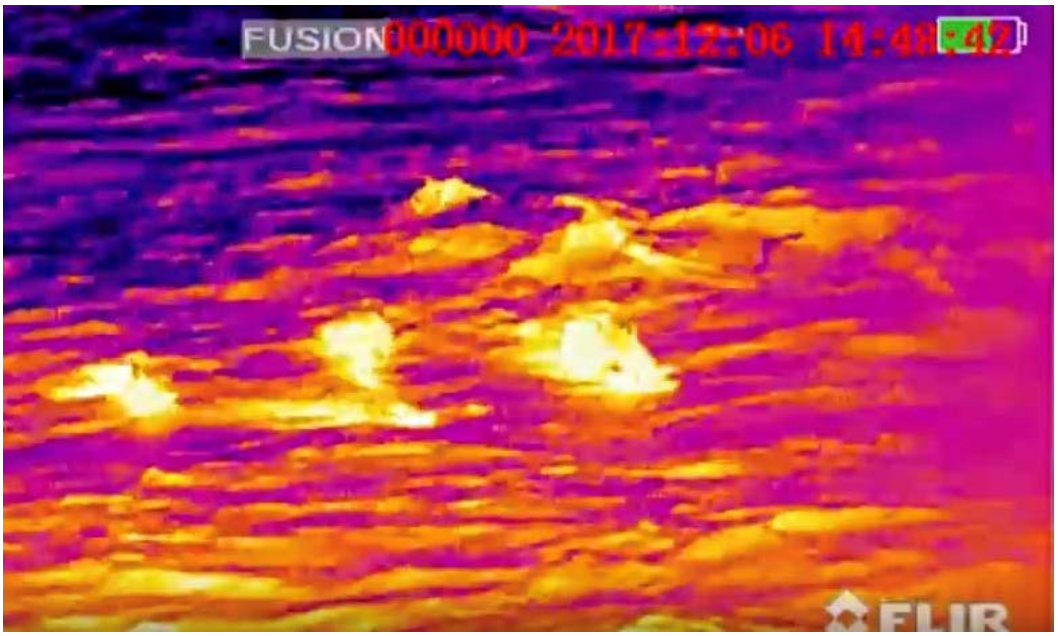

Figure 42. Common dolphins observed on 6 December 2017 through the FLIR IR bi-ocular device during *OCW01 Geotechnical Investigation 1A (2017) Phase 1*. Species was confirmed via NVD.