Protected Species Observer Technical Report for the Ørsted New England IHA, BOEM Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500; 2019–2020

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Abbreviations, Acronyms, and Initialisms

ARC	Automated Recognition of Cetaceans software
Bft	Beaufort scale
BOEM	Bureau of Ocean Energy Management
BOSIET	Basic Offshore Safety Induction and Emergency Training
CME	Construction and Marine Equipment
CPA	closest observed point of approach
CSA	CSA Ocean Sciences, Inc.
Current Corp IR	Current Corporation Night Navigator 2525 Infrared Camera System
dB	decibel
Deepwater Wind New England, LLC	Deepwater Wind (acquired by Ørsted in 2019)
delphinid	biological family including dolphins
delphinoid	biological superfamily including dolphins and harbor porpoise
DMA	Dynamic Management Area
DSLR	digital single-lens reflex
EZ	exclusion zone
FOV	field of view
ft	foot
Fugro	Fugro USA Marine, Inc.
Gardline	Gardline Limited
G&G	geotechnical and high-resolution geophysical
GPS	global positioning system
h	hour
HD	high-definition
HF	high-frequency
HRG	high-resolution geophysical
HSE	health, safety, and environment
IHA	Incidental Harassment Authorization
IR	infrared
kHz	kilohertz
kt	knot
km	kilometer
BOEM Leases	Bureau of Ocean Energy Management (BOEM) Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf Leases OCS-A 0486, OCS-A 0487, and OCS-A 0500
Lease Areas	Outer Continental Shelf Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500
LF	low-frequency
µPa	micropascal
MA	Massachusetts
MF	mid-frequency

m	meter
min	minute
mm	millimeter
MMPA	Marine Mammal Protection Act
MMT	MMT US Inc.
NARW	North Atlantic right whale (*Eubalaena glacialis*)
NBMCT	New Bedford Marine Commerce Terminal
NI DAQ	National Instruments Data Acquisition
NGO	non-governmental organization
NJ	New Jersey
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NVD	night vision device
Ørsted	Ørsted US Wind Power, LLC
PAM	passive acoustic monitoring
pinniped	marine mammals of the biological order Pinnipedia, including seals
PSO	protected species observer
PSO providers	Smultea Environmental Sciences, LLC; Gardline Limited; MMT US Inc.; and CSA Ocean Sciences, Inc.
QA/QC	quality assurance/quality control
RADES	Real-time Automated Distance Estimation Software
RB	reticle binocular
Regulatory Documents	BOEM Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500; 2019 Ørsted Incidental Harassment Authorization; and the North Atlantic Right Whale Agreement
REV01	Revolution Wind
RHVM	Remote High-Definition Visual Monitoring
RI	Rhode Island
RMS	root mean square
SBP	sub-bottom profiler
Seiche IR	Seiche Infrared Camera Monitoring System
SFW01	South Fork Wind
SMA	Seasonal Management Area
Smultea Sciences	Smultea Environmental Sciences, LLC
SRW01	Sunrise Wind
Surveys	high-resolution geophysical surveys of Ørsted wind farms Revolution Wind, South Fork Wind, Sunrise Wind, and Bay State Wind
TDOA	Time Difference of Arrival
TTS	temporary threshold shift
UE	unaided eye
USBL	ultra-short baseline

UTC	Universal Coordinated Time
WOW	waiting on weather

1 Executive Summary

This report provides a summary of all protected species monitoring and mitigation activities for geophysical surveys (Surveys) conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019), valid for the one-year period from 26 September 2019 through 25 September 2020. The IHA covered all high-resolution geophysical (HRG) survey work in four developing wind farms in New England waters, within and near the Bureau of Ocean Energy Management (BOEM) Commercial Leases of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf OCS A-0486, OCS-A 0487, and OCS-A 0500 (Lease Areas).

Protected species observers (PSOs) aboard eight different HRG survey vessels completed a total of 103,186 kilometers (km), representing 15,919 hours (h) of Monitoring Effort on the Surveys. Monitoring Effort was split approximately equally between *Daylight* versus *Darkness,* and in areas *Inside* versus *Outside* the three BOEM Lease Areas covered by the NMFS IHA.

During the Surveys, there was a total of 2,106 protected species groups/detections composed of an estimated 15,751 individuals. Short-beaked common dolphin and humpback whale were the most frequently detected species. A total of five North Atlantic right whale (NARW) individuals were seen in five different detection events. Most marine mammal detections occurred while HRG Sound was being produced below 200 kilohertz (kHz; HRG Sound *On*). Fifty sea turtles were detected, split equally between periods of HRG Sound *On* versus *Off*.

PSOs estimated only 8% of marine mammal detections were observed to change behavior while HRG Sound was *On*. The majority of these were short-beaked common dolphins *changing direction*, which is not considered an avoidance or disturbance behavior. Mysticete whales were observed to *blow* more when HRG Sound was *On*, and the median closest observed point of approach (CPA) was greater for all marine mammal species groups when HRG Sound was *On* versus *Off*. HRG Sound had no apparent effect on sea turtle behavior. These results indicate that any potential reactions of protected species to HRG Sound were localized and low-level.

The majority of the 259 total mitigation requests made by PSOs were for a *shutdown* (n=149) of electromechanical equipment operating below 200 kHz, or for a *delay* (n=104) of energizing this equipment. PSOs requested mitigation pertaining to vessel strike avoidance measures on 33 occasions. Short-beaked common dolphins were the primary cause of PSO-requested *shutdowns* and also for *delays during pre-clearance*, likely due to their curiosity about vessel activity. All mitigation requests were implemented quickly and effectively, helping to safeguard protected species from ship strikes and potential physical harm or behavioral disturbance from HRG equipment noise.

After excluding all individual marine mammal detections within the 180-m Level B isopleth that resulted in an immediate shutdown, as well as other individuals exposed to lower-

energy sounds sources, *the number of estimated Level B exposures for each species was less than the number of Level B incidental takes authorized by NMFS in Ørsted's IHA*.

An estimated nine individual, non-delphinoid cetaceans were detected within the 180-m Level B harassment zone while HRG sound sources were operating below 200 kHz and for which a *shutdown* was not implemented. However, none of these individuals came within the 100-m EZ stipulated within the IHA, thus no mitigation was required or requested by PSOs. Although all appropriate mitigation and shutdown protocols were followed, it is possible these individuals were exposed to impulsive sound levels above 160 decibels (dB) root mean square (RMS) for brief durations.

Mitigation and monitoring measures defined in the 2019 Ørsted IHA and BOEM Leases were properly implemented by PSOs throughout the Surveys and considered effective to safeguard protected species.

2 Introduction

2.1 Background

All marine mammals in the United States are protected under the Marine Mammal Protection Act (MMPA) of 1972. Per the MMPA, operations that emit noise into the marine environment must consult with the National Marine Fisheries Service (NMFS) if sound levels produced by the activity may disturb or injure marine mammals by exceeding pre-determined sound exposure thresholds and frequencies that may rise to the NMFS-determined level of "take."

On 10 June 2019, Ørsted US Wind Power, LLC (Ørsted) applied to NMFS for an Incidental Harassment Authorization (IHA) to permit high-resolution geophysical (HRG) surveys within Bureau of Ocean Energy Management (BOEM) Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (Lease Areas) associated with development of Ørsted offshore wind farms in the northeastern United States (Ørsted 2019). On 26 September 2019, NMFS issued Ørsted a one-year IHA covering all HRG survey work in coastal waters from New York to Massachusetts (2019 Ørsted IHA), including the requested Lease Areas and associated export cable routes (ECRs; NMFS 2019). This IHA covered portions of the surveys of the following wind farms, which are cumulatively referred to herein as Surveys:

- Revolution Wind (REV01),
- South Fork Wind (SFW01),
- Sunrise Wind (SRW01), and
- Bay State Wind (MAW01).

Surveys were conducted by the marine survey companies Fugro USA Marine, Inc. (Fugro), Gardline Limited (a wholly owned subsidiary of Royal Boskalis Westminster NV; Gardline), MMT US Inc. (MMT), and CSA Ocean Sciences, Inc. (CSA). Protected Species Observers (PSOs) were provided for the Surveys by Smultea Environmental Sciences, LLC (Smultea Sciences), Gardline, and CSA/Marine Ventures International, Inc. (CSA/MVI), cumulatively referred to herein as PSO providers. The PSO providers were contracted by the marine survey companies to conduct NMFS- and BOEM-required monitoring and mitigation for protected species during the Surveys. PSO providers supplied PSOs, passive acoustic monitoring (PAM) operators, and night vision equipment as required by the BOEM Leases OCS-A 0486, OCS-A 0487, and OCS-A 0500 (BOEM Leases), and by BOEM-approved survey and monitoring plans for each project. Marine survey companies, survey vessels (Figure 1–9), and PSO providers for each vessel are shown in Table 1.

The primary on-site responsibilities of the PSO and PAM teams were to monitor for protected marine species (i.e., marine mammals, sea turtles, and Atlantic sturgeon) and implement mitigation measures to avoid and minimize potential adverse impacts to those species. Mitigation measures included conducting visual observations 24 hours (h) per day and conducting PAM during *Darkness* and *Daylight* periods when visibility was limited. Specific mitigation measures for HRG Surveys and associated regulatory documents are described in the following sections.

Smultea Sciences was contracted by Ørsted to write the final summary PSO Technical Report for the 2019 Ørsted New England IHA, combining all PSO monitoring and mitigation data for HRG survey vessels that operated within the Lease Areas from 00:00 26 September 2019 through 23:59 25 September 2020. Standalone final PSO Technical Reports for each wind farm will be or have been submitted separately to Ørsted by individual PSO providers.

Table 1. Survey vessels, marine survey operators, vessel owners, and PSO providers, and wind farms surveyed under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Survey Vessel	Marine Survey Company Owner/Operator	PSO Provider	Wind Farm Surveyed
Offshore Vessels			
Searcher	Fugro[1]	Smultea Sciences[2]	Sunrise Wind
Enterprise	Fugro	Smultea Sciences	Revolution Wind and Sunrise Wind
Discovery	Fugro	Smultea Sciences	Revolution Wind
Kommandor Iona	Hays Ships Ltd/ Fugro	Smultea Sciences	Revolution Wind
Ocean Researcher	Gardline[3]	Gardline	Sunrise Wind
Deep Helder	MMT[4]	CSA/MVI[5]	Revolution Wind and South Fork Wind
Nearshore Vessels			
Westerly	Zephyr Marine/ Fugro	Smultea Sciences	Revolution Wind and Sunrise Wind
Dolphin	CSA	CSA/MVI	Revolution Wind UXO[6] and South Fork UXO

[1] Fugro = Fugro USA Marine, Inc.
[2] Smultea Sciences = Smultea Environmental Sciences, LLC
[3] Gardline = Gardline Limited
[4] MMT = MMT US Inc.
[5] CSA/MVI = CSA Ocean Sciences, Inc./Marine Ventures International, Inc.
[6] UXO = unexploded ordnance

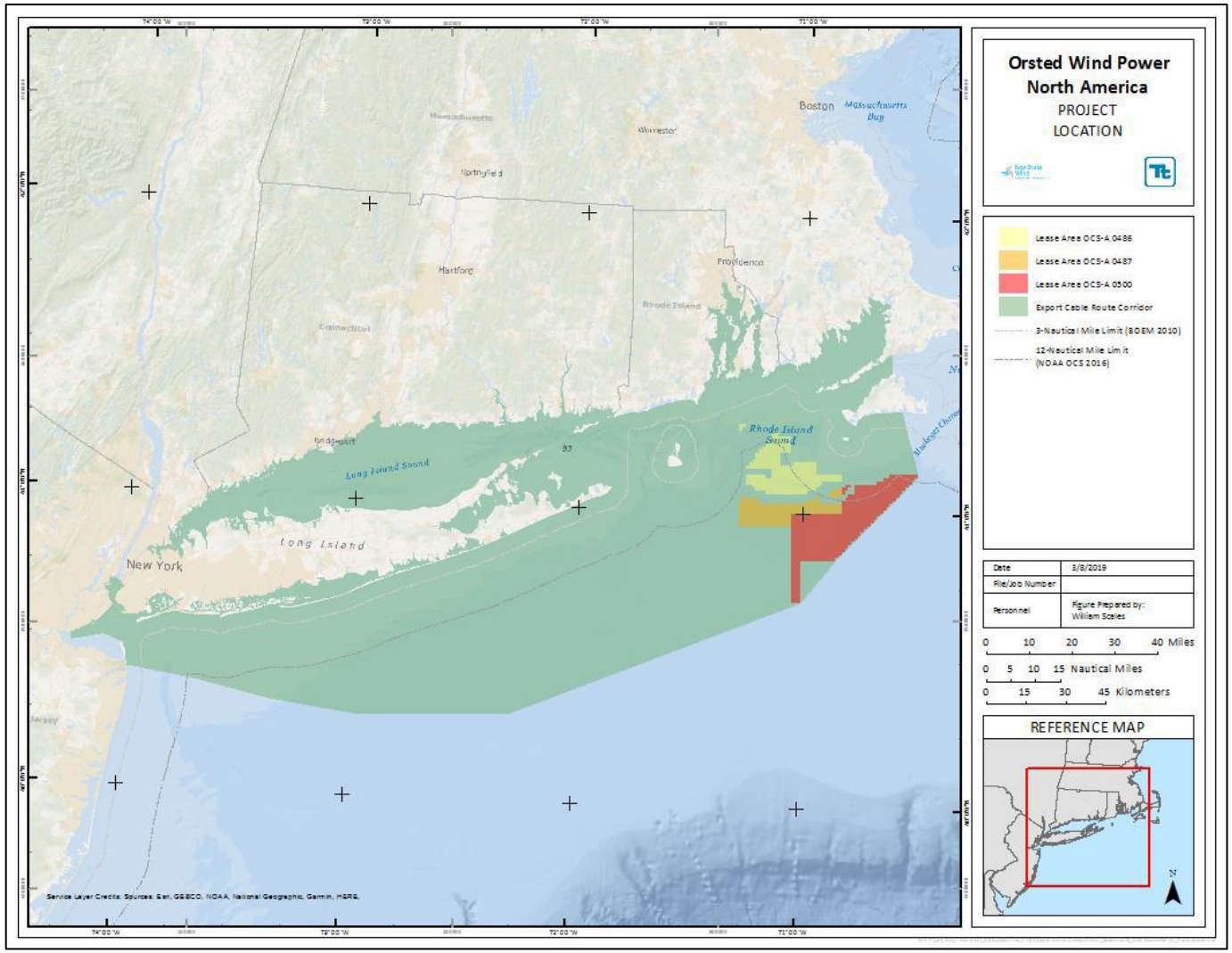

Figure 1. BOEM Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 and export cable route (ECR) survey areas covered under 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Figure taken from 2019 Ørsted IHA Application (Ørsted 2019).

Figure 2. Survey vessel *Fugro Searcher* used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Figure 3. Survey vessel *Fugro Enterprise* used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Figure 4. Survey vessel *Fugro Discovery* used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Figure 5. Survey vessel *Kommandor Iona* used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Figure 6. Nearshore survey vessel *Westerly* used surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Figure 7. Survey vessel *Ocean Researcher* used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Figure 8. Survey vessel *Deep Helder* used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Figure 9. Nearshore survey vessel *Dolphin* used surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

2.2 Regulatory Documents

Regulatory Documents defining mitigation measures for the Surveys were the 2019 Ørsted IHA, BOEM Lease Agreements (BOEM 2013a; BOEM 2013b, BOEM 2015), and a voluntary North Atlantic Right Whale (NARW) Agreement. Where differing and/or

overlapping mitigation measures existed within one or more Regulatory Documents, the most conservative measure was adopted in practice in the vast majority of cases.

The 2019 Ørsted IHA was issued late on 26 September 2019, and was in place for one year. This PSO Technical Report covers the one-year period from 00:00 26 September 2019 through 23:59 25 September 2020, during which time 24-h operations were conducted on all offshore vessels operating in the Lease Areas and limited incidental take was authorized.

Ørsted worked under three BOEM Leases covered under the 2019 Ørsted IHA. The BOEM Leases OCS-A 0486 and OCS-A 0487 were issued in October 2013 to Deepwater Wind New England, LLC (Deepwater Wind), and incorporate the offshore wind farm development areas for Revolution Wind, South Fork Wind, and part of Sunrise Wind. Deepwater Wind was acquired by Ørsted in 2018. BOEM Lease OCS-A 0500 was issued to RES America Developments Inc. in April 2015. On 12 June 2015, the Lease was reassigned to DONG Energy (now Ørsted), which renamed its American subsidiary Bay State Wind LLC. Together, Lease Areas OCS-A 0487 and a subsection of OCS-A 0500 cover the offshore development area of the Sunrise Wind Farm. Stipulations within the Leases, guided by NMFS and agreed to by Ørsted and BOEM, define additional regulations safeguarding protected species.

On 07 May 2014, Deepwater Wind (acquired by Ørsted in 2018, as mentioned above), entered into a voluntary agreement with non-governmental organizations (NGOs) to enhance mitigation measures to protect the North Atlantic right whale (NARW) during site assessment and characterization activities in the Rhode Island and Massachusetts wind energy area (NARW Agreement), which encompasses the Lease Areas addressed in this Technical Report. The mitigation measures in the NARW Agreement were in addition to the NMFS NARW minimum separation distance and seasonal operating requirements (https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-ship-strikes-north-atlantic-right-whales) and applied to the Deepwater Wind projects REV01 and SFW01, and also to SRW01.

HRG survey equipment operating at frequencies below 200 kilohertz (kHz), and therefore requiring mitigation for protected species, consisted of the shallow penetration sub-bottom profiler (SBP), medium penetration depth seismic source (Sparker), and ultra-short baseline (USBL) acoustic positioning system. Adopted mitigation measures for HRG operations were:

- 100-meter (m) pre-clearance zone and exclusion zone (EZ) for all protected species (except short-beaked common dolphins and North Atlantic right whales [NARW]),
- 180-m EZ for short-beaked common dolphins and unidentified dolphins that voluntarily approach the vessels,
- 200-m for sea turtles,
- 500-m pre-clearance zone and EZ for NARWs,
- 60-min pre-clearance of largest applicable EZ; entirety of the largest applicable EZ must be visible to pre-clear and maintain clearance of the EZ,
- Temporary equipment delays and shutdowns due to the incursion of any protected species within the applicable EZ,
- Any 20-min or longer suspension of sound sources operating below 200 kHz requires a new pre-clearance,
- Vessel strike-avoidance measures, and
- Enforcement of the NARW minimum separation distance and seasonal operating requirements (see Section 4.6.5 for more information).

2.3 BOEM and NMFS Reporting Requirements

This PSO Technical Report summarizes information required by the BOEM Leases and 2019 Ørsted IHA per Table 2 for the one-year period from 26 September 2019 through 25 September 2020.

The Lead PSOs distributed a daily PSO report to Ørsted, the marine survey companies, and their PSO providers at the end of each Coordinated Universal Time (UTC) calendar day. Each daily report summarized PSO effort and vessel operations, details related to detections of protected species, mitigation measures implemented, weather conditions, and estimated potential Level B exposures or takes. All data recorded in the field, including the specific BOEM- and NMFS-required data elements in Table 2, were provided to Ørsted with this Technical Report.

Table 2. Protected species reporting requirements per BOEM Leases OCS-A 0486, OCS-A 0487, and OCS-A 0500 and the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Reporting Requirement	Source Reference	Location Addressed in Technical Report
The Lessee must ensure that sightings of any dead or injured protected species (e.g., marine mammals, sea turtles, or sturgeon) are reported to the Lessor, NMFS, and the NMFS Greater Atlantic (Northeast) Region's Stranding Hotline (866-755-6622) within 24 hours of sighting, regardless of whether the injury is caused by a vessel. In addition, if the injury or death was caused by a collision with a project-related vessel, the Lessee notify the Lessor of the strike within 24 hours. The Lessee must use the form included as Appendix A to Addendum "C" to report the sighting or incident. If the Lessee's activity is responsible for the injury or death, the Lessee must ensure the vessel assist in any salvage effort as requested by NMFS.	BOEM Leases Addendum C Section 4.4.1 *and* NMFS IHA Section 6(b)	Protected Species Incident Reports
The Lessee must report any observations concerning impacts on Endangered Species Act listed marine mammals or sea turtles to the Lessor and NMFS within 48 hours. Any observed Takes of listed marine mammals or sea turtles resulting in injury or mortality must be reported within 24 hours to the Lessor and NMFS.	BOEM Leases Addendum C Section 4.4.2	Protected Species Exposures
The Lessee must provide the Lessor and NMFS with a report within 90 calendar days following the commencement of high-resolution geophysical (HRG) and/or geotechnical exploration activities and at the conclusion of HRG and/or geotechnical exploration activities that includes a summary of the survey activities and an estimate of the number of listed marine mammals and sea turtles observed or Taken during these survey activities.	BOEM Leases Addendum C Section 4.4.3 *and* NMFS IHA Section 6(a)	The entirety of this Technical Report
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:	BOEM Leases Addendum C Section 4.4.4 *and* Appendix B to Addendum "C" in BOEM Lease	Appendix G: Summary of All Protected Species Detections from Surveys Conducted under

Reporting Requirement	Source Reference	Location Addressed in Technical Report
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 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 - related to the vessel (drawing preferably); 13. Behavior (as explicit and detailed as possible, noting any observed changes in behavior); and 14. Activity of vessel when sighting occurred.	0500 *and* NMFS IHA Section 5 (d;e)	the Ørsted IHA (NMFS 2019)
Fully document the methods and monitoring protocols.	NMFS IHA Section 6 (a,ii)	Monitoring and Mitigation Program
Summarize the data recorded during monitoring.	NMFS IHA Section 6 (a,ii)	Results
Estimate the number of marine mammals that may have been taken during survey activities.	NMFS IHA Section 6 (a,ii)	Protected Species Exposures
Describe the effectiveness of various mitigation techniques.	NMFS IHA Section 6 (a,ii)	Interpretation of Results *and* Summary of Effectiveness of All Monitoring Tasks
Provide an interpretation of the results and effectiveness of all monitoring tasks.	NMFS IHA Section 6 (a,ii)	Interpretation of Results *and* Summary of Effectiveness of All Monitoring Tasks

3 Survey Overview

Surveys on the four Ørsted wind farms across the corresponding three BOEM Lease Areas (Table 1) were conducted under the 2019 Ørsted IHA from 26 September 2019 through 25 September 2020 from six 24-h offshore vessels (*Searcher*, *Enterprise*, *Discovery*, *Kommandor Iona*, *Ocean Researcher*, and *Deep Helder*) and two daytime-only nearshore vessels (*Westerly* and *Dolphin*; Table 1). The timeline for HRG operations for each vessel is shown in Table 3.

Table 3. Summary of geophysical operations event dates for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Event	Date
Incidental Harassment Authorization (IHA) issued late in day. *Searcher* and *Enterprise* already conducting HRG operations under restricted Letter of Concurrence regulations in Sunrise Wind and Revolution Wind Lease Areas. *Kommandor Iona* and *Discovery* already conducting HRG operations on Revolution Wind.	26 September 2019
Twenty-four hour operations and PAM monitoring begin on all active survey vessels.	27 September 2019
Westerly begins HRG operations on Revolution Wind.	29 September 2019
Searcher and *Enterprise* docked at New Bedford Marine Commerce Terminal (NBMCT) in New Bedford, Massachusetts (MA) waiting on weather (WOW).	07–12 October 2019
Enterprise docked at NBMCT WOW.	29 October–02 November 2019
Enterprise temporarily ends HRG operations on Sunrise Wind and returns to Construction and Marine Equipment (CME) dock in Elizabeth, New Jersey (NJ) to demobilize.	08 November 2019
Enterprise conducts HRG operations on Revolution Wind.	20 November 2019–10 January 2020
Westerly completes operations on Revolution Wind.	21 December 2019
Searcher ends HRG operations on Sunrise Wind and returns to NBMCT dock to demobilize.	30 December 2019
Enterprise briefly conducts benthic sampling for Sunrise Wind and then returns to Revolution Wind surveying.	13–16 January 2020
Enterprise conducts HRG operations on Revolution Wind.	20–24 January 2020
Discovery completes operations on Revolution Wind and transits to CME dock for demobilization.	23 January 2020
Kommandor Iona completes operations on Revolution Wind and transits to NBMCT dock for demobilization.	29 January 2020
PSO effort begins on *Westerly* as vessel leaves dock at Prime Marina Southampton in Long Island, New York (NY) for daytime-only operations.	06 March 2020
PSO effort ends on *Westerly*. Standby for COVID 19.	28 March 2020
Enterprise resumes HRG operations on Sunrise Wind.	05 April 2020

Event	Date
Enterprise ends HRG operations on Sunrise Wind and returns to NBMCT dock.	05 May 2020
Sunrise Wind switches from *Enterprise* to *Searcher.*	06 May 2020
Intermittent PSO/PAM Effort as *Searcher* moves between docks and conducts HRG equipment tests.	08–15 May 2020
Searcher resumes HRG operations.	16 May 2020
Westerly resumes HRG operations.	30 May 2020
PSO/PAM effort begins on *Deep Helder* for South Fork Wind as vessel leaves dock in New Bedford, MA.	03 June 2020
PSO/PAM effort begins on *Ocean Researcher* for Sunrise Wind as vessel leaves New Bedford, MA.	03 July 2020
HRG operations begin on *Ocean Researcher.*	13 July 2020
Deep Helder at Providence, Rhode Island (RI) WOW; *Ocean Researcher* WOW.	02–05 August 2020
Westerly completes HRG operations and docks at Prime Marina Southampton in Long Island, NY for demobilization. PSO monitoring complete.	08 August 2020
PSO effort begins on *Dolphin* for Revolution Wind as vessel operates out of Conanicut Marina in Jamestown, RI. Daylight operations only; vessel returns to port at the end of each workday.	12 August 2020
Ocean Researcher WOW.	14–19 August 2020
Searcher completes HRG operations and docks at NBMCT for demobilization. PSO/PAM monitoring complete.	23 August 2020
Dolphin completes HRG operations for Revolution Wind and moves to Prime Marina Southampton on Long Island, NY	08 September 2020
Ocean Researcher WOW.	11–15 September 2020
Deep Helder at Newport, RI WOW; *Dolphin* at Hampton Bays, NY WOW; *Ocean Researcher* WOW	20–23 September 2020
Dolphin completes HRG operations for South Fork Wind.	25 September 2020

HRG survey equipment consisted of multibeam echosounders, side scan sonar, SBPs, Sparkers (Single-channel Ultra High Resolution Seismic [S-UHRS] and Multi-channel Ultra High Resolution Seismic [M-UHRS] configurations), USBL acoustic positioning systems, and gradiometers. The SBP, Sparker, and USBL equipment operated at frequencies below 200 kHz (Table 4) and therefore required mitigation for protected species.

Table 4. Operating frequencies of survey equipment used on each vessel on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Impulsive High-Resolution Geophysical (HRG) Sound Source	Operating Frequencies	Offshore Vessels						Nearshore Vessels	
		Searcher	***Enterprise***	***Discovery***	***Kommandor Iona***	***Ocean Researcher***	***Deep Helder***	***Westerly***	***Dolphin***
Shallow Penetration Depth Seismic Source: Sub-bottom Profiler (SBP)									
Parametric **SBP** Innomar SES-2000 Medium-100	1.4–4.5 kHz 2–22 kHz 85–115 kHz	X	X	X	X	X	X	X	X
Medium Penetration Depth Seismic Source: Sparker									
Geo-Spark 2kJ Ultra Hi-Res **Sparker** System with Dual 200 Tip Geo Source	0.2–5 kHz	X	X						
Applied Acoustics Geo-Source Dura-Spark 400+400 **Sparker** (800 tips total) at 250–800 Joules with 96-channel 1-m group µSeis Streamer	0.5–3.5 kHz					X			
GeoMarine Geo-Source **Sparker** at 600 Joules	0.4-3 kHz		X	X	X				
Ultra-short Baseline (USBL) Positioning System									
Kongsberg HiPAP 501 **USBL** System	20–30 kHz	X	X						
Kongsberg HiPAP 500/351 **USBL** System	100–900 kHz		X	X	X				
iXBlue GAPS III **USBL** System	8–35 kHz						X		
Sonardyne Ranger 2 **USBL** System	19–34kHz					X			
Sonardyne Mini-Ranger 2 **USBL** System	19–34 kHz								X
Applied Acoustics Easytrak Nexus 2 **USBL** System	100–900 kHz							X	

4 Monitoring and Mitigation Program

The protected species monitoring and mitigation program for the Surveys was established to satisfy the mitigation and monitoring requirements outlined in the Regulatory Documents. The objectives of this program were (1) to minimize disturbance to protected species related to electromechanical acoustic equipment operating below 200 kHz, and (2) to reduce the risk of vessel collision with protected species. Specific monitoring and mitigation regulations are described in detail in the following sections.

4.1 Protected Species Observers (PSOs)

During the Surveys, between one and seven NMFS-certified and BOEM-approved visual PSOs and PAM operators were aboard each of the eight Survey vessels (Table 5). On each offshore vessel, among the six or seven PSOs onboard, at least two were trained PAM operators, and one was the Lead PSO. No PAM monitoring was required on the two nearshore, daytime-only vessels. The vessel crew on the nearshore *Westerly* monitored for the single PSO when he took breaks; the two PSOs on the nearshore *Dolphin* alternated every hour unless two PSOs were required for ramp-up or reduced visibility. A third PSO was available on the Dolphin to supplement PSO breaks if there were prolonged periods of poor conditions.

All PSOs met minimum requirements identified by BOEM and NMFS in the Regulatory Documents and were certified in basic offshore safety induction and emergency training (BOSIET). Prior to mobilization, PSOs were trained on specific project details and requirements including the identification, behavior, and occurrence of local protected species inhabiting the general Survey Area (i.e., northeastern U.S. waters). Species identification guides and references were available at the PSO station on each vessel at all times.

Table 5. Total number of Protected Species Observers (PSOs) and passive acoustic monitoring (PAM) operators on each vessel used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Survey Vessel	Total No. of PSOs/PAM Operators per Vessel	No. of PAM Operators per Vessel
Offshore Vessels		
Searcher	6	2
Enterprise	6	2
Discovery	6	2
Kommandor Iona	6	2
Deep Helder	6	2
Ocean Researcher	7	2
Nearshore Vessels		
Westerly	1	0
Dolphin	3	0

Visual and/or acoustic PSOs monitored during all vessel operations, including transit to and from the Survey Areas, equipment calibration, HRG survey operations, and when the

vessel conducted weather patterns (i.e., waiting on weather [*WOW*], positioning the vessel to minimize pitch and roll during rough weather). Exceptions included brief periods of high air moisture (i.e., heavy fog, rain, or snow) that reduced visibility to near zero, and/or when it was deemed unsafe to observe (see Section 4.4 for more information). In such conditions, survey operations also could not be conducted.

Monitoring occurred 24 h per day on the six offshore vessels while these vessels were surveying or underway, whereas PSO observation aboard the two nearshore vessels was conducted anytime the vessel was underway (in *Daylight* only). For all vessels, at least one visual PSO monitored during all *Daylight* periods and two visual PSOs monitored during ramp-up of HRG equipment. During REV01 and SFW01 surveys, two PSOs were on watch during *Daylight* as required by the NARW Agreement. During HRG surveying in *Darkness* on all offshore vessels except the *Deep Helder* and *Ocean Researcher*, at least two visual PSOs and one PAM operator conducted monitoring. During *Darkness* on the *Deep Helder* and *Ocean Researcher*, each of which had a mounted infrared (IR) camera system, one PSO maintained watch on deck with a night-vision device (NVD) while the second PSO monitored the mounted IR camera system. A PAM system was available as backup on the *Deep Helder* and *Ocean Researcher* if the NVDs and IR devices failed. During periods of reduced visibility (see Section 4.4) on the offshore vessels, at least one PSO monitored the visual extent of the EZ while a PAM operator monitored acoustically.

When PAM was not required during *Darkness* (e.g., during transit or vessel standby), one visual PSO conducted watch to assist the maritime crew in avoiding any potential vessel strike of a protected species.

PSOs maintained clear and effective communication at all times with the Survey chain of command on and off the vessels. On board, PSOs attended the daily Health, Safety, and Environment (HSE) meetings with the vessel and survey crew. Any project questions were addressed in that setting or as needed in real time.

4.2 Visual Observation Methods

During the Surveys, PSOs conducted visual monitoring using four different methods: the unaided eye (UE, which includes systematic use of reticle binoculars [RB]), handheld night-vision devices (NVDs), handheld infrared (HH IR) devices, and mounted infrared (mounted IR) camera systems. Monitoring equipment available on each vessel is shown in Table 6; model specifications for monitoring equipment are provided in Appendix B (All Appendices provided in separate document). All vessels also had digital single-lens reflex (DSLR) cameras with 70–300-millimeter (mm) lenses to document visual detections and verify species identification when possible.

Table 6. Monitoring equipment available on each vessel on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). X indicates device was available for use by PSOs on vessel.

Survey Vessel	PVS-7 HH[1] NVD[2] Bi-ocular	PVS-14-P HH NVD Mono-cular	Rongland GNVY-3 HH NVD	FLIR Scout 640 HH IR[3] Mono-cular	FLIR BHM XR+ Bi-ocular HH IR Camera	FLIR E6 WiFi HH IR Camera	Ship-mounted Seiche IR Dual Camera System	Ship-mounted Current Night Navigator 2525 IR Dual Camera System	Ship-Mounted NVTS Reliant 640HD IR Camera System	PAM[4]	RB[5] (various models)
Offshore Vessels											
Searcher	X	X		X	X					X	X
Enterprise	X	X		X	X		X			X	X
Discovery	X	X		X	X		X			X	X
Kommandor Iona	X	X		X	X		X	X		X	X
Deep Helder	X					X	X			X	X
Ocean Researcher			X		X				X	X	X
Nearshore Vessels											
Westerly											X
Dolphin											X

[1] HH = handheld
[2] NVD = night vision device
[3] IR = infrared
[4] PAM = passive acoustic monitoring
[5] RB = reticle binoculars

Visual PSOs watched for protected species primarily from the bridge deck (inside the bridge/wheelhouse or outside on the bridge wings). This was the most advantageous location as it provided a 360° view of the water surrounding the survey equipment and vessel, was the highest vantage point deemed safe for observers, and provided shelter from inclement weather. Visual observations were generally conducted outside as much as possible; when weather and/or high sea states made observation conditions detrimental to equipment or personal safety, visual watches were conducted inside the bridge.

The distance to the unobstructed horizon at sea can be calculated for each observation location on the vessels using known observer eye height and deck height above water level and applying trigonometry and corrections for curvature of the earth (Table 7). Individual PSO eye heights and deck heights were measured prior to the surveys. This information was entered into the *Mysticetus*™ observation software (*Mysticetus*) data collection system (described below in Section 4.5), which then automatically calculated distance to visual detections and plotted them on the map interface.

Table 7. Distance to the horizon from each observing location on the vessels used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Vessel	Observing Location	Height of Deck (m)	Height of Deck (m) + 1.6 m[1]	Distance to Horizon (km[2])
Offshore Vessels				
Searcher	Forecastle deck	8.3	9.9	10.3
Searcher	Bridge wing	11.2	12.8	12.8
Searcher	Bridge	11.3	12.9	12.9
Enterprise	Bridge and bridge wings	6.5	8.1	10.3
Discovery	Bridge and bridge wings	10.1	11.7	12.3
Kommandor Iona	Bridge	8.1	9.7	11.3
Deep Helder	Bridge and bridge wings	12.7	14.3	13.5
Ocean Researcher	Bridge and bridge wings	10.5	12.1	12.4
Ocean Researcher	Foredeck and upper deck	5.6	7.2	9.6
Nearshore Vessels				
Westerly	Bridge	0.6	2.2	5.3
Dolphin	Upper deck	1.5	3.1	6.3
Dolphin	Bridge	2.0	3.6	6.8

[1] 1.6 m is the average eye height calculated as the average of the average male (5 ft 9 in) and female (5 ft 4 in) height minus 4 in
[2] km = kilometers

Positioning of PSOs on the bridge and bridge wings facilitated clear and effective communication with the vessel crew and survey team, facilitating quick mitigation request communications. PSOs rotated shifts every 1 to 4 h to avoid observer fatigue, with a minimum 2-h rest period after shifts of 4 h. Time on-watch for each observer did not exceed 12 h in a 24-h period.

During survey operations while the vessels were stationary, PSOs monitored 360° around their vessel. While underway (when the vessels were surveying with towed equipment, moving between survey location, or transiting to/from port), PSOs focused monitoring forward and to approximately 90° on either side of their vessel heading, occasionally scanning astern in a sweeping pattern. Crew aboard the vessel also watched for protected species (insofar as practical) and alerted the PSOs in the event of a protected species detection.

All methods of visual monitoring (UE, NVD, HH IR, and mounted-IR) complemented each other depending on the environmental and vessel conditions, thus enabling the PSOs to effectively monitor the applicable EZs.

4.2.1 Visual Observations in *Daylight* – Unaided Eye (UE) and Reticle Binoculars (RB)

Daylight for HRG surveys was, for the most part, defined as the period between civil twilight rise and set (i.e., from dawn through dusk, or when the sun is higher than 6° below the horizon). On the *Deep Helder* and *Dolphin*, *Daylight* observations began as soon as visibility reached a minimum of 500 m and ended when visibility was reduced to less than 500 m due to darkness, which generally coincided with civil twilight. Visual observations were typically feasible during this time but were dependent on cloud cover and fog conditions. While on-watch during *Daylight*, PSOs systematically scanned waters surrounding the vessel in a sweeping pattern as described above, primarily with the unaided eye (UE) and with reticle binoculars (RB) as needed. RBs were used to confirm species' identification, group size, behavior, distance to the animal(s), and to scan for smaller or less-demonstrative species. The tradeoff for increased magnification with the RB was a narrower field of view (FOV); alternating between the two methods was an effective means of covering the entire visible surrounding area during *Daylight* (see Section 6 for further discussion of the effectiveness of monitoring methods and devices).

Distance estimates of visual detections were made by using the built-in RB reticles when conditions allowed (i.e., when the horizon was visible), by comparing an animal's location to objects or other vessels at a known distance (including using a vessel's radar), and/or by previous observer training and experience in estimating distances.

4.2.2 Visual Observations in *Darkness*

Darkness (i.e., nighttime) was defined as the period between civil twilight set and rise, or the period between dusk and dawn. PSOs could monitor with the UE during *Darkness* when the vessel operating lights or a gibbous moon illuminated the water sufficiently. Back deck lights remained on for safety during all periods of *Darkness*. PSOs reported that when these deck lights were on, the waters approximately 30 to 100 m abeam and 40 to 50 m off the bow were sufficiently illuminated for the PSOs to observe using only the UE. The lights did not cast much illumination astern, and visibility astern was often obscured by vessel superstructure.

4.2.2.1 *Handheld Night Vision Devices (NVDs) and Handheld Infrared (HH IR) devices*

UE monitoring during *Darkness* on the offshore vessels was supplemented with a ship-mounted IR camera (selected vessels; Section 4.2.2.2), HH NVDs, and HH IR devices as listed in Table 6. NVDs are light-sensitive, whereas IR devices are heat-sensitive. As such, NVDs could be used from inside the bridge when the lights were off, but HH IR devices could only be used outside the wheelhouse because there was too much heat inside the vessel (see Section 6 for further discussion of the effectiveness of monitoring methods). Vessel operators kept the bridge lights off whenever possible to minimize interference with detection ability of the NVDs. NVDs were used by the second PSO on watch during nighttime Survey operations to scan the waters astern of the vessel that were not illuminated by vessel lights.

PSOs did not keep detailed notes of exact start and end times of UE versus NVD because doing so would have been impractical and detract from their primary role of detecting and mitigating for protected species. Instead, PSOs followed a guideline of allotting a 1:1 ratio of UE:NVD or HH IR while monitoring with optical devices.

4.2.2.2 *Ship-Mounted Infrared (IR) Camera Systems*

The offshore vessels *Enterprise*, *Discovery*, *Kommandor Iona*, *Deep Helder*, and *Ocean Researcher* were equipped with a ship-mounted remote high-definition visual monitoring (RHVM) IR camera system that was used as the primary visual monitoring device during *Darkness* and other periods of reduced visibility. On the *Enterprise*, *Discovery*, and *Kommandor Iona* during *Darkness*, one visual PSO monitored the mounted IR cameras, one visual PSO monitored with NVD/UE, and one acoustic PSO monitored the PAM system. On the *Deep Helder* and *Ocean Researcher*, one PSO monitored the mounted IR while the other monitored with NVD/UE. PAM was available as a backup to either visual method on these two vessels.

The Seiche IR Camera Monitoring System (Seiche IR) was the primary mounted-IR camera system during Surveys and was used on all vessels listed above except the *Ocean Researcher*; the *Kommandor Iona* switched from Seiche IR to the Current Night Navigator 2525 IR Camera System (Current Corp IR) from 19 November 2019 until this vessel completed its portion of the Survey on 29 January 2020. *Ocean Researcher* used the ship-mounted NVTS Reliant 640HD IR camera system (Reliant 640HD). All three vessel-mounted IR camera systems meet or exceed specifications previously accepted by BOEM and NMFS for geotechnical and high-resolution geophysical (G&G) surveying in the Atlantic Ocean and consisted of two IR and high-definition (HD) cameras mounted on the vessels. PSOs occasionally used the HD cameras during twilight. Specifications for each camera system and details of their configuration on the vessels are given in Appendix B (All Appendices provided in separate document).

4.3 Passive Acoustic Monitoring (PAM) Methods

PAM was available on the offshore vessels throughout the Survey period. On the *Searcher*, *Enterprise*, *Discovery*, and *Kommandor Iona*, PAM was used during all HRG survey hours during *Darkness* and periods of *Daylight* with reduced visibility. On the *Deep Helder* and *Ocean Researcher*, PAM was a backup monitoring method during *Darkness* and reduced visibility during *Daylight* in case the primary monitoring devices of NVDs and IR devices (HH and ship-mounted) failed. Specifications for each vessel's PAM system are provided in Appendix B (All Appendices provided in separate document).

4.4 Periods of Reduced Visibility During Daylight

On all Survey vessels, if visibility was reduced to less than 500 m, pre-clearance could not be completed by PSOs until the entire 500-m EZ could be visually monitored and confirmed free of protected species for at least 60 continuous min. Two PSOs were on watch during periods of reduced visibility, one of whom would maintain visual observation while the other monitored either the ship-mounted IR system (on the *Deep Helder*) or the PAM system (on all other offshore vessels). PAM could not be used independent of visual monitoring for pre-clearance of the EZ, but could be used to maintain clearance of the EZ if visibility was reduced after regulated HRG sources were activated.

4.5 Mysticetus™ Observation Software

Protected species visual and PAM detections, detection details, PSO and PAM monitoring effort, and operational and environmental conditions were collected with a laptop running *Mysticetus*™ observation software (*Mysticetus*). *Mysticetus* displays the location of protected species detections relative to EZs and vessel location on real-time map displays.

All data across all vessels were collected by PSOs on the standardized 2019 or 2020 Ørsted *Mysticetus* data collection template. These templates contained prompts for all BOEM- and NMFS-required data elements identified in Appendix B of Addendum "C" in the Lease (see Table 2). The templates constrained data entry to acceptable variables, but *Mysticetus* could not prevent all PSO entry error or inconsistency. PSO providers took all efforts to minimize any errors: data were reviewed by PSOs at the start and end of each watch shift, and by the Lead PSO at the end of each day. Data were reviewed again within 24–48 h by the shore-based Project Manager as well as the shore-based Data Analyst. Internet bandwidth varied across vessels and vessel locations and occasionally affected delivery of data to shore. However, data were almost always received onshore within 2 h and no later than 1–2 days after collection. This proactive quality assurance/quality control (QA/QC) process allowed for timely feedback between the shore-based QA/QC team and PSOs offshore, which improved the overall integrity of the data. *Mysticetus* recorded every original data entry and subsequent QA/QC edits using state-of-the-art encryption techniques. All data gathered across all platforms were securely stored in the *Mysticetus* Cloud and backed up daily on 1–2 external hard drives. Final data were made available for retrieval, QA/QC, aggregation, and further analysis in numerous file formats. The final Survey database was provided to Ørsted with the final report.

4.5.1 Method of Cross-Vessel Sighting Coordination

In order to coordinate detections between PSOs on different vessels, *Mysticetus* software notified PSOs on other vessels of the same PSO providers through an automated detection alert if vessels were within 20 km of each other. This feature helped alert PSOs on nearby vessels of any known protected species in the area.

4.6 Mitigation Measures

Mitigation measures for the Survey are presented below. The HRG equipment that produced sound at frequencies below 200 kHz, and therefore required mitigation measures, were the SBP, Sparker, and USBL. Mitigation measures were identified in the Survey Plan, IHA, BOEM Leases, and NARW Agreement and were implemented aboard all survey vessels. Where regulations differed among documents the more conservative measure was implemented in nearly all cases. Summary graphics of the mitigation decision flow process described below are in Appendix D (All Appendices provided in separate document).

4.6.1 Ramp-up Procedures

Per BOEM Lease Addendum C Stipulation 4.3.6.8 and IHA stipulation 4(h), when technically feasible, electromechanical survey equipment must be "ramped up" such that regulated noise is introduced into the water incrementally beginning with the lowest power output possible. Specifically, acoustic output must not exceed a 6 decibel (dB)

increase per 5-min period. Only the Sparker could be mechanically ramped up during this HRG Survey. A 20-min ramp-up for the Sparker was required upon initial start-up and following all shutdowns.

4.6.2 Biological Incursions into Exclusion Zones (EZs)

NMFS IHA Section 4, the BOEM Leases, and the NARW Agreement established pre-clearance zones and EZs for protected species while HRG survey equipment was active and operating below 200 kHz. PSOs on the *Searcher*, *Enterprise*, *Discovery*, *Kommandor Iona*, and *Westerly* implemented the following EZs:

- 100-m pre-clearance zone and EZ for all marine mammals except short-beaked common dolphins and NARWs,
- 180-m EZ for short-beaked common dolphins and unidentified dolphins that voluntarily approached the vessel,
- 200-m EZ for sea turtles, and
- 500-m pre-clearance zone and EZ for NARWs.

Prior to 27 July 2020, no shutdown was required for delphinids (i.e., oceanic dolphins from the genera *Delphinus*, *Lagenorhynchus*, *Stenella*, or *Tursiops*) that voluntarily approached the vessels. After 27 July 2020, the 180-m EZ was implemented per above.

PSOs on the *Deep Helder*, *Dolphin*, and *Ocean Researcher* implemented a more conservative approach when the Sparker was *On*: a 500-m EZ for all species except for the 180-m EZ for short-beaked common dolphins or unidentified dolphins (from 27 July through 25 September 2020).

During Surveys for REV01, SFW01, and SRW01, more conservative mitigation and EZs were implemented as part of the NARW Agreement, which applied to Surveys conducted on Leases formerly held by Deepwater Wind prior to acquisition by Ørsted in 2018 (see Section 2.2):

- 100-m pre-clearance EZ for delphinids (established by 2019 IHA),
- 200-m EZ for all non-NARW marine mammals and turtles if only the USBL was active, and
- 500-m EZ for all protected species, including NARW, if the SBP or Sparker was active.

EZs were centered around the estimated output of the loudest sound source, typically the Sparker. Distance estimations were recorded as the distance from the animal to the closest point on the vessel and to sound sources.

Prior to starting HRG sound sources operating below 200 kHz, or if there was a pause of >20 min in those sound sources (see Section 4.6.3), PSOs conducted a 60-min pre-clearance of the largest applicable EZ (500-m). The entirety of all EZs had to be visible during the full pre-clearance period. If a protected species was observed inside its applicable EZ during the 60-min pre-clearance period, the pre-clearance period was restarted until EZs were clear of all protected species for at least 60 min prior to activation of HRG sound sources with operational frequencies below 200 kHz. PSOs maintained clear communication with bridge and survey crews so HRG operations could begin immediately following the pre-clearance period.

Once HRG operations had begun, shutdown of equipment operating below 200 kHz (i.e., SBP, Sparker, and/or USBL) was requested immediately by visual PSOs or PAM operators

if any protected species was detected within or approaching its respective EZ, or if a NARW was detected acoustically. If the animal(s) dove and was not detected again,

re-start of sound sources operating below 200 kHz was cleared by PSOs after the following re-clearance times:

- 15 min for delphinoid cetaceans (i.e., dolphins and porpoises) and pinnipeds,
- 30 min for any non-delphinoid cetacean (i.e., mysticetes [baleen whales] and sperm whales),
- 60 min for sea turtles, and
- 60 min for NARW, even if the animal was seen leaving the EZ.

If the animal (except for a NARW or sea turtle) was seen leaving the EZ, Survey operations could resume without the additional delay.

4.6.3 Pauses in Electromechanical Survey Sound Sources

Per BOEM Lease stipulation 4.3.6.10.1, if the electromechanical survey equipment was shut down due to mechanical failure or vessel transit (i.e., not due to biological incursion into the EZ) for more than 20 min, PSOs conducted a 60-min pre-clearance of the EZ of all protected species. Full ramp-up procedures could then be initiated.

If survey equipment was shut down for less than 20 min, visual monitoring had been conducted continuously during the silent period, and the EZ had remained clear of protected species, survey equipment could be restarted as soon as practicable. If visual monitoring was not conducted continuously following the mechanical pause, a 60-min pre-clearance of the EZ of all protected species was required before full ramp-up procedures could be initiated.

4.6.4 Vessel Strike-Avoidance for Survey Vessels

Vessels were required not to exceed 10 knots (kt) in any Dynamic Management Area (DMA; defined in Section 4.6.5) indicated for the NARW or from 01 November through 30 April. At all times when the vessel was underway, the vessel operator was required to maintain the following separation distances to avoid potential vessel strike:

- 50 m from any delphinoid cetacean (i.e., dolphins), pinniped, or sea turtle,
- 100 m from any non-delphinoid cetacean (i.e., mysticetes and sperm whales), and
- 500 m from NARWs.

If an animal was detected within the separation distance while the vessel was underway, required mitigation varied by species. In the case of a delphinoid cetacean, pinniped, or sea turtle within 50 m, the vessel remained parallel to the animal's course when possible, avoided abrupt changes of course or speed, and ensured speed was below 10 kt when pods (including mother-calf pairs) or large assemblages were seen.

If a non-delphinoid cetacean was within the 100-m separation distance, the vessel reduced speed and shifted to neutral, if practicable, until the whale was beyond 100 m.

If a NARW was within 100 m, the vessel reduced speed and shifted to neutral until the whale was beyond 100 m. If the whale was detected within the 500-m separation distance while the vessel was towing gear and restricted in her ability to maneuver, the vessel reduced speed and steered a course away from the whale. If the whale was within

500 m and the vessel was not towing gear, the vessel would shift to neutral if practicable.

4.6.5 North Atlantic Right Whale (NARW) Mitigation Measures

Mitigation measures specific to NARWs were implemented during the Survey. PSOs regularly monitored online for the presence of any NMFS-established DMAs and/or NARWs in or near transit corridors and the Survey Area (https://www.nefsc.noaa.gov/psb/surveys/MapperiframeWithText.html). A DMA is a temporary area designated by the National Oceanic and Atmospheric Administration (NOAA) and NMFS consisting of a regulatory polygon centered on a confirmed aggregation of NARW, within which vessels must not exceed 10 kt.

At least every 4 h, the PSO on duty checked the NMFS NARW Sighting Advisory System (e.g., via the NMFS website and/or NMFS Whale Alert application). If a DMA was established in or near the Survey Area, the Lead PSO would immediately inform the designated Survey point of contact on the vessel and ensure that Ørsted was notified. Each time a DMA check was undertaken by the PSO, a column was marked in the *Mysticetus* data entry form, and was automatically associated with a date, time, global positioning system (GPS) position, and any relevant comments.

PSOs were also aware of any NARW Seasonal Management Areas (SMAs) within transit corridors or the Survey Area. All vessels more than 19.8 m long must not exceed 10 kts when within these areas to reduce the threat of ship collisions with NARWs.

In addition, PSOs on the vessel were to prepare a one-page written summary of sighting details for any NARW detected from a Survey vessel, including photographs, so that Ørsted could submit this information to NMFS. A NARW report template was available to PSOs on the vessels for this purpose. The Lead PSOs entered sighting data for any NARWs into the NMFS Whale Alert cellular phone application, and *Mysticetus* automatically sent out an alert text and email notifications to the Survey point of contact, Ørsted, and PSO providers' land-based personnel notifying them of the time and location of the detection.

4.7 Data Collection and Analysis Methods

The same data collection protocols were applied to all Survey operations and analysis. PSOs and PAM operators documented all protected species detections and effort throughout all project operations. All data identified in the Regulatory Documents (see Table 2) were collected in a pre-determined template on a laptop using *Mysticetus*.

Effort data consisted of environmental variables and vessel activity, and were recorded every 30 min, whenever operational or monitoring conditions changed, and during each detection (see Table 2 for list of variables). These effort data are summarized here as two different categories: Monitoring Effort and PSO Effort.

Monitoring Effort captures any period when at least one visual or acoustic PSO was on watch (Table 8). By definition, Monitoring Effort cannot exceed 24 h in a single day, regardless of how many PSOs conducted active monitoring during a given day. Monitoring Effort is presented across a range of environmental and operational conditions, and is reported as both time (e.g., hours) and vessel trackline distance (e.g., kilometers).

PSO Effort is the total PSO person-hours allocated to monitoring for protected species across all monitoring methods (e.g., UE, NVDs, HH IR, PAM). By definition, PSO Effort can exceed 24 h in a day to reflect all hours of monitoring across all PSOs independently. PSO Effort is presented across different monitoring methods to compare the relative detection effectiveness between methods. PSO Effort hours are also summarized based on *Daylight* versus *Darkness*, *Inside* versus *Outside* the Lease Areas, closest observed point of approach (CPA), and HRG sound source operating below 200 kHz *On* versus *Off* (Table 8).

For each detection, PSOs recorded the lowest taxonomic level of animal identification for which they were confident, down to species when possible. Detection distances, including CPA, were measured or estimated from the animal to the closest point on the vessel and to sound sources for every detection. Protected species' movements relative to the vessel, initial and secondary behaviors, and any behavior reaction were recorded for each detection based on pre-defined protocol and ethograms.

Behaviors included: *blow*, *bow ride*, *breach*, *dead*, *feed*, *fluke up*, *look*, *mill*, *N/A PAM* (behavior could not be determined for PAM-only detections when the animals were not detected visually), *none*, *other* (defined in *Mysticetus* notes), *porpoise*, *rest*, *socialize*, *splash*, *surface-active mill*, *surface-active travel*, *swim*, *tail slap*, *travel*, *unknown* (when behavior could not be determined for visual detections).

Behavior reactions (an observed overt change in behavior perceived by PSOs as a potential reaction to the vessel and/or Survey operations) included: *change direction*, *dive*, *look*, *N/A PAM* (behavior could not be determined for PAM-only detections when the animals were not seen), *none*, *slow down*, *speed up*, *splash,* and *unknown* (when behavior could not be determined for visual detections).

Behavior descriptions followed those used in numerous other 90-day reports associated with oil and gas, and geotechnical and HRG operations (e.g., Aerts et al. 2008; Blees et al. 2010; Lomac-MacNair et al. 2014) and are listed in Appendix A (All Appendices provided in separate document).

Table 8. Definitions of data collection and analysis terminology used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Term	Definition
Darkness	Period between civil twilight set and rise (i.e., the period between dusk and dawn when the sun is lower than 6° below the horizon)
Daylight	Period between civil twilight rise and set (i.e., the period between dawn and dusk when the sun is higher than 6° below the horizon)
Detection	A protected species group sighted visually (with UE, HH IR, ship-mounted IR, or NVD) or identified acoustically with PAM
Detection Rate	Number of initial detections per 1,000 hours of PSO Effort
HRG Sound On	Periods when Sparker, SBP, and/or USBL was active
HRG Sound Off	Periods when Sparker, SBP, and/or USBL was not active
Group	One or more protected species individuals seen close together and coordinated in a similar manner (e.g., coordinated surfacing, feeding, traveling); also synonymous with Detection
Monitoring Effort	Active use of visual or acoustic monitoring methods in hours–cannot exceed 24 h in a day, which differentiates it from PSO Effort
Monitoring Effort On	Periods when at least one visual or acoustic PSO (i.e., PAM operator) was monitoring for protected species–no more than 24 h a day
Monitoring Effort Off	Periods when no visual or acoustic PSO was monitoring for protected species
PSO Effort	Total PSO person-hours allocated to monitoring for protected species – can exceed 24 h in a day, unlike Monitoring Effort

Detection rates were used to standardize the number of detections by PSO unit of effort. Detection rates were calculated as the number of initial detections per 1,000 h of PSO Effort (Table 8). For different/alternative monitoring devices, detection rates were calculated as the number of initial detections by monitoring method, divided by the number of hours of PSO Effort for each respective method, multiplied by 1,000. Hours were used as the effort until for detection rate analysis because trackline distance in km was not considered appropriate in this case, as some vessels alternated between stationary and underway (i.e., moving) periods, and vessels were not traversing a survey corridor designed for systematic biological sampling.

For robust analysis of the effectiveness of monitoring devices (NVD, HH IR, mounted IR, PAM, and UE/RB), PSO Effort and detection data were combined for all six offshore vessels on the Surveys and for the two nearshore vessels (see Table 1). Data were separated for offshore versus nearshore Surveys because the two nearshore vessels (*Westerly* and *Dolphin*) surveyed only in *Daylight* and used only the UE and RB–no additional monitoring devices were required.

4.7.1 Estimating Number of Exposures

NMFS defines a Level B harassment, or a "take by harassment," for marine mammals as any exposure to sound levels that could potentially result in temporary threshold shift (TTS) or a behavioral disturbance to the animals (NMFS 2018). NMFS considers a Level B take to occur at continuous anthropogenic sound levels ≥120 dB re 1 μPa root mean square (RMS) and impulsive sound levels ≥160 dB re 1 μPa RMS. The regulated sound sources utilized in this Survey (SBP, Sparker, and USBL; see **Table 9** for operating frequencies) are considered impulsive sound sources and thus are subject to the ≥160 dB re 1 μPa RMS Level B harassment isopleth.

Table 9. Regulated acoustic sources and operational frequencies by vessel for HRG surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Impulsive High-Resolution Geophysical (HRG) Sound Source	Operating Frequencies	Offshore Vessels						Nearshore Vessels	
		Searcher	***Enterprise***	***Discovery***	***Kommandor Iona***	***Ocean Researcher***	***Deep Helder***	***Westerly***	***Dolphin***
Shallow Penetration Depth Seismic Source: Sub-bottom Profiler (SBP)									
Parametric **SBP** Innomar SES-2000 Medium-100	1.4–4.5 kHz 2–22 kHz 85–115 kHz	X	X	X	X	X	X	X	X
Medium Penetration Depth Seismic Source: Sparker									
Geo-Spark 2kJ Ultra Hi-Res **Sparker** System with Dual 200 Tip Geo Source	0.2–5 kHz	X	X						
Applied Acoustics Geo-Source Dura-Spark 400+400 **Sparker** (800 tips total) at 250–800 Joules with 96-channel 1-m group µSeis Streamer	0.5–3.5 kHz					X			
GeoMarine Geo-Source **Sparker** at 600 Joules	0.4-3 kHz		X	X	X				
Ultra-short Baseline (USBL) Positioning System									
Kongsberg HiPAP 501 **USBL** System	20–30 kHz	X	X						
Kongsberg HiPAP 500/351 **USBL** System	100–900 kHz		X	X	X				
iXBlue GAPS III **USBL** System	8–35 kHz						X		
Sonardyne Ranger 2 **USBL** System	19–34kHz					X			
Sonardyne Mini-Ranger 2 **USBL** System	19–34 kHz								X
Applied Acoustics Easytrak Nexus 2 **USBL** System	100–900 kHz							X	

Level A take is defined as injury or mortality to marine mammals and occurs at higher sound thresholds that vary by species. The maximum estimated Level A harassment isopleth was less than 2 m for HF cetaceans (Ørsted 2019). Thus, the risk of Level A exposure from active HRG equipment of any kind was considered highly unlikely. Level A take is not typically authorized by NMFS, and it is assumed that project mitigation measures will protect marine mammals from Level A exposures as well as the vast majority of potential Level B exposures. Furthermore, what does or does not rise to the level of take is assessed and determined solely by NMFS on a case-by-case basis. Therefore, only *potential* Level B exposure estimates are reported herein.

Distances to the Level A and Level B exposure thresholds for marine mammals for equipment meeting or exceeding NMFS exposure guidelines were calculated by Ørsted in the Survey IHA application (Ørsted 2019; Table 10). The maximum estimated Level B harassment zone was 141 m for a Sparker. To minimize the number of marine mammals potentially taken by Level B harassment, the Level B isopleth was conservatively set at 180 m by the 2019 IHA (NMFS 2019). The number of potential exposures was based on direct observations of protected species (see Sections 4.2 and 4.3 for monitoring methods) within this 180-m Level B isopleth of the equipment operating at that time. The estimated number of animals detected within these distances were considered potential exposures.

Potential exposures also were assessed in the context of the "maximum" active source at the time of detection to account for the significant differences between estimated Level B radii for different sources. For example, if a USBL device with an estimated Level B radius of ~2 m was the only source operating below 200 kHz at the time marine mammals were detected within the 180-m Harassment Zone, then it is highly unlikely these individuals would have been exposed to Level B sounds. PSOs detected well over 1,000 marine mammals within the 180-m Harassment Zone during periods when only the USBL or another lower-energy source (e.g., Sub-bottom Profiler) was operating.

Table 10. Estimated distances to NMFS Level A and Level B sound level thresholds by types of equipment used on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Table 4 for operating frequencies and specific equipment operated on each vessel.

Impulsive Sound Source	Distance to Level A Threshold (m) for each Species Hearing Group				Distance to Level B Threshold (m)
	Low-frequency (LF) cetacean	Mid-frequency (MF) cetacean	High-frequency (HF) cetacean	Pinniped	All Species
Shallow Penetration Depth Seismic Source: Sub-bottom Profiler (SBP)					
Shallow Penetration Parametric Sub-bottom Profiler Innomar SES-2000 Medium-100 (**SBP**)	0	0	<2	0	63
Medium Penetration Depth Seismic Source: Sparker					
Geo-Spark 2kJ Ultra Hi-Res Sparker System with Dual 200 Tip Geo Source (**Sparker**)	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
Applied Acoustics Geo-Source Dura-Spark 400+400 **Sparker** (800 tips total) at 250–800 Joules with 96-channel 1-m group µSeis Streamer	<1	0	<4	<1	141
GeoMarine Geo-Source **Sparker** at 600 Joules	<1	0	<4	<1	86
Ultra-short Baseline (USBL) Positioning System					
Kongsberg HiPAP 501 **USBL** System	0	0	<1	0	2
Kongsberg HiPAP 500/351 **USBL** System	0	0	<1	0	2
iXBlue GAPS III **USBL** System	0	0	<1	0	2
Sonardyne Ranger 2 **USBL** System	0	0	<1	0	2
Sonardyne Mini-Ranger 2 **USBL** System	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]
Applied Acoustics Easytrak Nexus 2 **USBL** System	0	0	<1	0	2

[1] The IHA application did not assess this exact model of Sparker.
[2] The IHA application did not assess this exact model of USBL but threshold distances are likely to align with other USBL systems listed here.
Source: Ørsted IHA application (Ørsted 2019)

5 Results

Monitoring Effort, protected species distribution, and protected species detection data for all vessels during Surveys conducted under the 2019 NMFS IHA are summarized below by *Daylight* versus *Darkness*, HRG Sound *On* versus *Off*, and *Inside* versus *Outside* the Lease Areas. HRG Sound *On* indicates when at least one regulated sound source (i.e., Sparker, SBP, and/or USBL) was active at frequencies below 200 kHz.

Monitoring device effectiveness is discussed in Section 6.

Please note that any discrepancies in table *totals* are due to rounding.

5.1 Monitoring Effort

This section presents Monitoring Effort, defined as any period when at least one visual or acoustic PSO was on watch (Table 8).

The eight HRG Survey vessels accrued a combined total of 103,186 km of vessel tracklines while PSOs and/or PAM operators were conducting Monitoring Effort, inclusive of all Vessel Activities and periods of HRG Sound *On* and *Off* (Table 11). The grand total of 103,186 km of Monitoring Effort occurred over a combined total of 15,919 h.

Figure 10 through Figure 13 present the grand total 15,919 h of Monitoring Effort by Vessel Activity and various measures of environmental conditions. The most common Vessel Activities monitored by PSOs were *surveying*, *waiting on weather* (WOW), *transit*, and *standby*; Figure 10).

Table 11. Kilometers of high-resolution geophysical (HRG) survey trackline completed with PSO Monitoring Effort *On* versus *Off* by each vessel on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Survey Vessel	Wind Farm(s) Surveyed	Monitoring Effort (km)		
		HRG Sound On	HRG Sound Off	Total
Offshore Vessels				
Searcher	Sunrise Wind	16,735	9,508	**26,234**
Enterprise	Revolution Wind and Sunrise Wind	8,151	9,985	**18,136**
Discovery	Revolution Wind	7,930	4,695	**12,625**
Kommandor Iona	Revolution Wind	6,662	4,184	**4,184**
Ocean Researcher	Sunrise Wind	3,211	9,730	**12,941**
Deep Helder	Revolution Wind and South Fork Wind	15,073	1,957	**17,030**
Nearshore Vessels				
Westerly	Revolution Wind and Sunrise Wind	570	2,954	**3,524**
Dolphin	Revolution Wind and South Fork Wind	917	933	**1,850**
Total		**59,249**	**43,946**	**103,186**

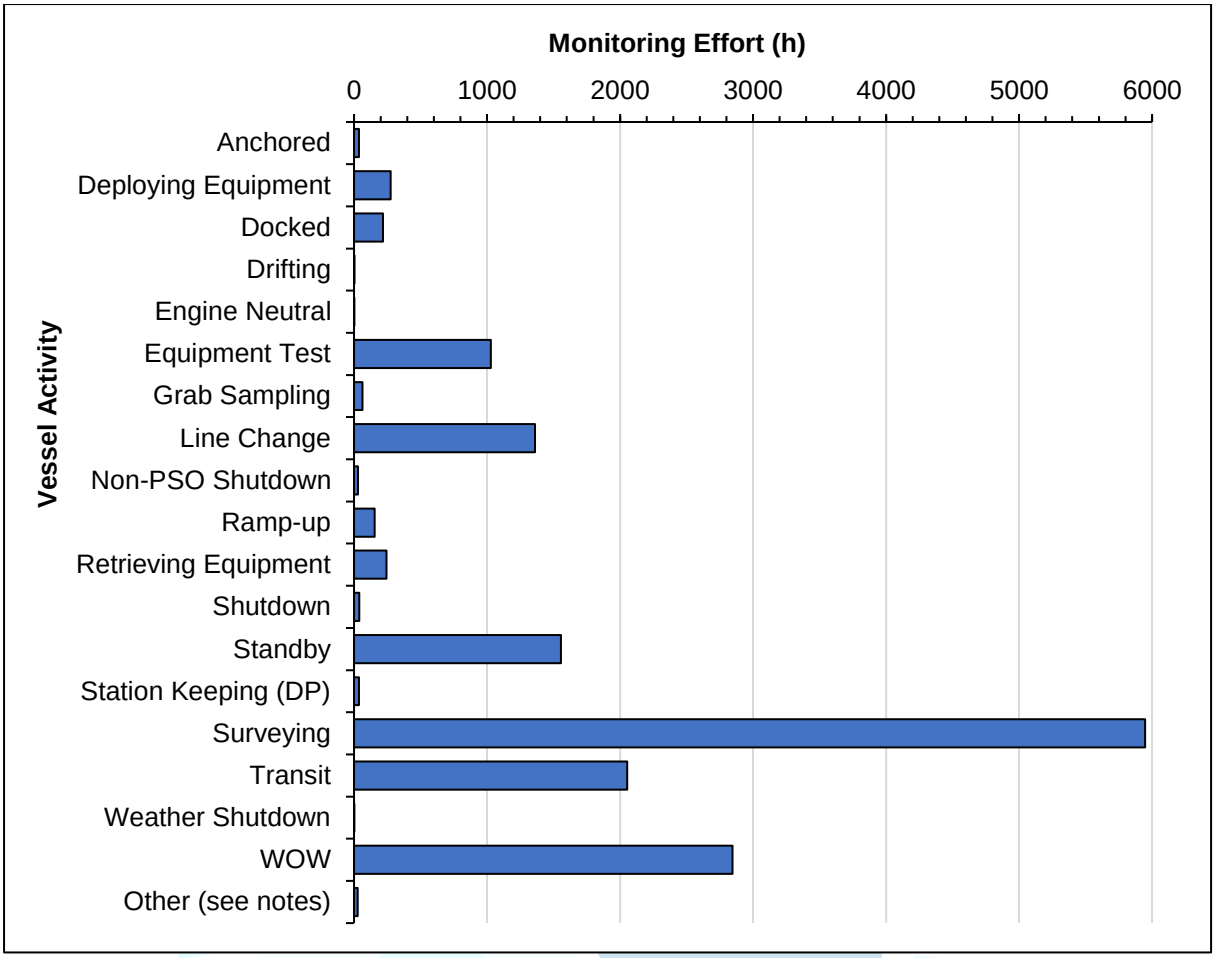

Figure 10. Monitoring Effort by vessel activity on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Environmental conditions varied throughout the Survey. Beaufort sea state (Bft) was favorable for most of the Survey with 81% of the Monitoring Effort conducted during periods with Bft 4 or less (Figure 11). Atmospheric Conditions were also favorable for most of the Survey with periods of precipitation or fog accounting for only 14% of all Monitoring Effort (Figure 12). Visibility Quality was defined as *poor* if either Bft was 5 or greater and/or Visibility Distance was 500 m or less. PSOs recorded *poor* Visibility Quality for 34% of the total Monitoring Effort, although the majority, 63%, occurred during *Darkness* when ambient light reduced visibility to 500 m or less (Figure 13). Monitoring Effort conducted during *Daylight* was in primarily *good* Visibility Quality (57% of the time); the majority of Visibility Quality during *Darkness* was coded as *poor* by default (Figure 13).

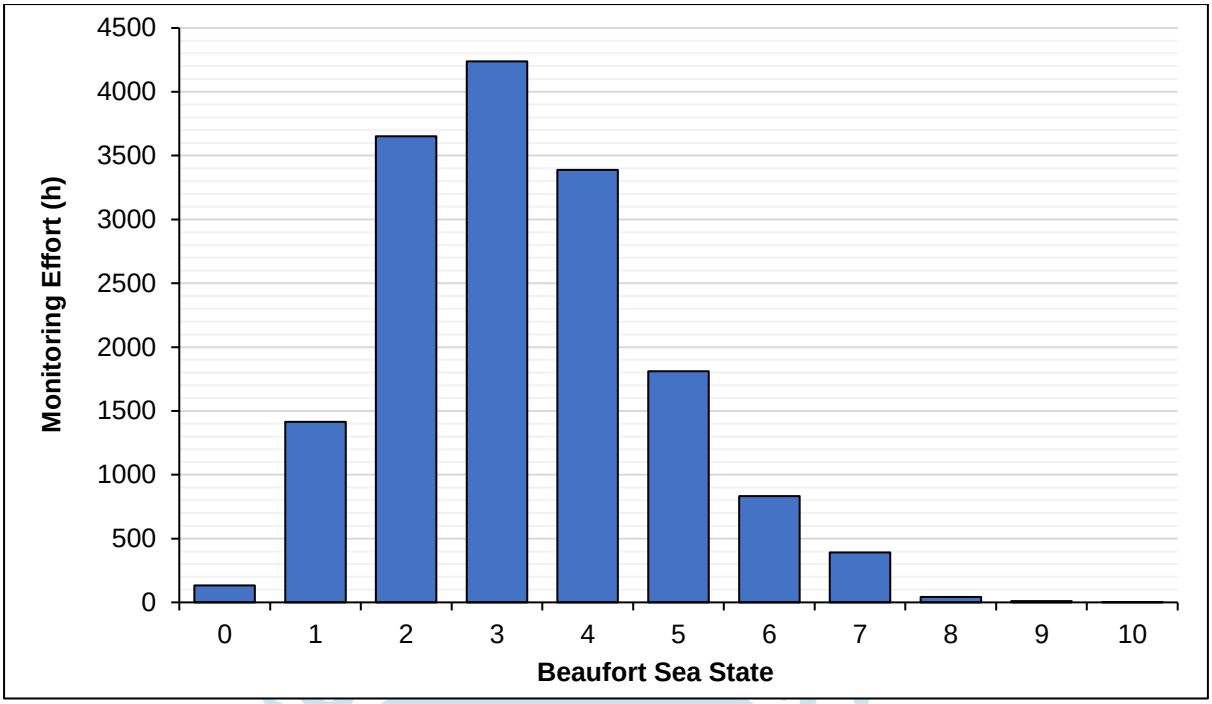

Figure 11. Monitoring effort by Beaufort sea state (Bft) on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

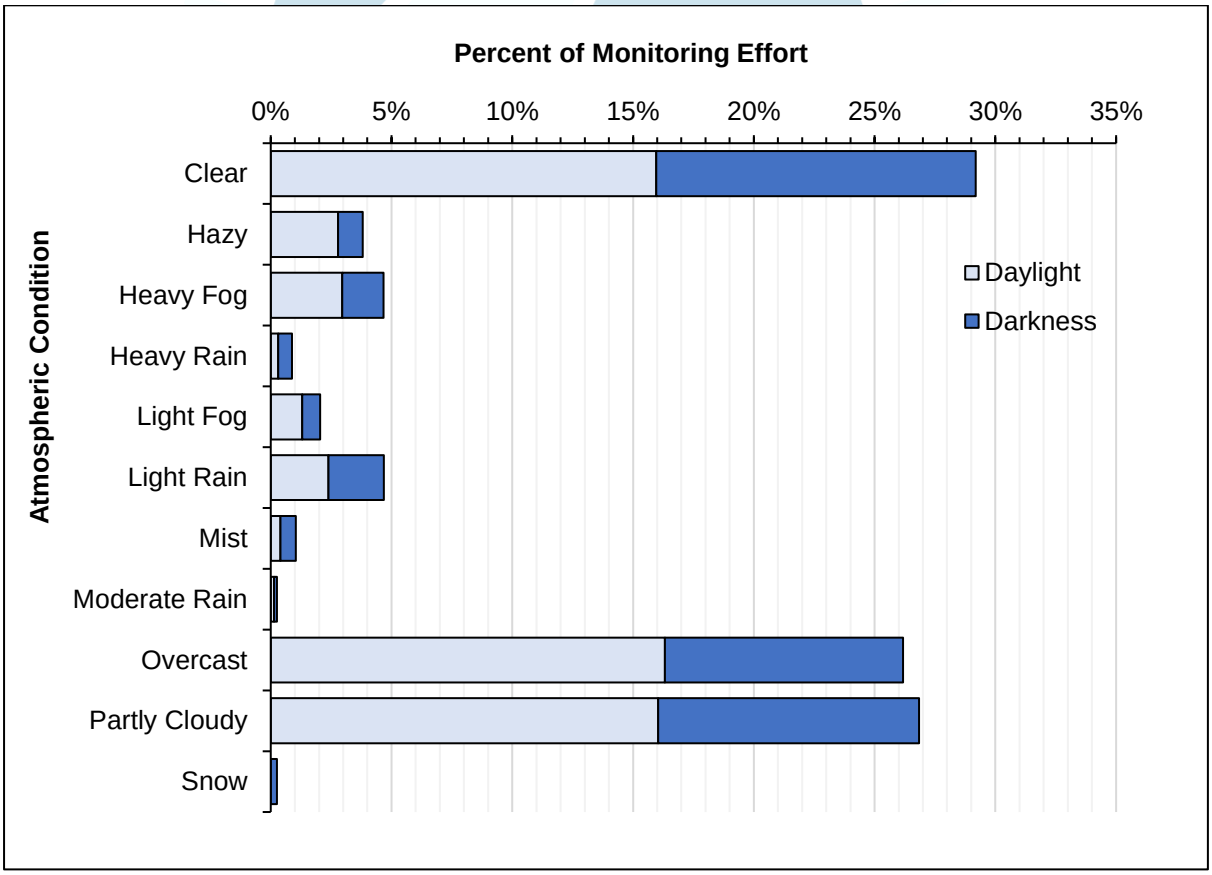

Figure 12. Percent of Monitoring Effort by atmospheric condition in *Daylight* and *Darkness* on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

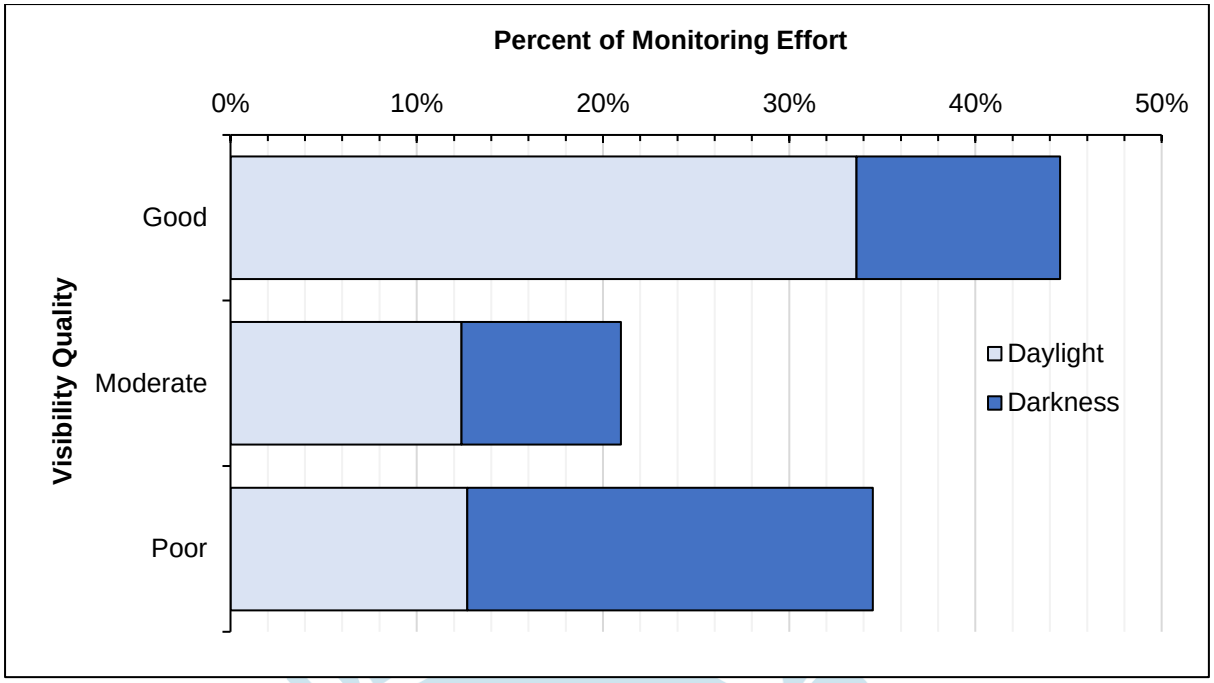

Figure 13. Percent of Monitoring Effort by visibility quality in *Daylight* and *Darkness* on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for definitions of visibility quality categories.

5.2 Monitoring Effort by Vessel

This section presents Monitoring Effort by vessel, defined as any period when at least one visual or acoustic PSO was on watch (Table 8). Figure 14–Figure 21 show tracklines of Monitoring Effort *On* versus *Off* for each vessel. Figure 22–Figure 29 show tracklines of Monitoring Effort *On* during *Daylight* versus *Darkness* for each vessel. Figure 30–Figure 37 show tracklines of Monitoring Effort *On* for HRG Sound *On* versus *Off* for each vessel. Full details of survey activity for each vessel can be found in Table 3.

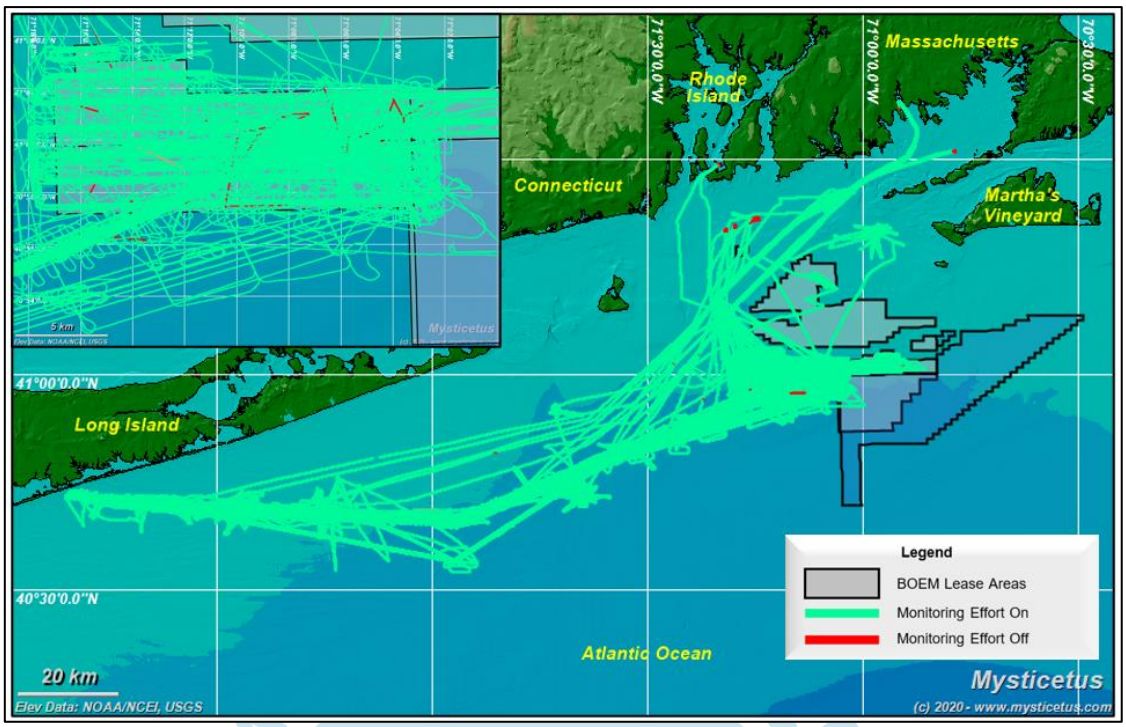

Figure 14. ***Searcher*** **tracklines showing Monitoring Effort *On* (PSO on watch) and *Off* (no PSO on watch) *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—effort lines cover most of survey area), on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.**

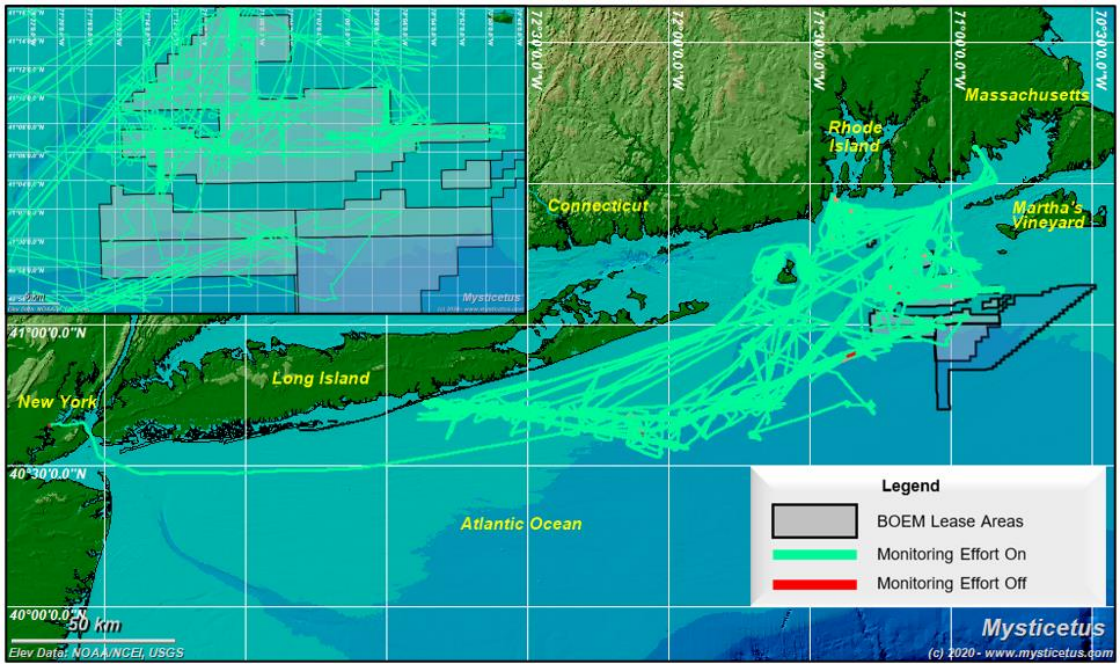

Figure 15. ***Enterprise*** **tracklines showing Monitoring Effort *On* (PSO on watch) and *Off* (no PSO on watch) *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—effort lines cover most of survey area), on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.**

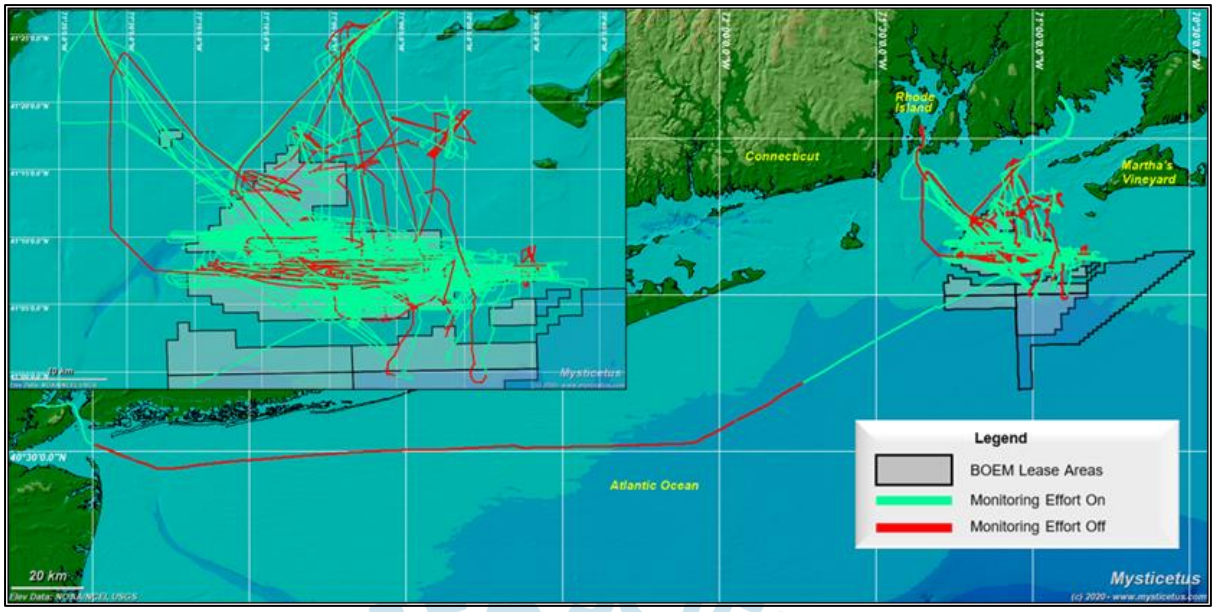

Figure 16. *Discovery* tracklines showing Monitoring Effort *On* (PSO on watch) and *Off* (no PSO on watch) *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—effort lines cover most of survey area), on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.

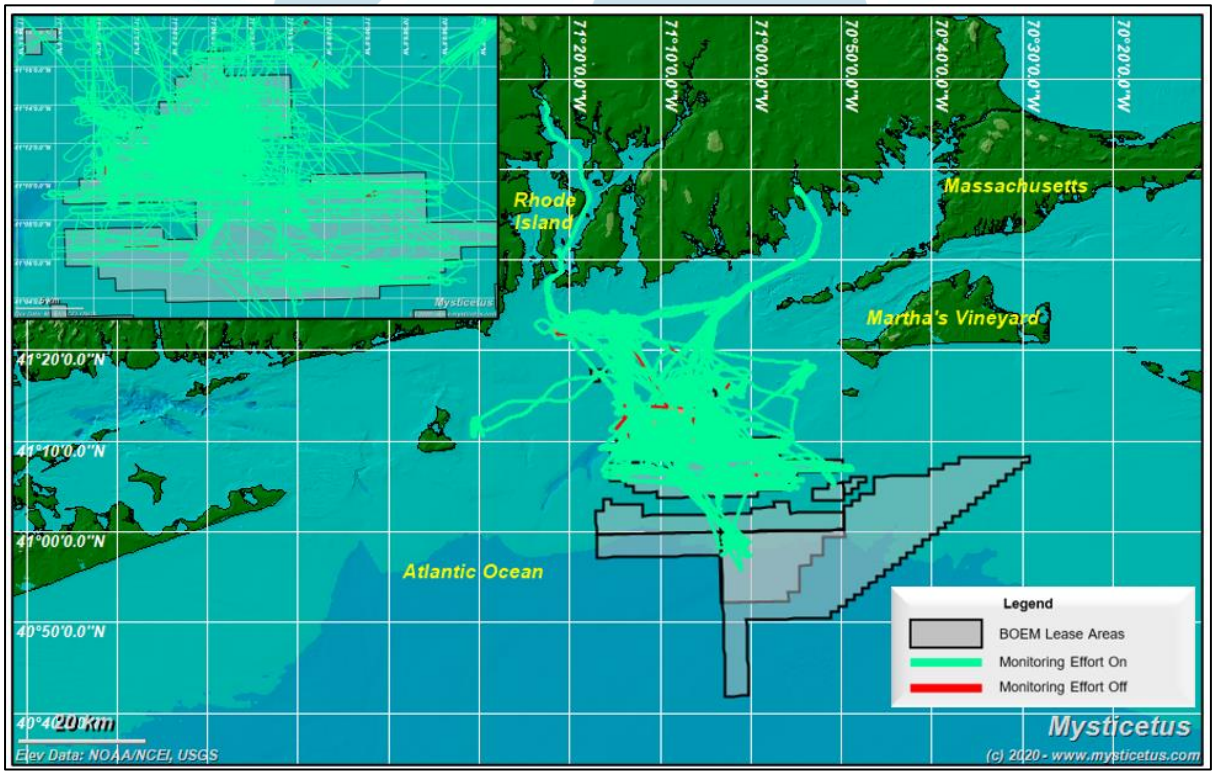

Figure 17. *Kommandor Iona* tracklines showing Monitoring Effort *On* (PSO on watch) and *Off* (no PSO on watch) *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—effort lines cover most of survey area), on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.

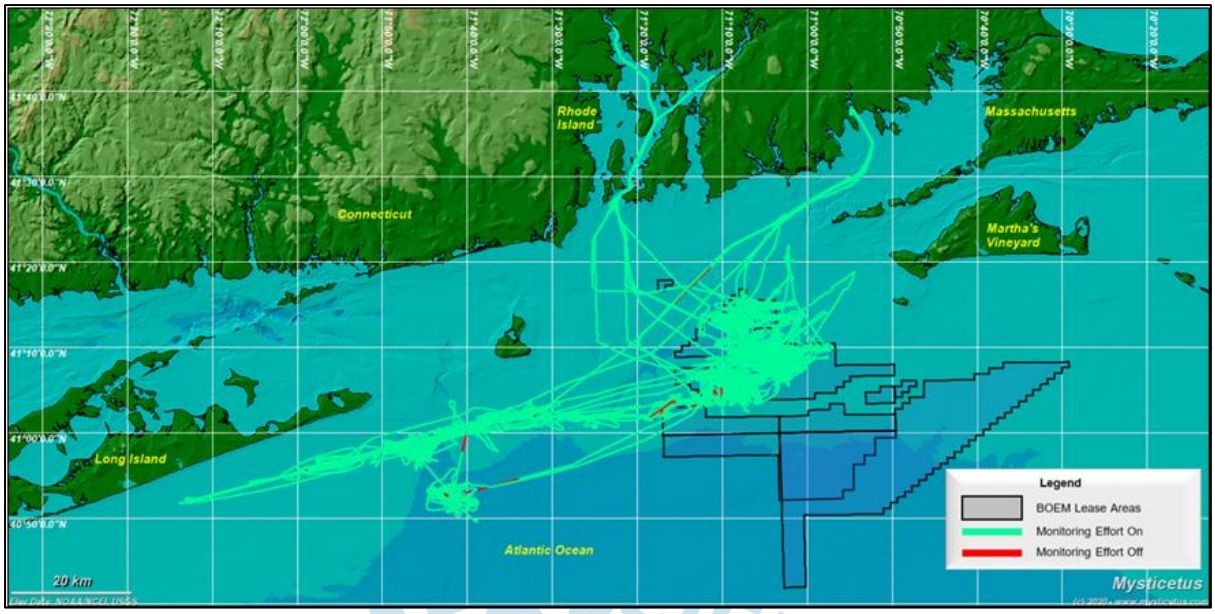

Figure 18. ***Deep Helder*** **tracklines showing Monitoring Effort** ***On*** **(PSO on watch) and** ***Off*** **(no PSO on watch)** ***Inside*** **and** ***Outside*** **the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—effort lines cover most of survey area), on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).**

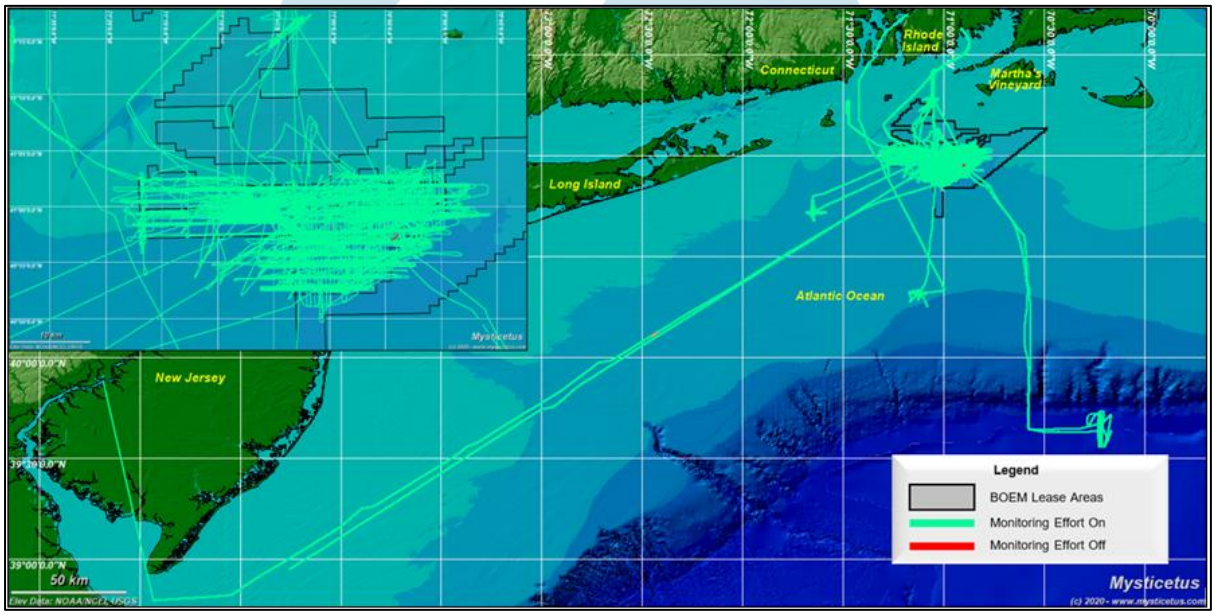

Figure 19. ***Ocean Researcher*** **tracklines showing Monitoring Effort** ***On*** **(PSO on watch) and** ***Off*** **(no PSO on watch)** ***Inside*** **and** ***Outside*** **the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—effort lines cover most of survey area), on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.**

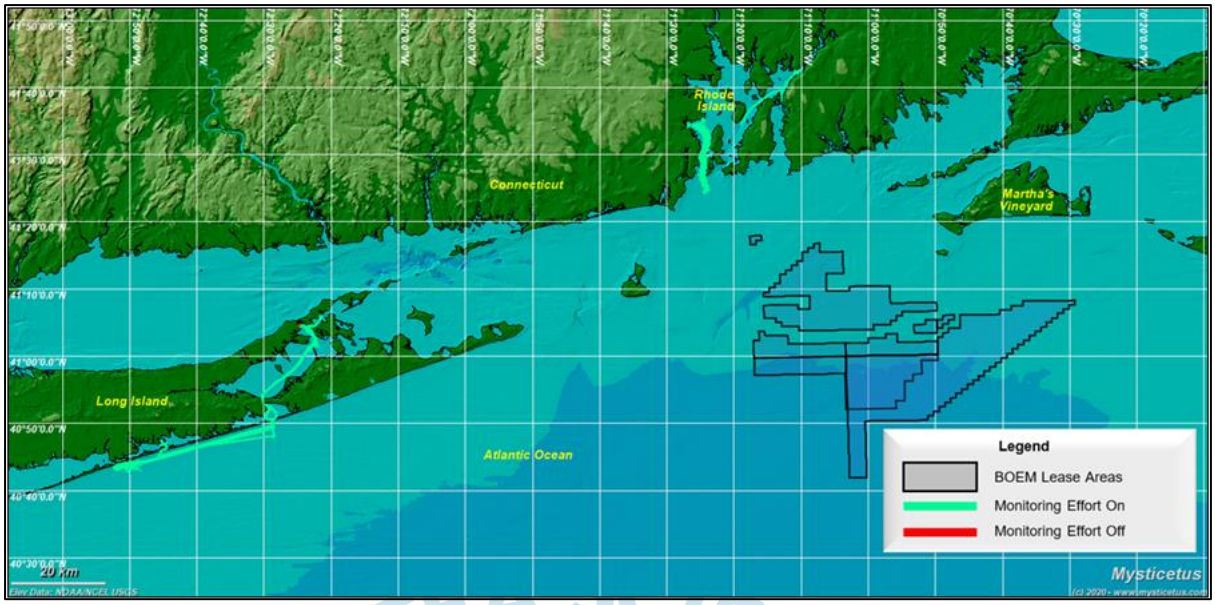

Figure 20. *Westerly* tracklines showing Monitoring Effort *On* (PSO on watch) and *Off* (no PSO on watch) *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons) on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

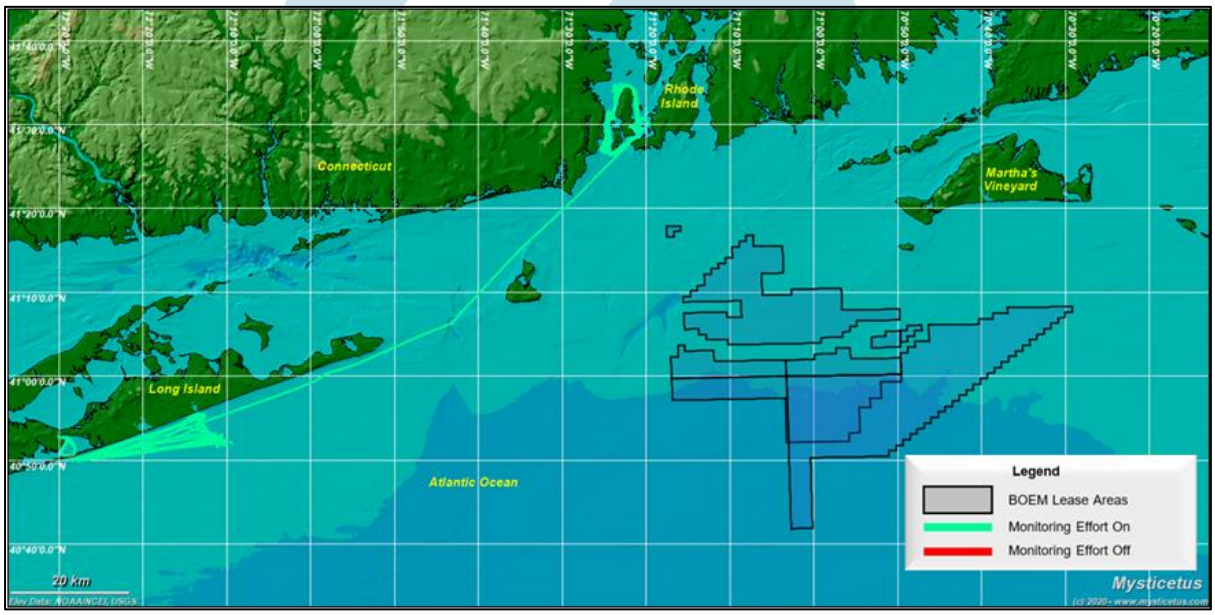

Figure 21. *Dolphin* tracklines showing Monitoring Effort *On* (PSO on watch) and *Off* (no PSO on watch) *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons), on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

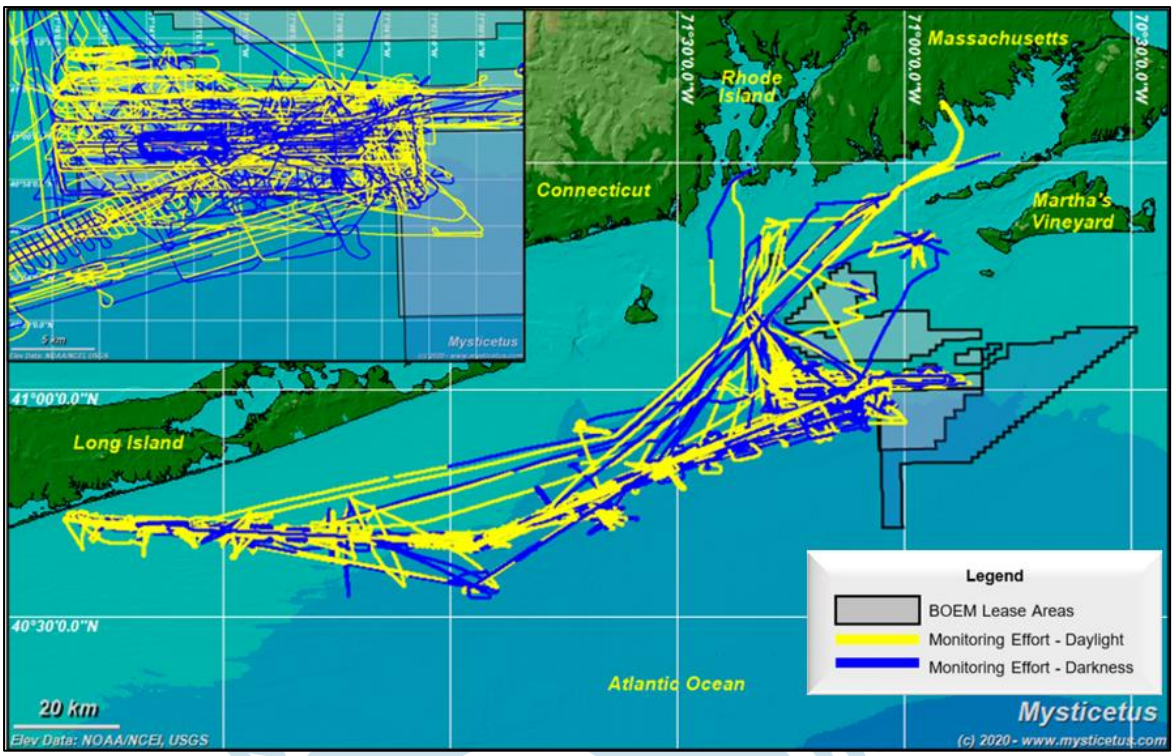

Figure 22. *Searcher* tracklines showing Monitoring Effort *On* during *Daylight* versus *Darkness Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by gray polygons—effort lines cover most of survey area), for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.

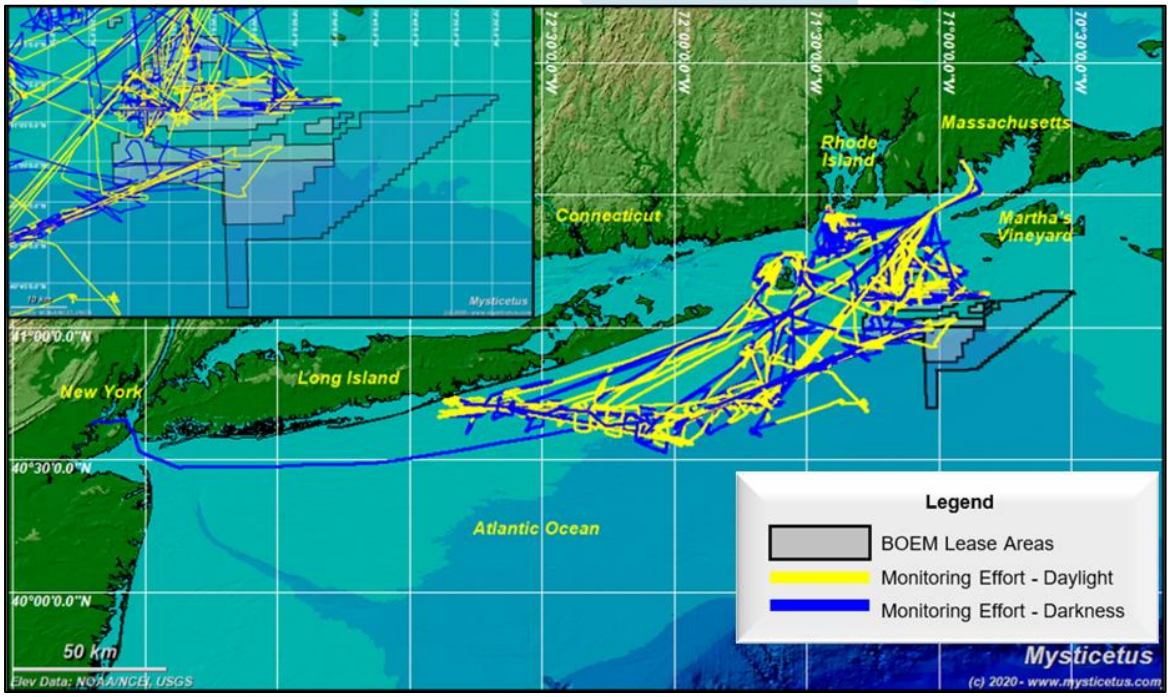

Figure 23. *Enterprise* tracklines showing Monitoring Effort *On* during *Daylight* versus *Darkness Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by gray polygons—effort lines cover most of survey area), for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.

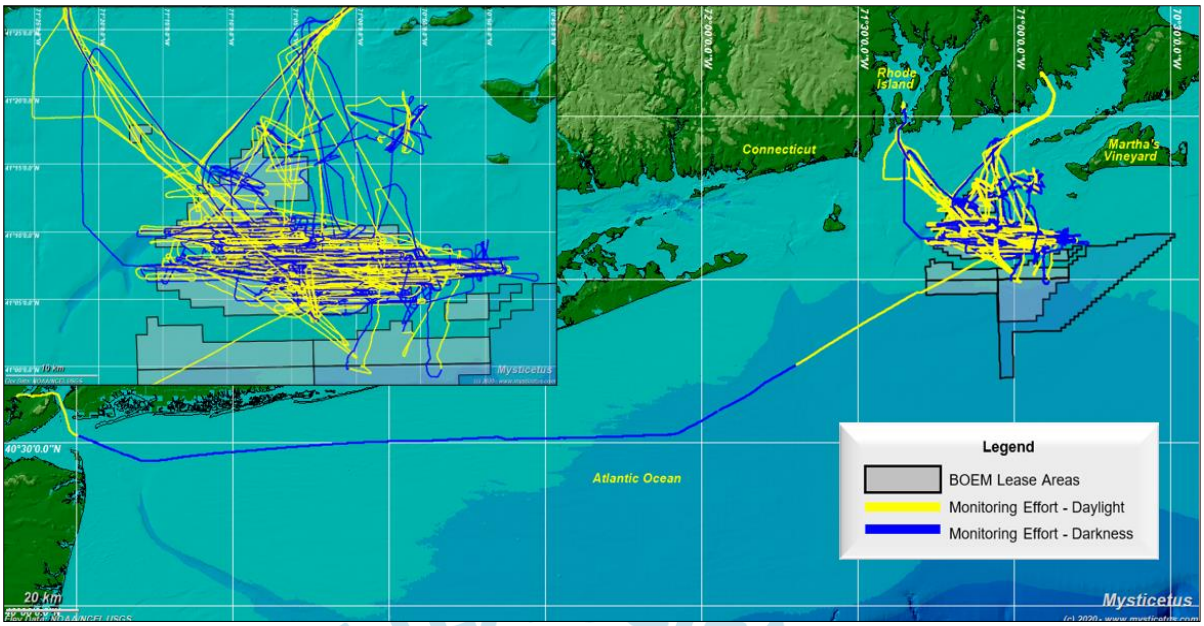

Figure 24. ***Discovery*** **tracklines showing Monitoring Effort** ***On*** **during** ***Daylight*** **versus** ***Darkness Inside*** **and** ***Outside*** **the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by gray polygons—effort lines cover most of survey area), for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.**

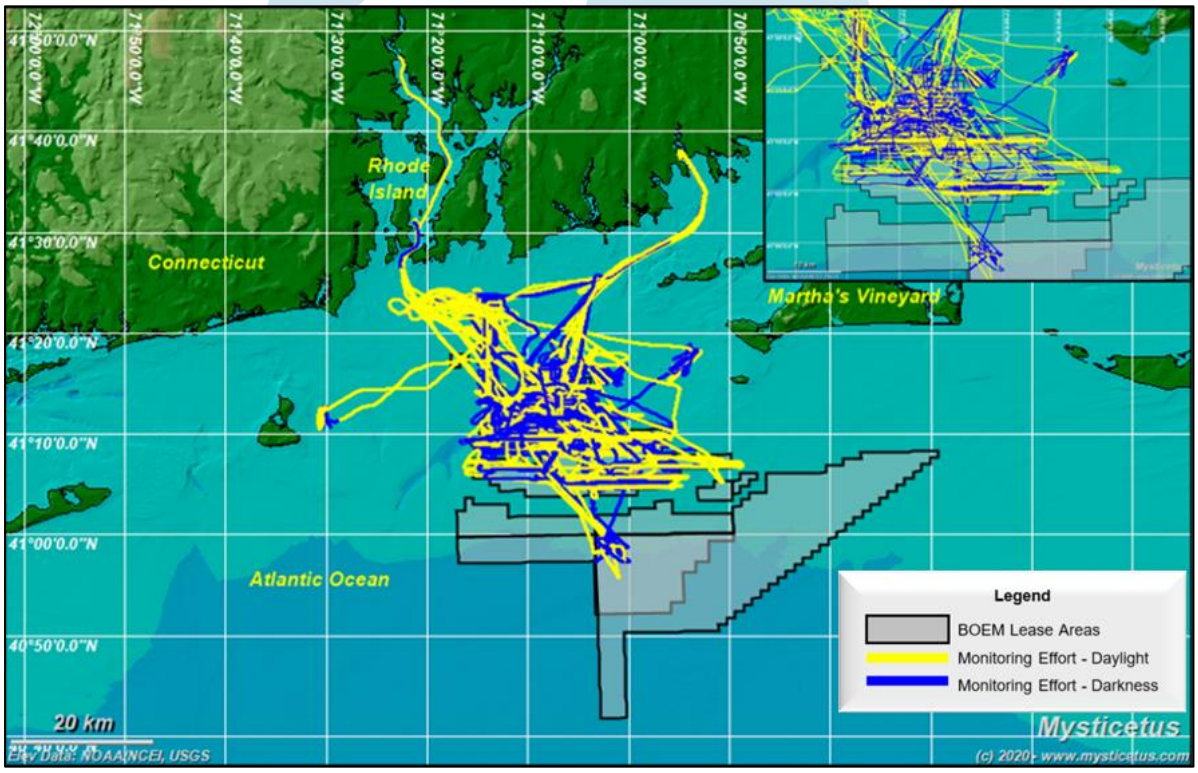

Figure 25. ***Kommandor Iona*** **tracklines showing Monitoring Effort** ***On*** **during** ***Daylight*** **versus** ***Darkness Inside*** **and** ***Outside*** **the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by gray polygons—effort lines cover most of survey area), for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.**

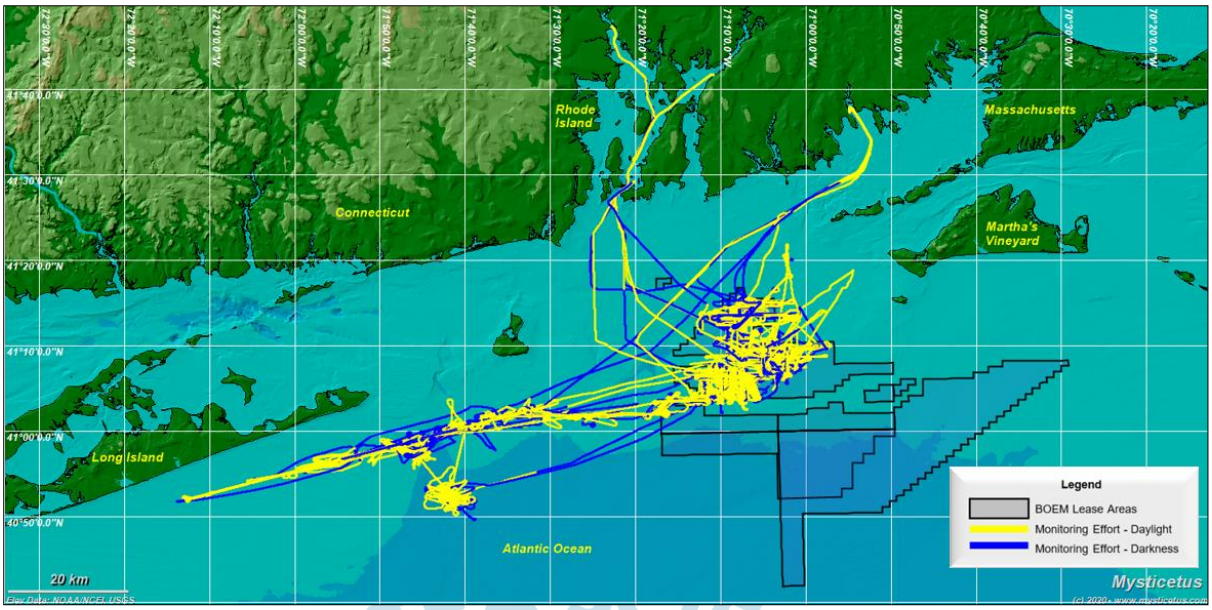

Figure 26. *Deep Helder* tracklines showing Monitoring Effort *On* during *Daylight* versus *Darkness Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by gray polygons—effort lines cover most of survey area), for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

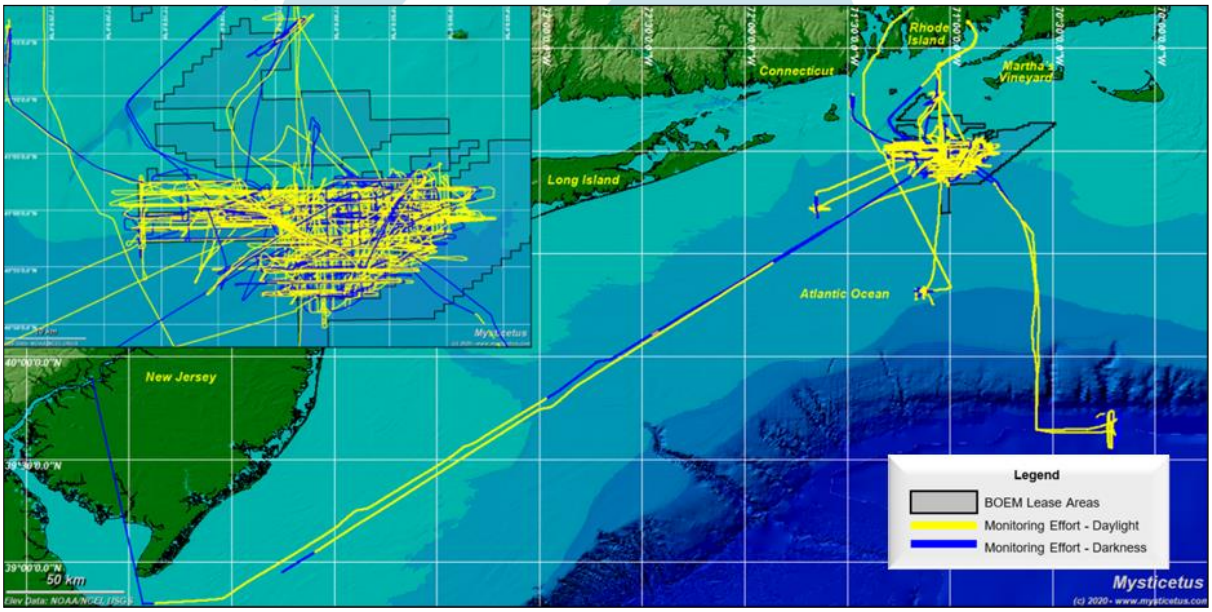

Figure 27. *Ocean Researcher* tracklines showing Monitoring Effort *On* during *Daylight* versus *Darkness Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by gray polygons—effort lines cover most of survey area), for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.

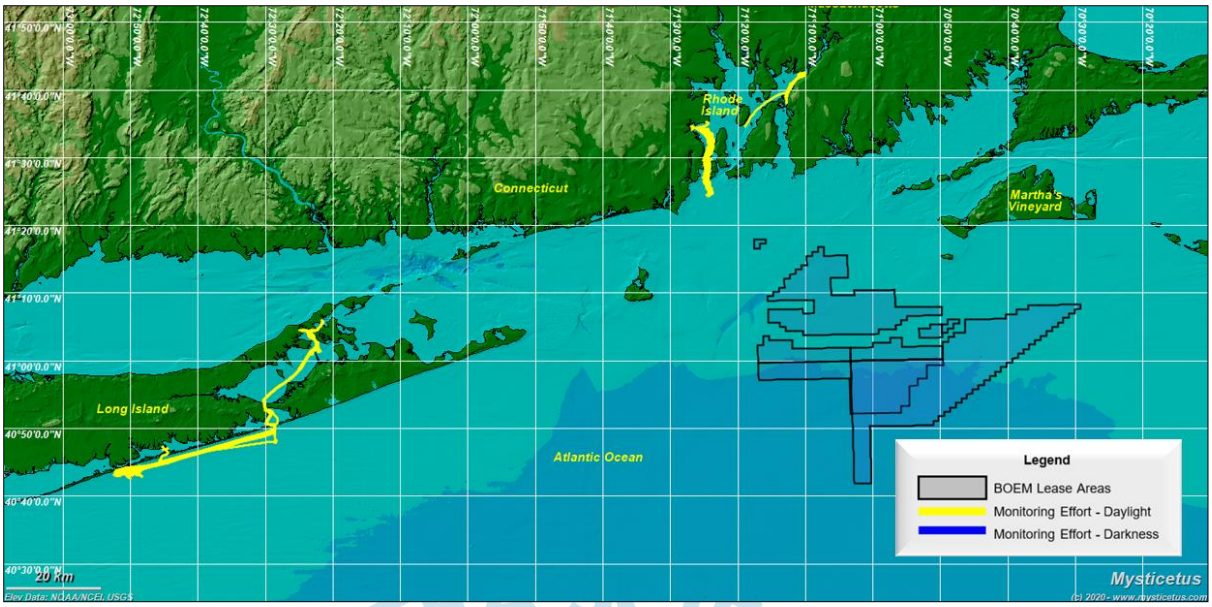

Figure 28. *Westerly* tracklines showing Monitoring Effort *On* during *Daylight* versus *Darkness* *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by gray polygons), for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

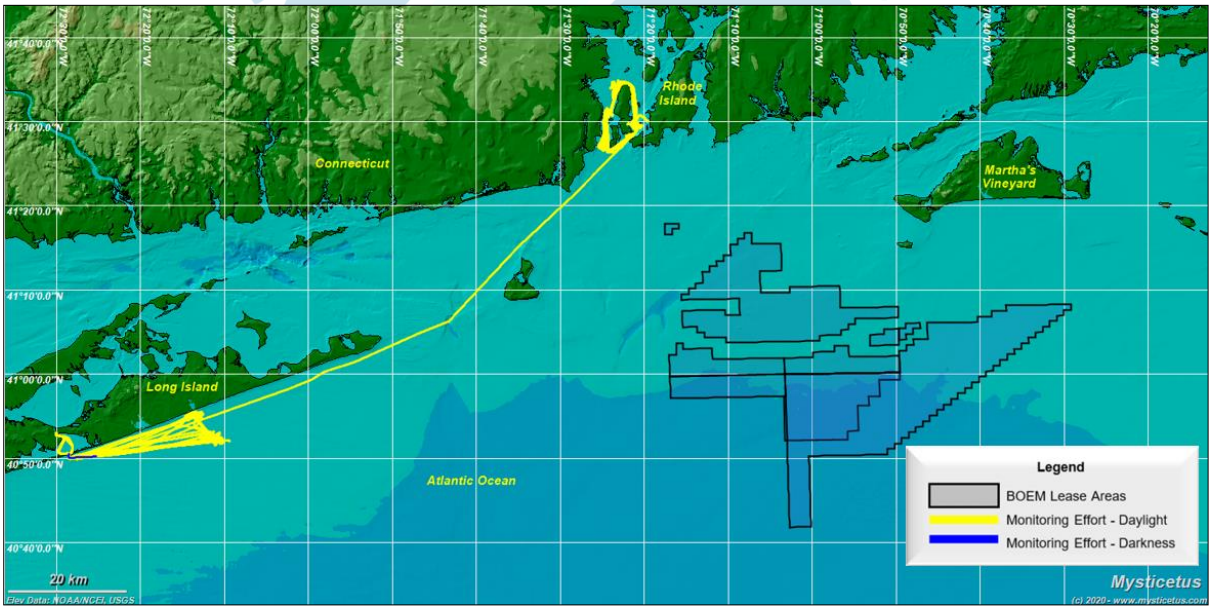

Figure 29. *Dolphin* tracklines showing Monitoring Effort *On* during *Daylight* versus *Darkness* *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by gray polygons), for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

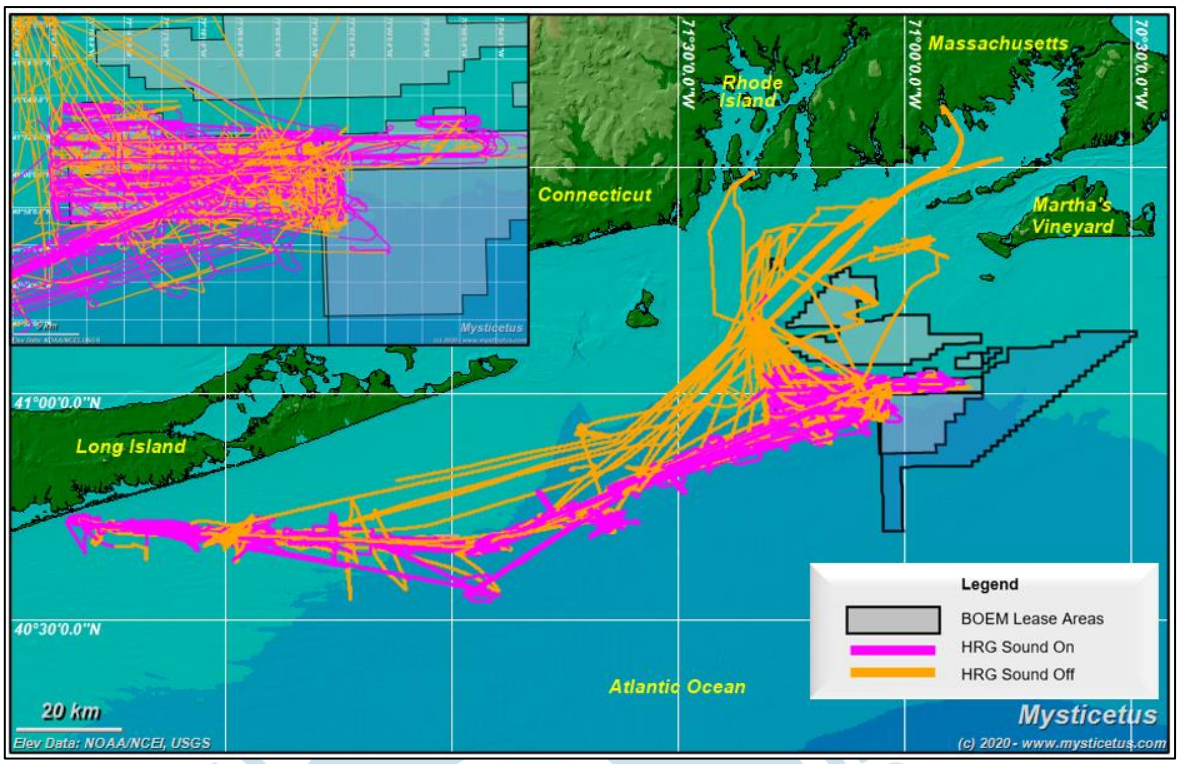

Figure 30. *Searcher* tracklines showing Monitoring Effort *On* during HRG Sound *On* (pooled Sparker, SBP, and/or USBL equipment operational) versus *Off*, *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons) for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.

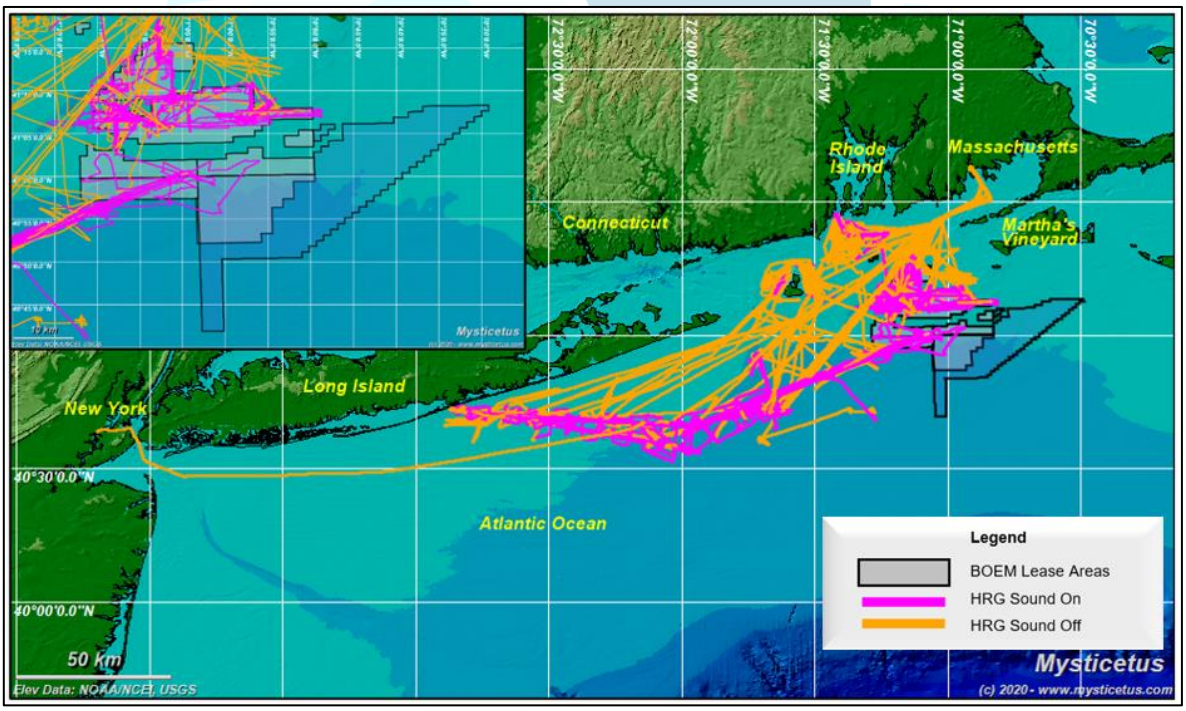

Figure 31. *Enterprise* tracklines showing Monitoring Effort *On* during HRG Sound *On* (pooled Sparker, SBP, and/or USBL equipment operational) versus *Off*, *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS 0500 (indicated by the gray polygons) for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.

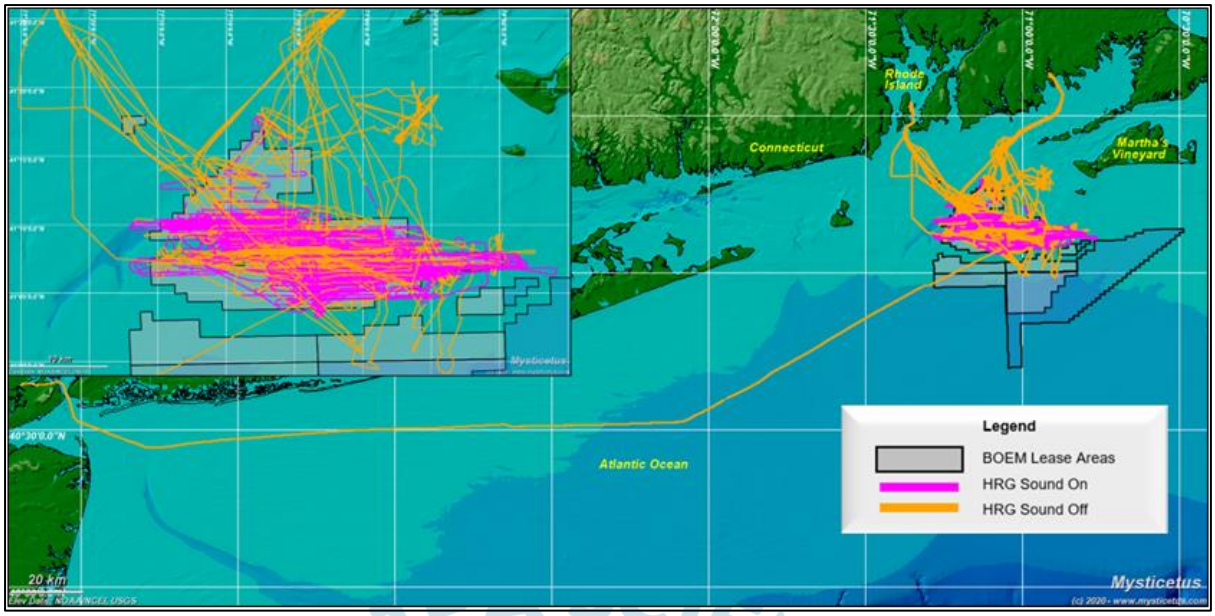

Figure 32. ***Discovery*** **tracklines showing Monitoring Effort *On* during HRG Sound *On* (pooled Sparker, SBP, and/or USBL equipment operational) versus *Off*, *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—most of which is covered by tracklines) for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.**

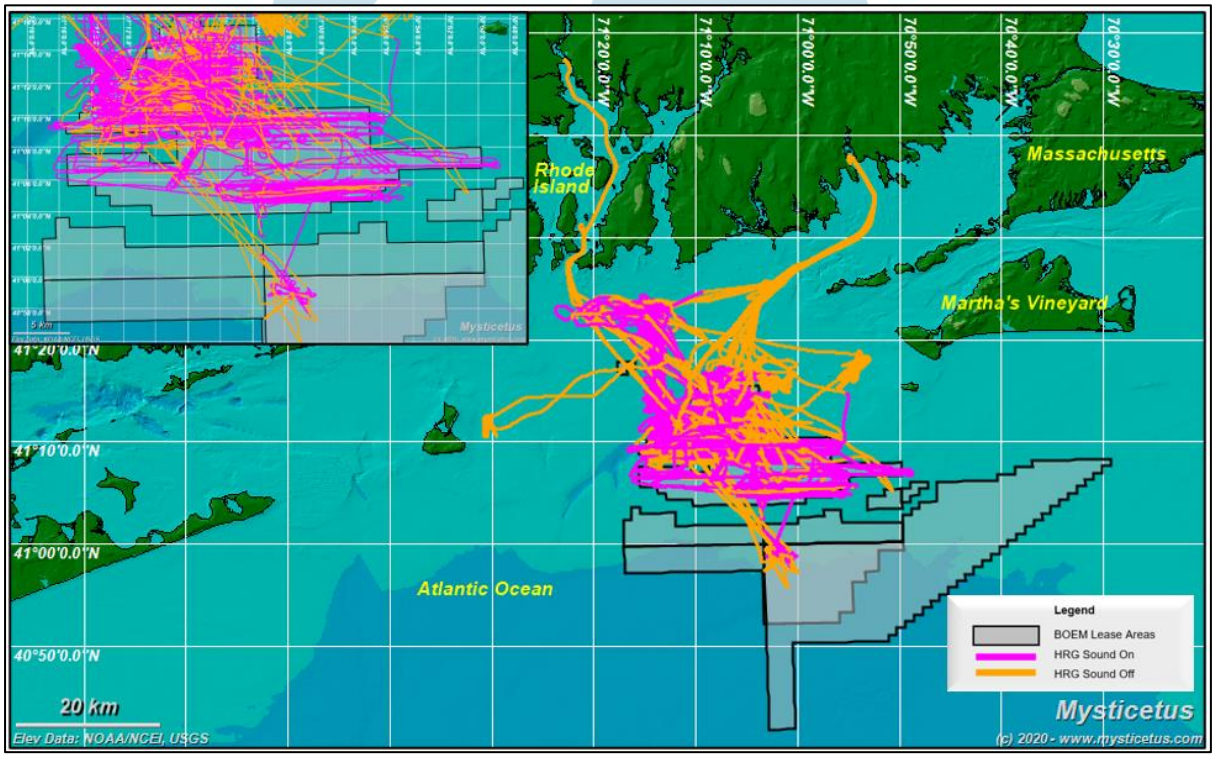

Figure 33. ***Kommandor Iona*** **tracklines showing Monitoring Effort *On* during HRG Sound *On* (pooled Sparker, SBP, and/or USBL equipment operational) versus *Off*, *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—most of which is covered by tracklines) for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.**

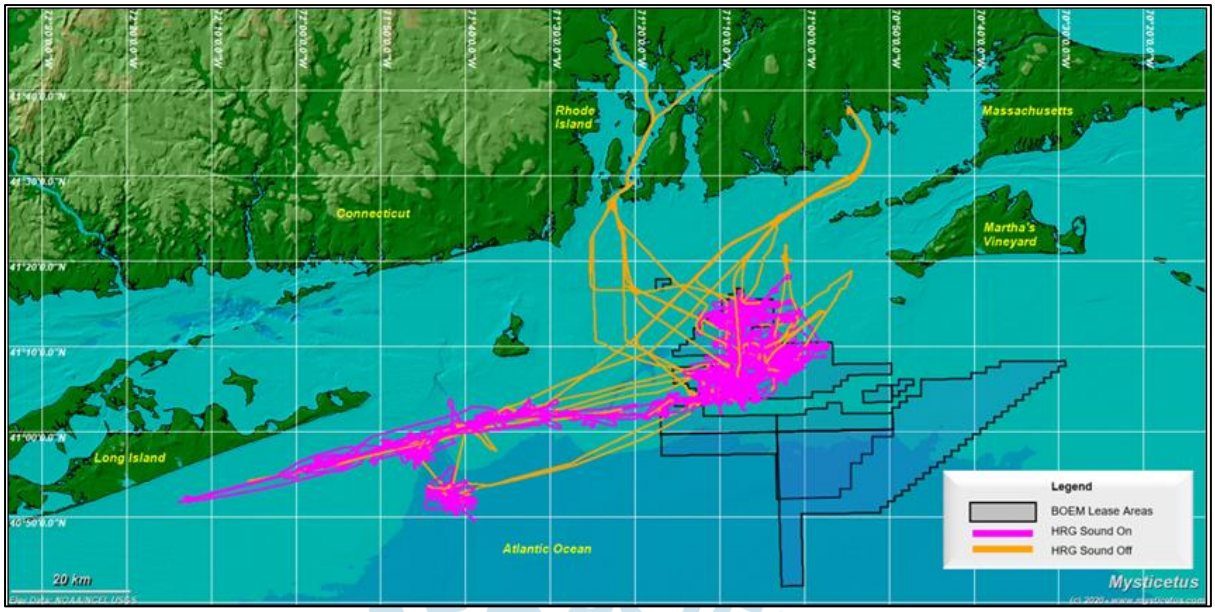

Figure 34. *Deep Helder* tracklines showing Monitoring Effort *On* during HRG Sound *On* (pooled Sparker, SBP, and/or USBL equipment operational) versus *Off*, *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—most of which is covered by tracklines) for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

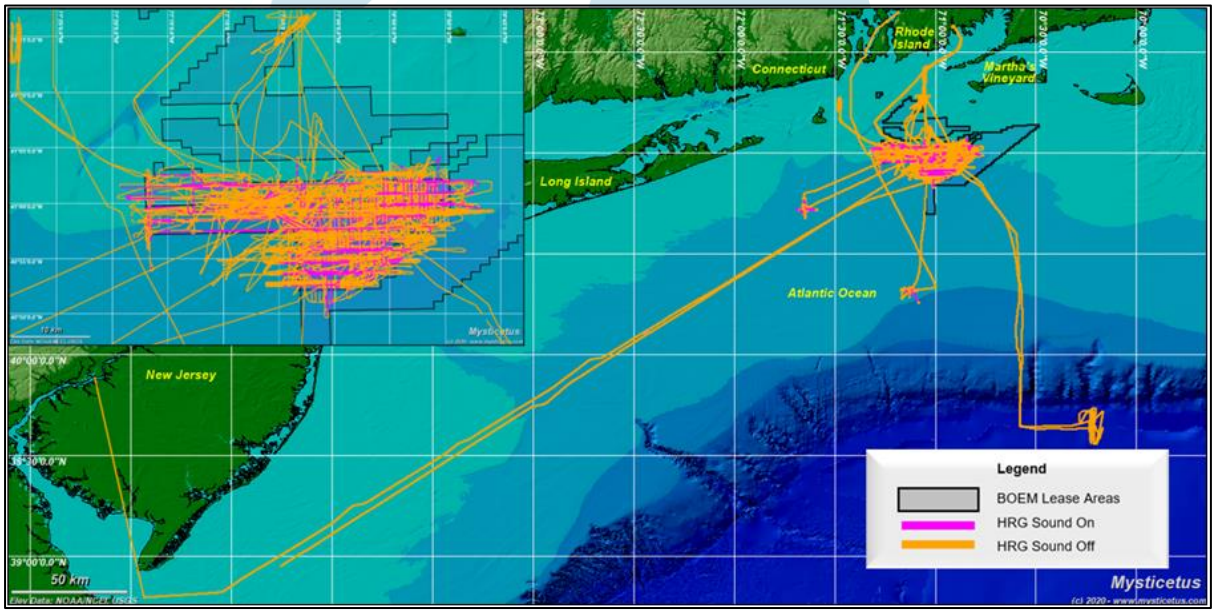

Figure 35. *Ocean Researcher* tracklines showing Monitoring Effort *On* during HRG Sound *On* (pooled Sparker, SBP, and/or USBL equipment operational) versus *Off*, *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons—most of which is covered by tracklines) for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.

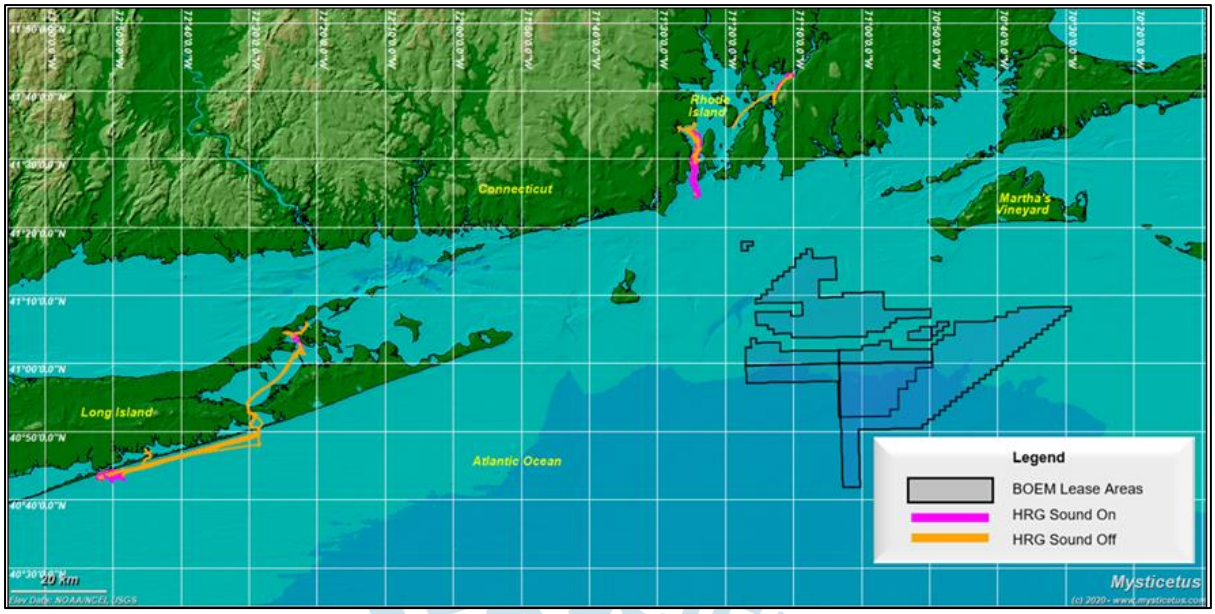

Figure 36. *Westerly* tracklines showing Monitoring Effort *On* during HRG Sound *On* (pooled Sparker, SBP, and/or USBL equipment operational) versus *Off*, *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons) for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

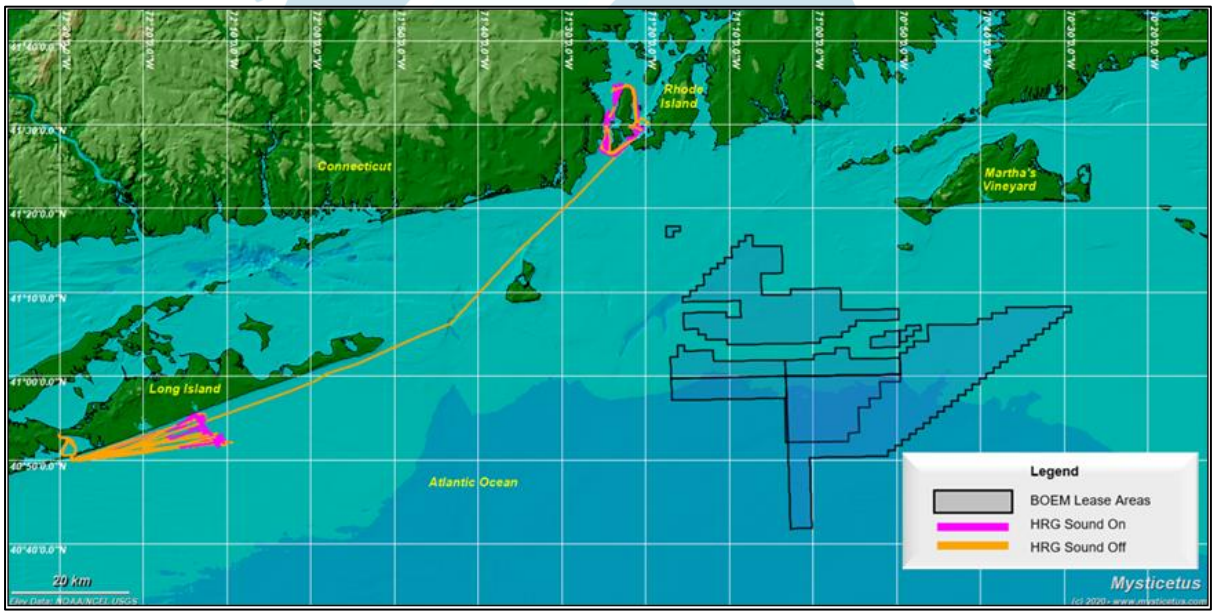

Figure 37. *Dolphin* tracklines showing Monitoring Effort *On* during HRG Sound *On* (pooled Sparker, SBP, and/or USBL equipment operational) versus *Off*, *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (indicated by the gray polygons) for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

5.3 PSO Effort

This section presents PSO Effort, defined as the total PSO person-hours allocated to monitoring for protected species across all monitoring methods (e.g., UE, NVDs, HH IR, ship-mounted IR, and PAM; Table 8). By definition, PSO Effort can exceed 24 h in a day to reflect all hours of monitoring across all PSOs independently.

A total of 26,890 h of PSO Effort occurred during the Survey, split approximately equally between *Daylight* and *Darkness* (Table 12). All monitoring devices were used approximately equally during *Darkness* except for HH IR devices, which were used for only 4% of PSO Effort during *Darkness* (Table 12). PAM monitoring accounted for 21% of PSO Effort during *Darkness*.

PSO Effort occurred equally *Inside* versus *Outside* the Lease Areas (Table 13). The majority of PSO Effort occurred while at least one regulated sound source was active (64%; Table 14).

Table 12. PSO Effort by monitoring method during *Daylight* and *Darkness* for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). PSO Effort includes simultaneously occurring effort, representing totals for each person on watch by method.

Time Period	UE[1] (h)	HH IR[2] (h)	Current Corp IR[3] (h)	NVTS IR[3] (h)	Seiche IR[3] (h)	NVD[4] (h)	Total Visual (h)	PAM[5] (h)	Total (h)
Daylight	11,977	4	9	15	174	8	**12,187**	286	**12,474**
Darkness	3,918	573	557	173	2,967	3,268	**11,456**	2,960	**14,416**
Total	**15,895**	**577**	**566**	**188**	**3,142**	**3,275**	**23,644**	**3,246**	**26,890**

[1] UE = unaided eye with systematic use of reticle binoculars
[2] HH IR = handheld infrared device
[3] Current Corp IR, NVTS IR, and Seiche IR are ship-mounted IR camera systems
[4] NVD = night vision device
[5] PAM = passive acoustic monitoring

Table 13. PSO Effort by monitoring method *Inside* versus *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). PSO Effort includes simultaneously occurring effort, representing totals for each person on watch by method.

Region	UE[1] (h)	HH IR[2] (h)	Current Corp IR[3] (h)	NVTS IR[3] (h)	Seiche IR[3] (h)	NVD[4] (h)	Total Visual (h)	PAM[5] (h)	Total (h)
Inside Lease Areas	7,152	130	421	173	1,973	1,669	**11,518**	1,708	**13,225**
Outside Lease Areas	8,744	447	145	14	1,169	1,607	**12,126**	1,539	**13,665**
Total	**15,895**	**1,142**	**566**	**188**	**3,142**	**3,275**	**23,644**	**3,246**	**26,890**

[1] UE = unaided eye with systematic use of reticle binoculars
[2] HH IR = handheld infrared device
[3] Current Corp IR, NVTS IR, and Seiche IR are ship-mounted IR camera systems
[4] NVD = night vision device
[5] PAM = passive acoustic monitoring

Table 14. PSO Effort by monitoring method during HRG Sound *On* and *Off* (HRG sound source below 200 kHz *On* and *Off*) periods for surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). PSO Effort includes simultaneously occurring effort, representing totals for each person on watch by method.

HRG Sound	UE[1] (h)	HH IR[2] (h)	Current Corp IR[3] (h)	NVTS IR[3] (h)	Seiche IR[3] (h)	NVD[4] (h)	Total Visual (h)	PAM[5] (h)	Total (h)
On	9,496	405	320	81	2,008	2,030	**14,340**	2,886	**17,226**
Off	6,399	172	246	107	1,133	1,246	**9,303**	360	**9,664**
Total	**15,895**	**1,142**	**566**	**188**	**3,142**	**3,275**	**23,644**	**3,246**	**26,890**

[1] UE = unaided eye with systematic use of reticle binoculars
[2] HH IR = handheld infrared device
[3] Current Corp IR, NVTS IR, and Seiche IR are ship-mounted IR camera systems
[4] NVD = night vision device
[5] PAM = passive acoustic monitoring

5.4 Protected Species Detections

A total of 2,106 protected species detections composed of an estimated 15,751 individuals were recorded by PSOs across all vessels during the Survey (Table 15; Appendix F [All Appendices provided in separate document]). Of these, 59% of detections (representing 80% of individuals) were identified to species level, while the other 41% of detections were identified only to taxonomic family level. Of the protected species identified to species level, short-beaked common dolphin was most frequently detected (793 detections of approximately 10,760 individuals), followed by humpback whale (169 detections of approximately 245 individuals). Maps of all detections are shown in Figure 38–45.

More detections occurred *Outside* the Lease Areas (58% of detections and 61% of individuals) compared to *Inside* the Lease Areas (Table 16). More marine mammal detections occurred when HRG sound sources operating below 200 kHz were *On* (61% of detections and 58% of individuals) compared to periods when HRG Sound was *Off* (Table 17). An equal number of sea turtles were detected when HRG Sound was *On* versus *Off* (Table 17).

Table 15. Total number of protected species detections and estimated number of individuals detected on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Species Common Name	Species Scientific Name	No. of Detections	Est. No. of Individuals
Mysticete		591	810
Fin Whale	*Balaenoptera physalus*	42	90
Humpback Whale	*Megaptera novaeangliae*	169	245
Long-Finned Pilot Whale	*Globicephala macrorhynchus*	1	1
Minke Whale	*Balaenoptera acutorostrata*	51	54
North Atlantic Right Whale	*Eubalaena glacialis*	4	7
Sei Whale	*Balaenoptera borealis*	1	1
Sperm Whale	*Physeter macrocephalus*	2	2
Unidentified Mysticete Whale	N/A	321	410
Odontocete		1,369	14,594
Atlantic Spotted Dolphin	*Stenella frontalis*	2	20
Bottlenose Dolphin	*Tursiops truncatus*	64	1175
Harbor Porpoise	*Phocoena phocoena*	1	1
Risso's Dolphin	*Grampus griseus*	2	14
Short-Beaked Common Dolphin	*Delphinus delphis*	793	10,760
Unidentified Dolphin or Porpoise	N/A	507	2,624
Pinniped		91	291
Gray Seal	*Halichoerus grypus*	46	58
Harbor Seal	*Phoca vitulina*	21	201
Unidentified Pinniped	N/A	24	32
Sea Turtle		50	50
Green Sea Turtle	*Chelonia mydas*	3	3
Hawksbill Sea Turtle	*Eretmochelys imbricata*	1	1
Kemp's-Ridley Sea Turtle	*Lepidochelys kempii*	1	1
Leatherback Sea Turtle	*Dermochelys coriacea*	16	16
Loggerhead Sea Turtle	*Caretta caretta*	14	14
Unidentified Sea Turtle	N/A	15	15
Other	N/A	1	1
Unknown (PAM)	N/A	4	5
Total		**2,106**	**15,751**

Table 16. All protected species detections and estimated number of individuals *Inside* versus *Outside* Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Species	Inside Lease Areas		Outside Lease Areas		Total	
	No. of Detections	Est. No. of Individuals	No. of Detections	Est. No. of Individuals	No. of Detections	Est. No. of Individuals
Mysticete						
Fin Whale	10	11	32	79	**42**	**90**
Humpback Whale	46	56	123	189	**169**	**245**
Long-Finned Pilot Whale	1	1	--	--	**1**	**1**
Minke Whale	23	25	28	29	**51**	**54**
North Atlantic Right Whale	2	4	2	3	**4**	**7**
Sei Whale	--	--	1	1	**1**	**1**
Sperm Whale	--	--	2	2	**2**	**2**
Unidentified Mysticete Whale	128	150	193	260	**321**	**410**
Odontocete						
Atlantic Spotted Dolphin	--	--	2	20	**2**	**20**
Bottlenose Dolphin	2	90	62	1,085	**64**	**1175**
Harbor Porpoise	1	1	--	--	**1**	**1**
Risso's Dolphin	--	--	2	14	**2**	**14**
Short-Beaked Common Dolphin	380	4,644	413	6,116	**793**	**10,760**
Unidentified Dolphin or Porpoise	285	1,142	222	1,482	**507**	**2,624**
Pinniped						
Gray Seal	2	2	44	56	**46**	**58**
Harbor Seal	2	2	19	199	**21**	**201**
Unidentified Pinniped	5	5	19	27	**24**	**32**
Sea Turtle						
Green Sea Turtle	1	1	2	2	**3**	**3**
Hawksbill Sea Turtle	1	1	--	--	**1**	**1**
Kemp's-Ridley Sea Turtle	1	1	--	--	**1**	**1**
Leatherback Sea Turtle	2	2	14	14	**16**	**16**
Loggerhead Sea Turtle	--	--	14	14	**14**	**14**
Unidentified Sea Turtle	1	1	14	14	**15**	**15**
Unknown (PAM)	--	--	4	5	**4**	**5**
Total	**893**	**6,139**	**1,212**	**9,611**	**2,105**	**15,750**

Table 17. All protected species detections and estimated number of individuals during HRG Sound *On* versus *Off* on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Species	HRG Sound On		HRG Sound Off		Total	
	No. of Detections	Est. No. of Individuals	No. of Detections	Est. No. of Individuals	No. of Detections	Est. No. of Individuals
Mysticete						
Fin Whale	36	79	6	11	**42**	**90**
Humpback Whale	109	160	60	85	**169**	**245**
Long-Finned Pilot Whale	1	1	--	--	**1**	**1**
Minke Whale	25	28	26	26	**51**	**54**
North Atlantic Right Whale	3	5	1	2	**4**	**7**
Sei Whale	1	1	--	--	**1**	**1**
Sperm Whale	1	1	1	1	**2**	**2**
Unidentified Mysticete Whale	190	255	131	155	**321**	**410**
Odontocete						
Atlantic Spotted Dolphin	--	--	2	20	**2**	**20**
Bottlenose Dolphin	17	328	47	847	**64**	**1175**
Harbor Porpoise	1	1	--	--	**1**	**1**
Risso's Dolphin	1	4	1	10	**2**	**14**
Short-Beaked Common Dolphin	452	6445	341	4315	**793**	**10760**
Unidentified Dolphin or Porpoise	388	1860	119	764	**507**	**2624**
Pinniped						
Gray Seal	9	13	37	45	**46**	**58**
Harbor Seal	3	3	18	198	**21**	**201**
Unidentified Pinniped	8	8	16	24	**24**	**32**
Sea Turtle						
Green Sea Turtle	1	1	2	2	**3**	**3**
Hawksbill Sea Turtle	--	--	1	1	**1**	**1**
Kemp's-Ridley Sea Turtle	--	--	1	1	**1**	**1**
Leatherback Sea Turtle	7	7	9	9	**16**	**16**
Loggerhead Sea Turtle	10	10	4	4	**14**	**14**
Unidentified Sea Turtle	7	7	8	8	**15**	**15**
Unknown (PAM)	2	2	2	3	**4**	**5**
Total	**1,272**	**9,219**	**833**	**6,531**	**2,105**	**15,750**

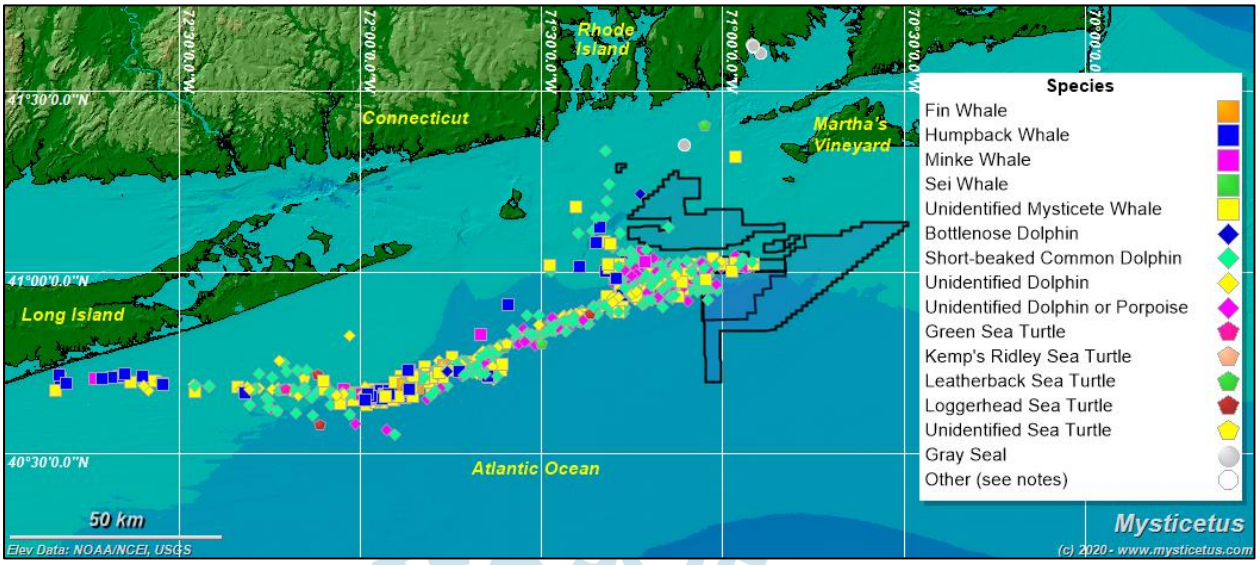

Figure 38. Locations of all protected species detections relative to Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made from the *Searcher* on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

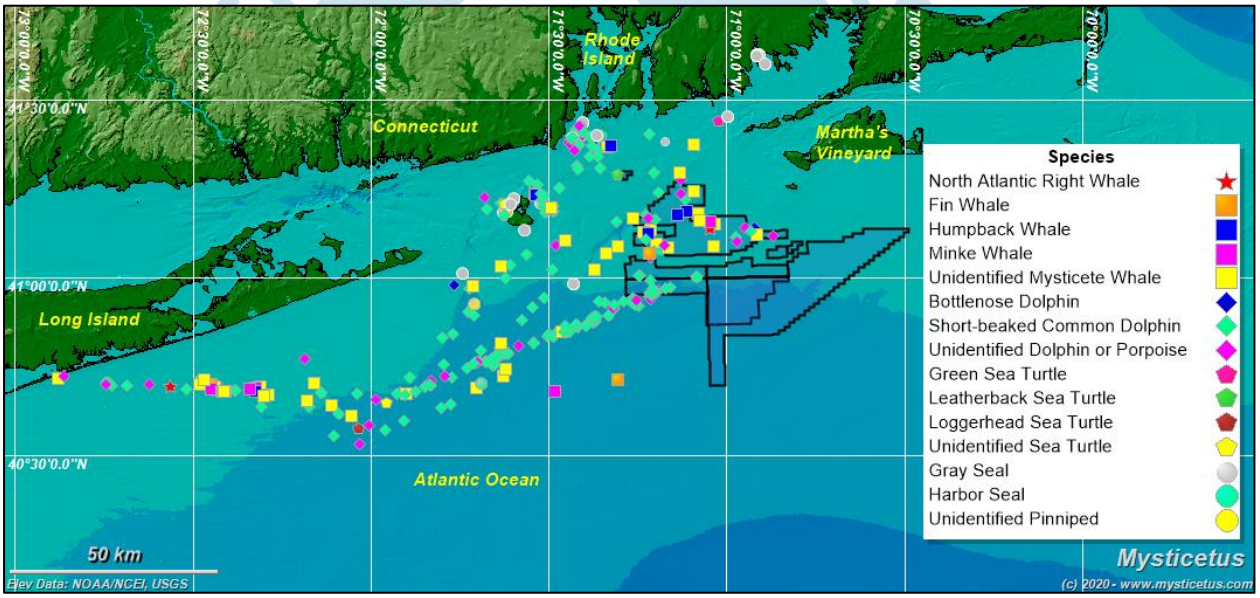

Figure 39. Locations of all protected species detections relative to Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made from the *Enterprise* on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

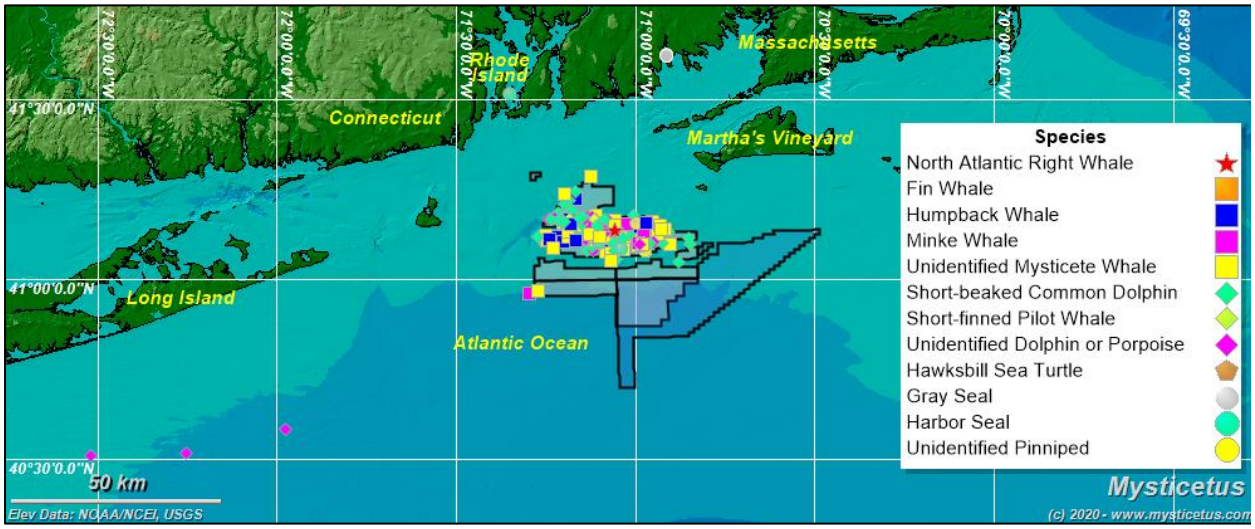

Figure 40. Locations of all protected species detections relative to Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made from the *Discovery* on surveys conducted under the Ørsted Incidental Harassment Authorization (NMFS 2019).

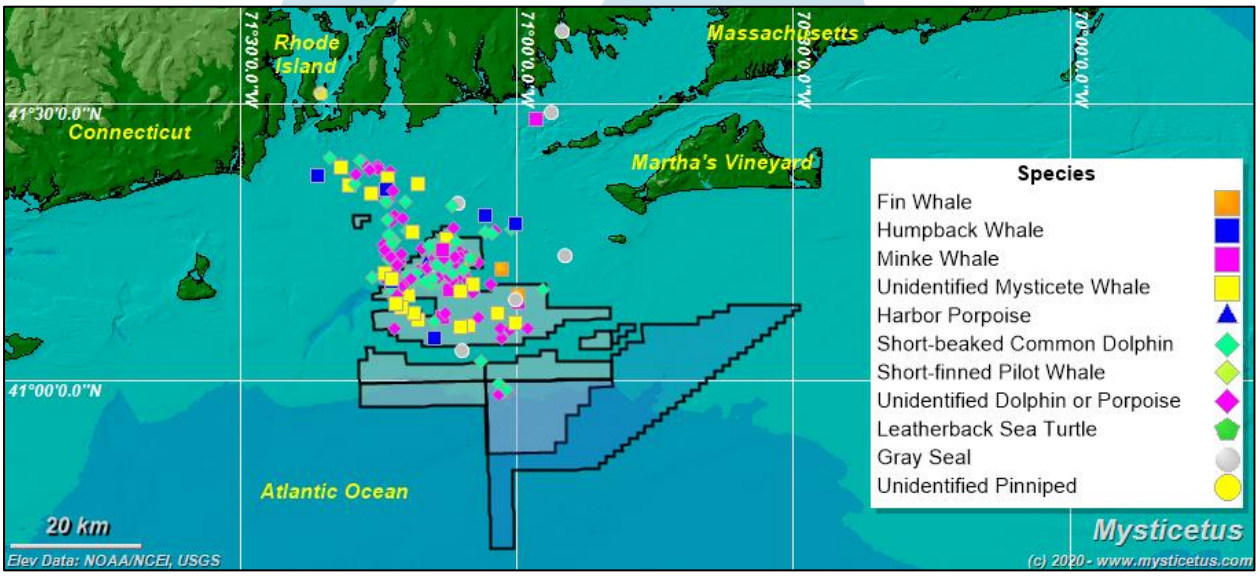

Figure 41. Locations of all protected species detections relative to Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made from the *Kommandor Iona* on surveys conducted under the Ørsted Incidental Harassment Authorization (NMFS 2019).

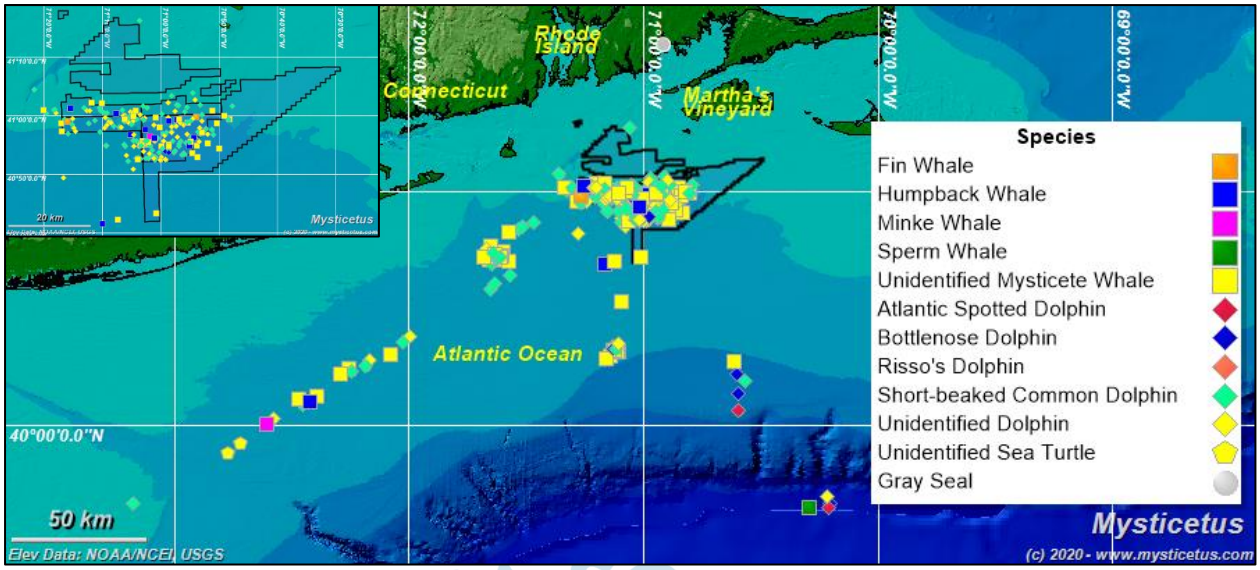

Figure 42. Locations of all protected species detections relative to Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made from the *Ocean Researcher* on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Map inset is enlargement of the Survey Area.

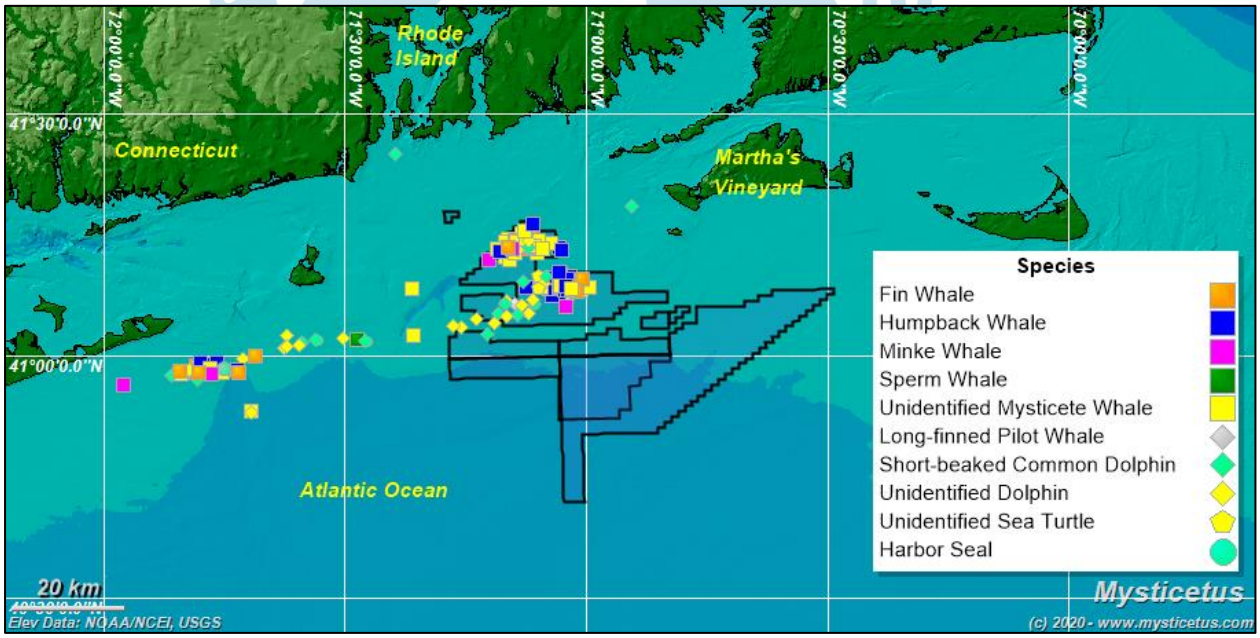

Figure 43. Locations of all protected species detections relative to Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made from the *Deep Helder* on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

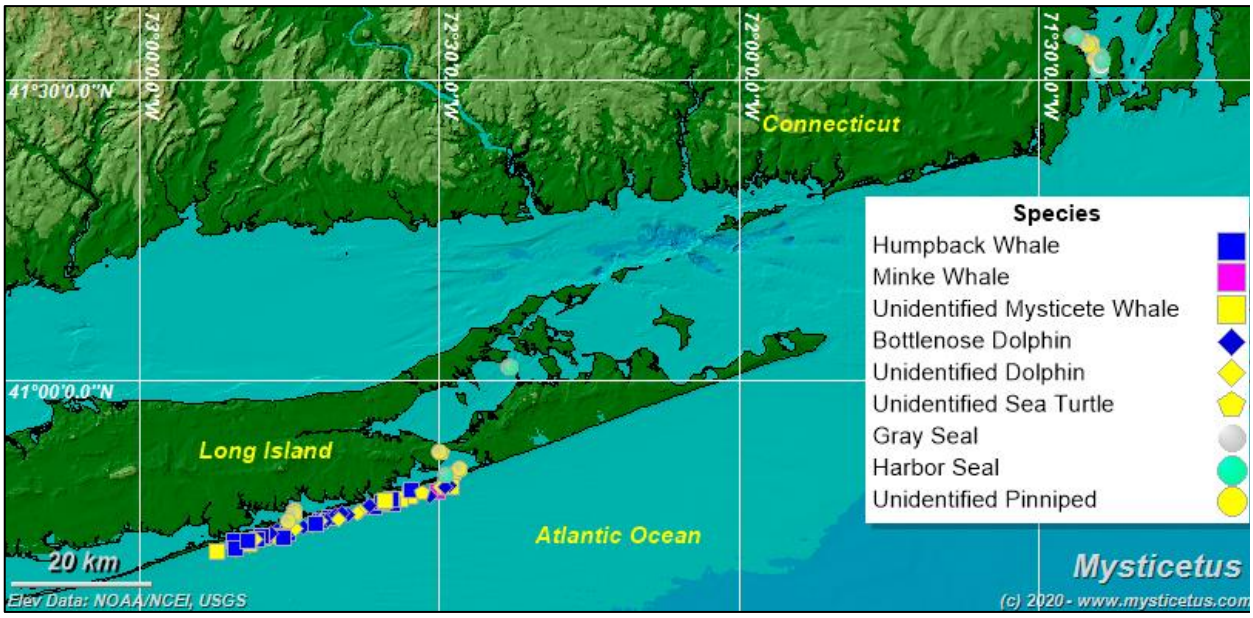

Figure 44. Locations of all protected species detections relative to Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made from the *Westerly* on surveys conducted under the Ørsted Incidental Harassment Authorization (NMFS 2019).

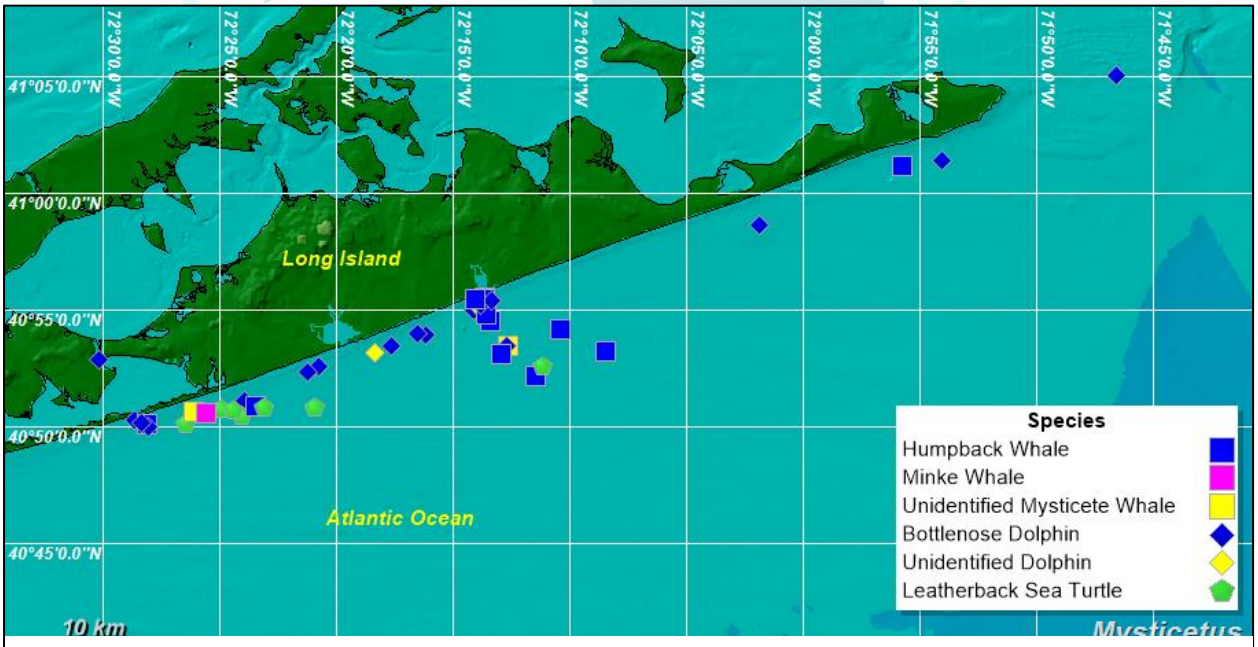

Figure 45. Locations of all protected species detections relative to Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made from the *Dolphin* on surveys conducted under the Ørsted Incidental Harassment Authorization (NMFS 2019).

5.4.1 Dynamic Management Areas (DMAs) and Seasonal Management Areas (SMAs)

Seasonal and dynamic management areas (SMAs and DMAs) are established by NOAA in specific locations and for specific durations in an effort to prevent vessel strikes with NARWs. No DMAs were in effect in the Survey Area during the Survey, but all offshore vessels tested equipment and surveyed within the Block Island SMA; the *Enterprise* and *Discovery* transited through the New York SMA, and the *Ocean Researcher* transited through the Philadelphia SMA. These three SMAs are part of the Mid-Atlantic US SMA, in effect from 01 November through 20 April.

5.4.2 North Atlantic Right Whale (NARW) Detections

Four detections of seven total individual NARWs were made on Surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019; Figure 46). Two of these detections occurred on 28 December 2019 and were of the same two individuals, first seen by PSOs on the *Discovery*. *Mysticetus* sent an automatic alert to PSOs on nearby vessels, cueing PSOs on the *Enterprise* where to watch for the animals.

Two detections of two individuals each were recorded by PSOs aboard the *Discovery* and *Enterprise* on 28 December 2019. PSOs on the *Discovery* first sighted two NARWs at 13:50 UTC (08:50 AM EST), one likely a juvenile, approximately 2 km from the vessel, apparently socializing with each other in close proximity. The *Discovery* was surveying with all HRG equipment under 200 kHz active (SBP, Sparker, and USBL). The vessel maintained its heading, transiting forward while the whales moved slowly in the opposite direction. No mitigation was required as the CPA was 750 m.

At 16:28 UTC (11:28 AM EST) on 28 December 2019, PSOs on the *Enterprise* sighted the two individuals NARWs (first detected by *Discovery* PSOs) approximately 2 km away from the *Enterprise*. The animals were still socializing at the surface, spending a lot of time on their backs, waving their flippers in the air, slapping the water, and slowly traveling. The *Enterprise* maintained its course and speed, surveying with the SBP and USBL. No mitigation was required as the CPA was 1,286 m, which was determined by PSOs using reticle binoculars (RB).

PSOs on the *Enterprise* recorded two additional NARW detections during the Surveys. The first, a single whale seen on 07 November 2019, was surface-active traveling at an initial sighting distance of 1,500 m. When it became evident the whale was approaching the 500-m EZ, the PSO on watch requested *shutdown* of the USBL, the only equipment operating below 200 kHz at the time of the detection. The mitigation request was implemented immediately and the whale continued to travel on its original course with no discernible reaction to the Survey vessel. The CPA of the whale was 450 m and it remained in the inactive EZ for approximately 1 min.

The second of these two additional NARW detections by *Enterprise* PSOs was of two whales on 07 April 2020. The whales were initially observed traveling slowly and blowing frequently at a distance of approximately 1,300 m from the *Enterprise*. The vessel was transiting at the time and no regulated sound sources were active. The whales did not approach closer than 1,300 m and no mitigation was required.

Each of the four total NARW groups (seven individuals) initiated dedicated NARW reporting protocols and notifications for PSO providers, marine survey companies,

Ørsted, and NOAA/NMFS. NARW sighting reports are included in Appendix D (All Appendices provided in separate document).

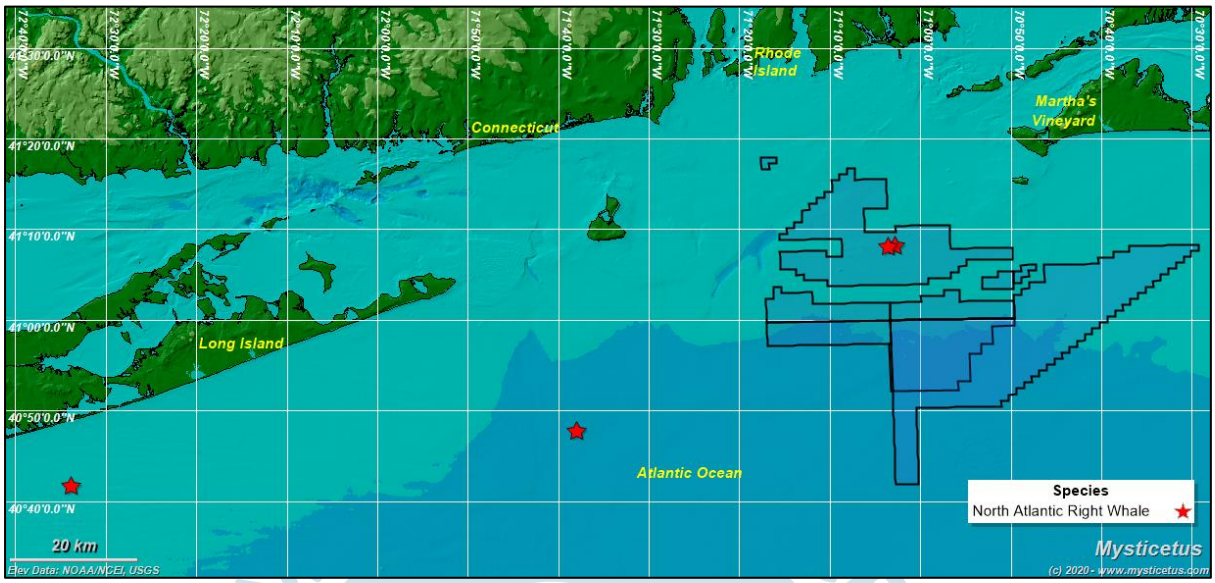

Figure 46. Locations of all four North Atlantic right whale detections relative to Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

5.4.3 Sea Turtle Detections

Fifty detections of an estimated 50 individual sea turtles occurred during the Surveys (Figure 47). The most frequently detected sea turtle species were leatherback (32%) and loggerhead (28%; Table 15). Eighty-eight percent of all sea turtle detections occurred *Inside* the Lease Areas (Table 16); detections occurred equally while HRG sound sources were *On* versus *Off* (Table 17).

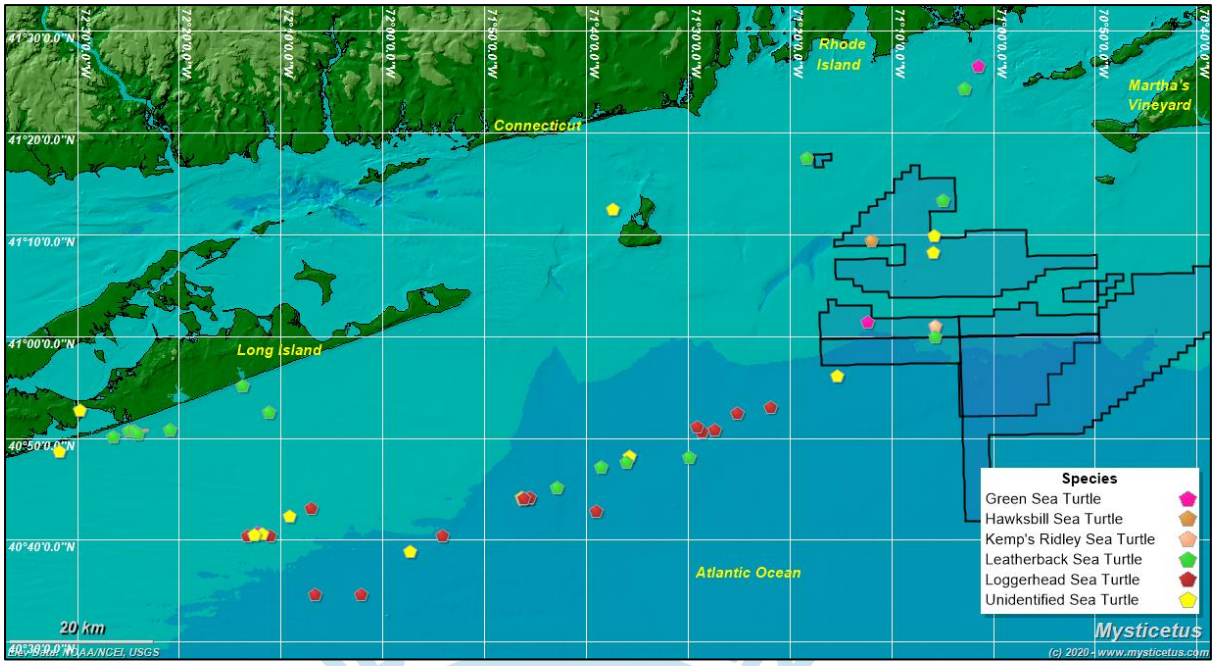

Figure 47. Locations of all 50 sea turtle detections relative to the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 (gray polygons) made on surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

5.4.4 Avian and Bat Detections

No dead or injured birds or bats were detected during the Survey.

5.5 Protected Species Behavior

It is worth noting the difficulty associated with vessel-based observations of marine mammal and sea turtle behaviors, particularly when behavioral study is not a primary objective of PSOs. A PSO's primary responsibility upon detection of a protected species is to assess the need for appropriate mitigation measures. Only after all mitigation measures have been assessed and possibly implemented do PSOs dedicate additional observation effort to assess animal behavior and potential reactions to the vessel or Surveys.

To the best of PSOs' abilities, Initial Behavior, Second Behavior, and possible Behavior Reaction data were recorded for each protected species detection and are presented here separately for marine mammals and sea turtles. During PAM-only detections (with no concurrent visual detection) behavior data could not be determined beyond "*vocalizing*" and so is reported as "*N/A (PAM)*".

Initial Behavior of marine mammals as recorded by PSOs consisted primarily of *travel*, *surface-active travel*, *surface-active mill*, and *blow* (Table 18). Mysticetes were initially observed to *blow* more often when HRG Sound was *On* (Table 19; Figure 48). Odontocetes appeared to initially *surface-active mill*, *surface-active travel*, *travel*, and *bowride* slightly more often when HRG Sound was *On* (Figure 49). Relatively few pinnipeds were detected while HRG Sound was *On*. Taking this small sample size into account, more pinnipeds were observed to initially *rest* when HRG Sound was *Off* (Table 20; Figure 50).

Second Behavior of marine mammals was primarily *blow*, *bow ride*, and *porpoise* (Table 21). Mysticetes were observed to secondarily *blow* more when HRG Sound was *On* (Table 18). Odontocetes were observed to secondarily *porpoise* more while HRG Sound was *On* and *breach* more when HRG Sound was *Off* (Figure 52). Pinnipeds tended to *look* at the Survey vessel more when HRG Sound was *Off* (Figure 53).

Initial Behavior of sea turtles was primarily *rest* (56%, Table 22; Figure 54). *Swim* was the primary Second Behavior, while almost half of all detections exhibited no Second Behavior (Table 23; Figure 55). HRG Sound *On* versus *Off* had no apparent effect on Initial or Second Behavior (Figure 55).

Table 18. Initial Behavior of marine mammal detections during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Initial Behavior	HRG Sound On		HRG Sound Off		Total	
	No. of Detections	Percent	No. of Detections	Percent	No. of Detections	Percent
Blow	148	12%	56	7%	**204**	**10%**
Bow Ride	57	5%	32	4%	**89**	**4%**
Breach	35	3%	19	2%	**54**	**3%**
Chase Fish	2	0%	1	0%	**3**	**0%**
Dead	1	0%	3	0%	**4**	**0%**
Feed	10	1%	5	1%	**15**	**1%**
Fluke Up	11	1%	2	0%	**13**	**1%**
Look	--	0%	1	0%	**1**	**0%**
Mill	20	2%	24	3%	**44**	**2%**
N/A PAM	268	22%	22	3%	**290**	**14%**
None	1	0%	1	0%	**2**	**0%**
Other[1]	2	0%	3	0%	**5**	**0%**
Porpoise	38	3%	47	6%	**85**	**4%**
Rest	60	5%	76	9%	**136**	**7%**
Socialize	1	0%	4	0%	**5**	**0%**
Splash	29	2%	17	2%	**46**	**2%**
Surface-active Mill	104	8%	91	11%	**195**	**10%**
Surface-active Travel	135	11%	96	12%	**231**	**11%**
Swim	52	4%	63	8%	**115**	**6%**
Tail Slap	4	0%	2	0%	**6**	**0%**
Travel	241	19%	222	28%	**463**	**23%**
Unknown	26	2%	19	2%	**45**	**2%**
Total	**1,245**	**100%**	**806**	**100%**	**2,051**	**100%**

[1] Other = HRG Sound On: humpback chin slaps, mouth-feeding lunges, and spy hops; seal look. HRG Sound Off: mysticete sunk straight down, seal fought off two gulls, seal investigated floating trash

Table 19. Initial Behavior of marine mammal detections by species during periods of HRG Sound *On* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Species	HRG Sound On																					
	Blow	Bow Ride	Breach	Chase Fish	Dead	Feed	Fluke Up	Look	Mill	None	Other[1]	Porpoise	Rest	Socialize	Splash	Surface-active Mill	Surface-active Travel	Swim	Tail Slap	Travel	Unknown	Total
Mysticete																						
Fin Whale	5	--	--	--	--	3	--	--	1	11	1	--	--	--	--	1	1	4	--	7	2	**36**
Humpback Whale	22	--	9	--	1	5	28	--	2	16	2	--	--	--	--	--	--	7	4	11	2	**109**
Long-Finned Pilot Whale	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	**1**
Minke Whale	3	--	--	--	--	--	--	--	--	14	--	1	--	--	--	--	--	1	1	4	1	**25**
North Atlantic Right Whale	--	--	1	--	--	--	--	--	--	--	1	--	--	1	--	--	--	--	--	--	--	**3**
Sei Whale	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1**
Sperm Whale	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	**1**
Unidentified Mysticete Whale	69	--	3	--	--	1	1	--	2	77	--	--	--	--	5	1	1	5	--	11	14	**190**
Odontocete																						
Atlantic Spotted Dolphin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**--**
Bottlenose Dolphin	--	--	1	--	--	2	--	--	1	6	--	2	--	2	--	1	--	2	--	--	--	**17**
Risso's Dolphin	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1**
Short-Beaked Common Dolphin	1	67	5	28	--	27	--	--	7	37	2	193	--	7	12	8	28	6	--	16	7	**451**
Unidentified Dolphin or Porpoise	2	9	3	5	--	5	--	--	2	17	1	36	--	--	11	5	6	7	--	11	2	**122**
Pinniped																						
Gray Seal	--	--	--	--	--	--	--	7	--	2	--	--	--	--	--	--	--	--	--	--	--	**9**
Harbor Seal	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	**3**
Unidentified Pinniped	--	--	--	--	--	1	--	2	--	3	--	--	--	--	--	--	--	--	--	--	2	**8**
Total	**102**	**76**	**23**	**33**	**1**	**45**	**29**	**12**	**15**	**184**	**7**	**232**	**--**	**10**	**28**	**16**	**37**	**32**	**5**	**60**	**30**	**977**
	Percent of HRG Sound On																					
Total (%)	**10**	**8**	**2**	**3**	**0**	**5**	**3**	**1**	**2**	**19**	**1**	**24**	**--**	**1**	**3**	**2**	**4**	**3**	**1**	**6**	**3**	**100**

[1] Other = multiple breaches and pec-slaps, fluke-slaps; travel; splashes with bird activity; whistles on PAM; coordinated maneuvers around the vessel; blowing, pec-slapping, waving flippers in the air

Table 20. Initial Behavior of marine mammal detections by species during periods of HRG Sound *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Species	HRG Sound Off																						
	Blow	Bow Ride	Breach	Chase Fish	Dead	Dive	Feed	Fluke Up	Look	Mill	None	Other[1]	Porpoise	Rest	Socialize	Splash	Surface-active Mill	Surface-active Travel	Swim	Tail Slap	Travel	Unknown	Total
Mysticete																							
Fin Whale	4	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	1	--	**6**
Humpback Whale	9	--	6	--	1	--	1	13	--	--	15	--	--	--	--	4	1	5	1	1	3	--	**60**
Long-Finned Pilot Whale	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**--**
Minke Whale	6	--	2	--	--	--	--	--	1	1	11	--	--	--	--	--	--	1	1	--	2	1	**26**
North Atlantic Right Whale	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	**1**
Sei Whale	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**--**
Sperm Whale	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	**1**
Unidentified Mysticete Whale	48	--	6	--	--	--	--	1	--	--	48	1	--	--	--	1	3	2	1	--	7	13	**131**
Odontocete																							
Atlantic Spotted Dolphin	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**2**
Bottlenose Dolphin	--	3	--	--	--	--	1	1	--	--	18	--	3	--	1	1	1	7	2	7	2	--	**47**
Risso's Dolphin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	**1**
Short-Beaked Common Dolphin	1	77	9	24	--	--	32	--	--	--	26	4	106	--	8	4	10	12	13	--	12	3	**341**
Unidentified Dolphin or Porpoise	2	8	1	--	--	--	3	--	1	2	19	--	25	--	1	4	2	6	12	--	10	1	**97**
Pinniped																							
Gray Seal	--	--	--	--	--	1	3	--	19	--	13	--	--	--	--	1	--	--	--	--	--	--	**37**
Harbor Seal	--	--	--	--	--	--	--	--	7	--	4	5	--	--	--	--	--	--	--	--	--	2	**18**
Unidentified Pinniped	--	--	--	--	--	--	--	--	4	--	10	--	--	--	--	--	--	--	--	--	--	2	**16**
Total	**70**	**90**	**24**	**24**	**1**	**1**	**40**	**15**	**32**	**3**	**165**	**10**	**134**	**1**	**10**	**17**	**17**	**33**	**30**	**8**	**37**	**22**	**784**
	Percent of HRG Sound Off																						
Total (%)	**9**	**11**	**3**	**3**	**0**	**0**	**5**	**2**	**4**	**0**	**21**	**1**	**17**	**0**	**1**	**2**	**2**	**4**	**4**	**1**	**5**	**3**	**100**

[1] Other = dove x 2; dove under vessel; rode wave swell; full body breach; look then dove x 4; could be heard blowing/breathing

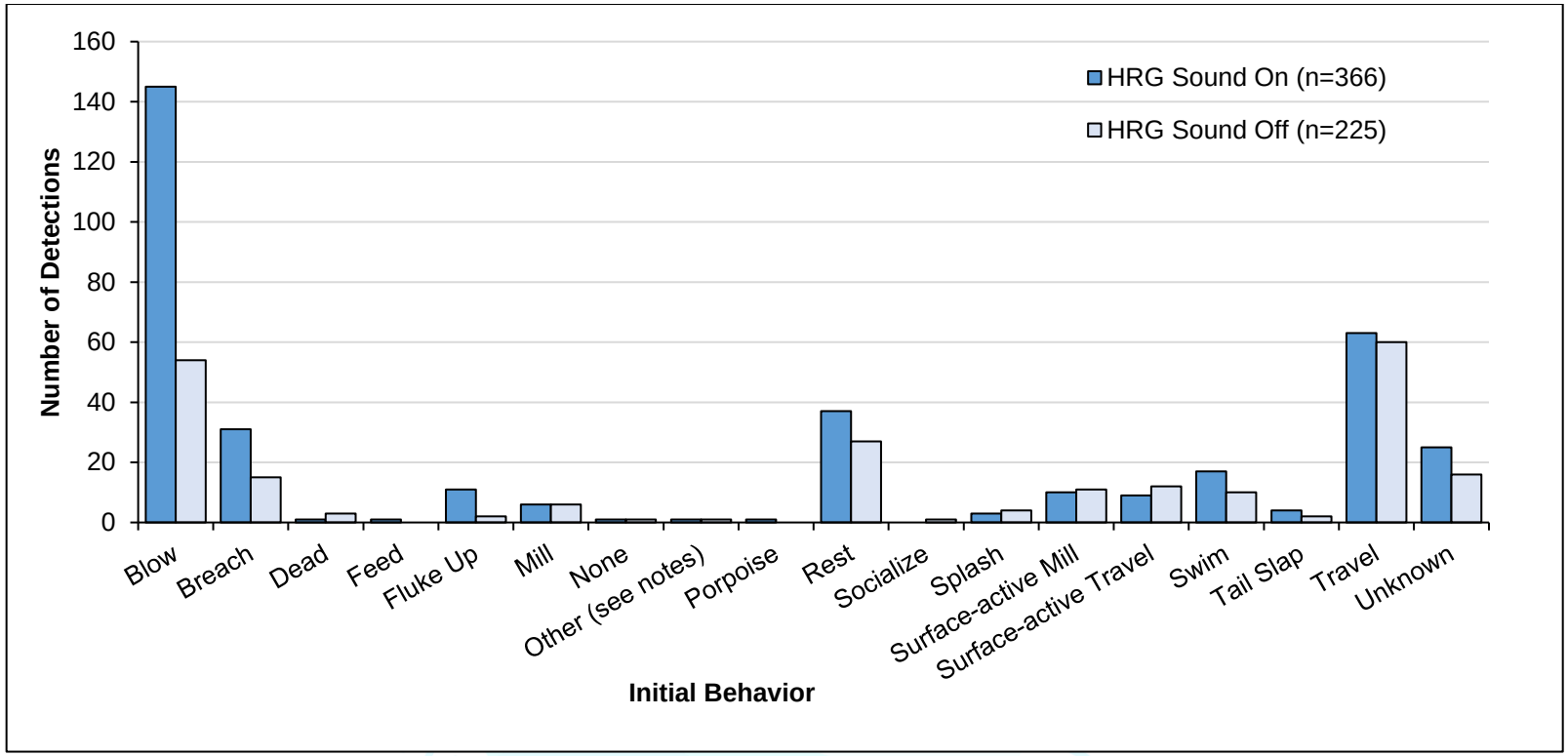

Figure 48. Initial Behavior of all mysticete detections during HRG Sound *On* versus *Off* periods during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions. Other for HRG Sound *On* = multiple breaches and pec-slaps, fluke-slaps; travel; splashes with bird activity; whistles on PAM; coordinated maneuvers around the vessel; blowing, pec-slapping, waving flippers in the air; Other for HRG Sound *Off* = dove x 2; dove under vessel; rode wave swell; full body breach; look then dove x 4; could be heard blowing/breathing.

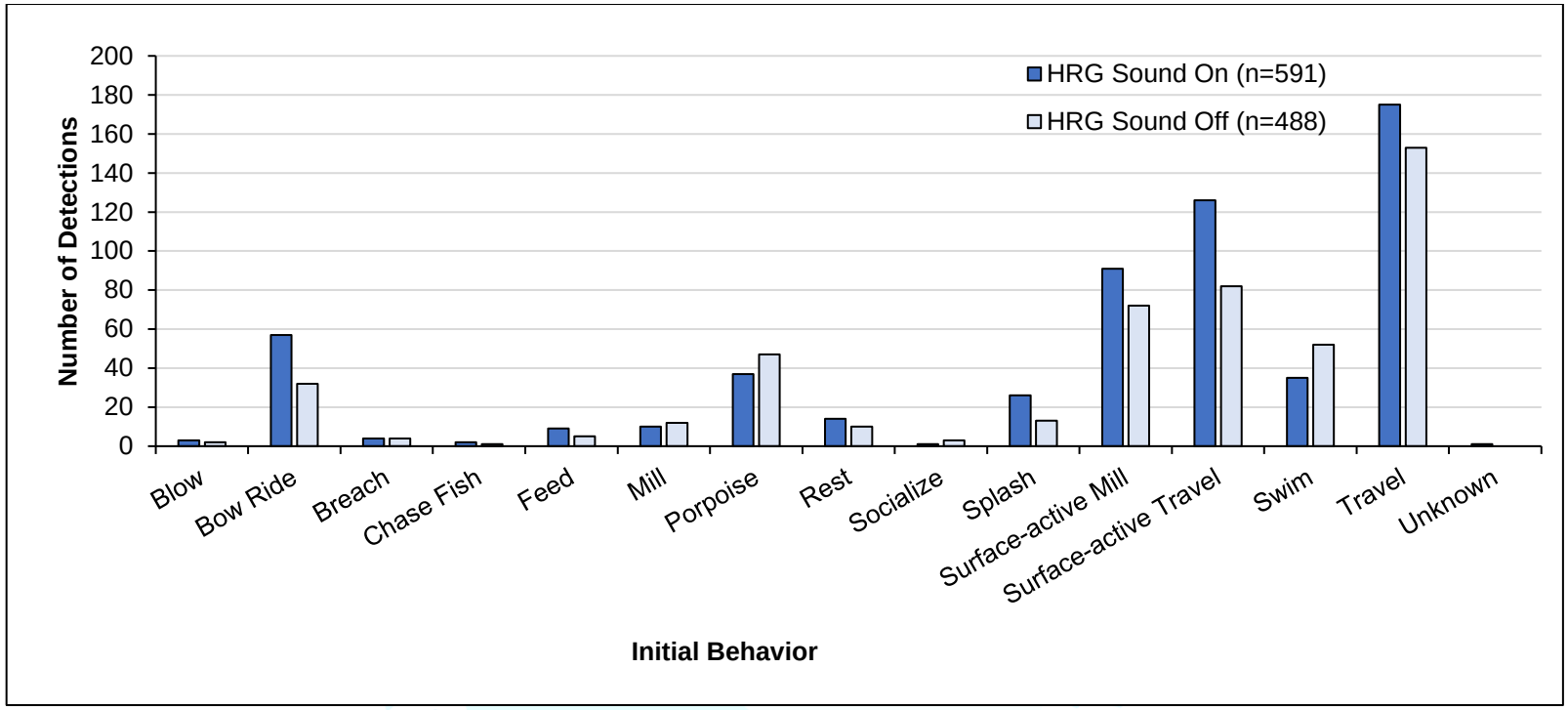

Figure 49. Initial Behavior of all odontocete detections during HRG Sound *On* versus *Off* periods during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

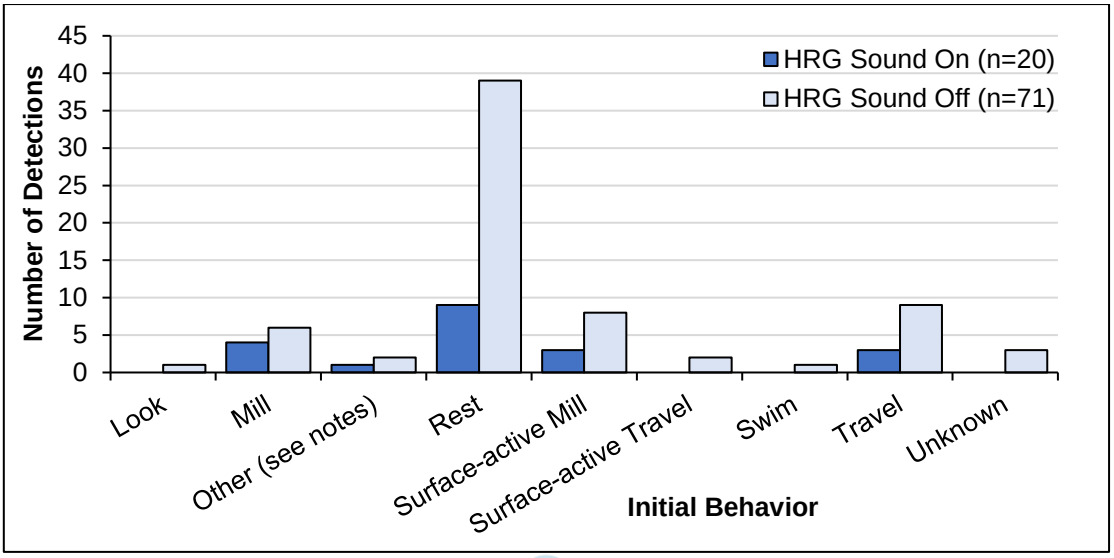

Figure 50. Initial Behavior of all pinniped detections during HRG Sound *On* versus *Off* periods during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Table 21. Second Behavior of all mysticete detections during HRG Sound *On* versus *Off* periods during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Second Behavior	HRG Sound On		HRG Sound Off		Total	
	No. of Detections	Percent	No. of Detections	Percent	No. of Detections	Percent
Blow	102	8%	70	9%	**172**	**8%**
Bow Ride	76	6%	90	11%	**166**	**8%**
Breach	23	2%	24	3%	**47**	**2%**
Chase Fish	33	3%	24	3%	**57**	**3%**
Dead	1	0%	1	0%	**2**	**0%**
Dive	--	0%	1	0%	**1**	**0%**
Feed	45	4%	40	5%	**85**	**4%**
Fluke Up	29	2%	15	2%	**44**	**2%**
Look	12	1%	32	4%	**44**	**2%**
Mill	15	1%	3	0%	**18**	**1%**
N/A PAM	268	22%	22	3%	**290**	**14%**
None	184	15%	165	20%	**349**	**17%**
Other[1]	7	1%	10	1%	**17**	**1%**
Porpoise	232	19%	134	17%	**366**	**18%**
Rest	--	0%	1	0%	**1**	**0%**
Socialize	10	1%	10	1%	**20**	**1%**
Splash	28	2%	17	2%	**45**	**2%**
Surface-active Mill	16	1%	17	2%	**33**	**2%**
Surface-active Travel	37	3%	33	4%	**70**	**3%**
Swim	32	3%	30	4%	**62**	**3%**
Tail Slap	5	0%	8	1%	**13**	**1%**
Travel	60	5%	37	5%	**97**	**5%**
Unknown	30	2%	22	3%	**52**	**3%**
Total	**1,245**	**100%**	**806**	**100%**	**2,051**	**100%**

[1] Other for HRG Sound *On* = multiple breaches and pec-slaps, fluke-slaps; travel; splashes with bird activity; whistles on PAM; coordinated maneuvers around the vessel; blowing, pec-slapping, waving flippers in the air
Other for HRG Sound *Off* = dove x 2; dove under vessel; rode wave swell; full body breach; look then dove x 4; could be heard blowing/breathing

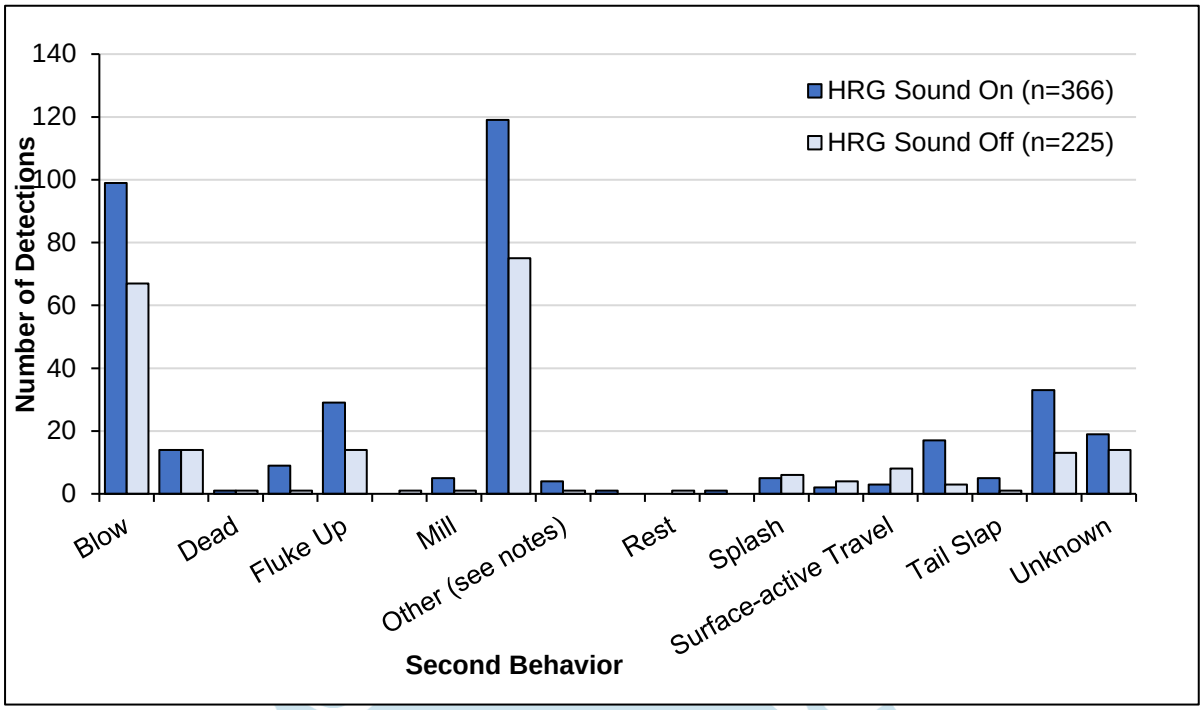

Figure 51. Second Behavior of all mysticete detections during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions. Other for HRG Sound *On* = multiple breaches and pec-slaps, fluke-slaps; travel; splashes with bird activity; whistles on PAM; coordinated maneuvers around the vessel; blowing, pec-slapping, waving flippers in the air; Other for HRG Sound *Off* = dove x 2; dove under vessel; rode wave swell; full body breach; look then dove x 4; could be heard blowing/breathing.

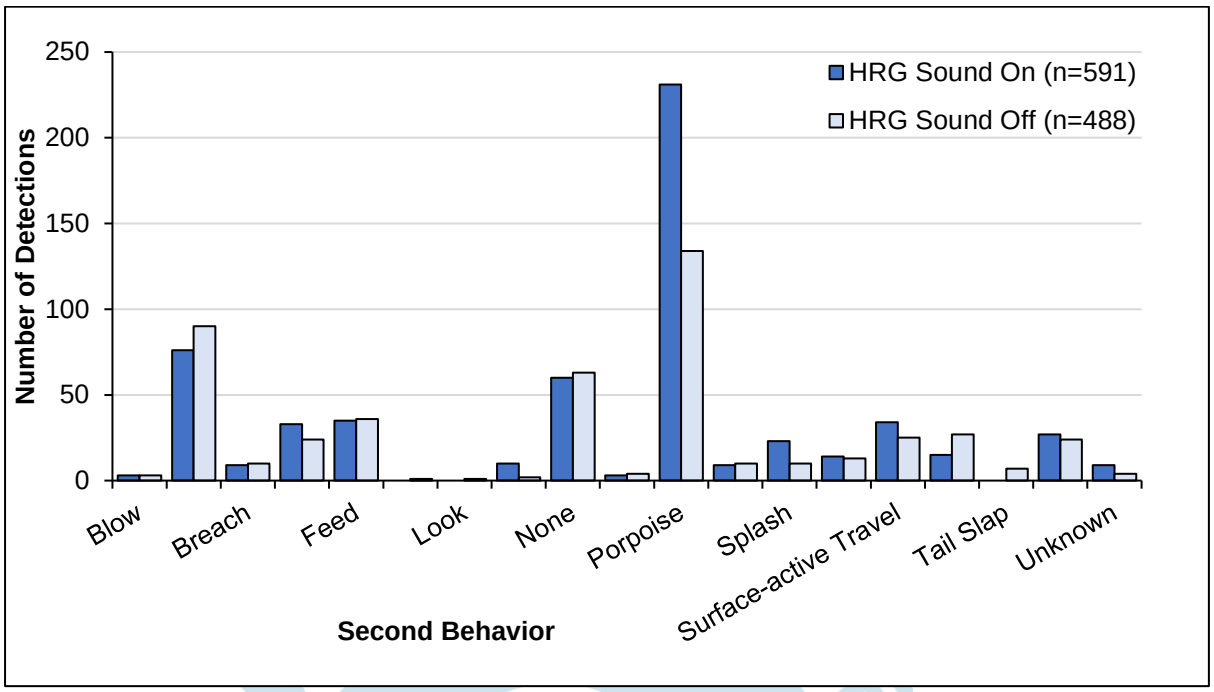

Figure 52. Second Behavior of all odontocete detections during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A for behavior definitions.

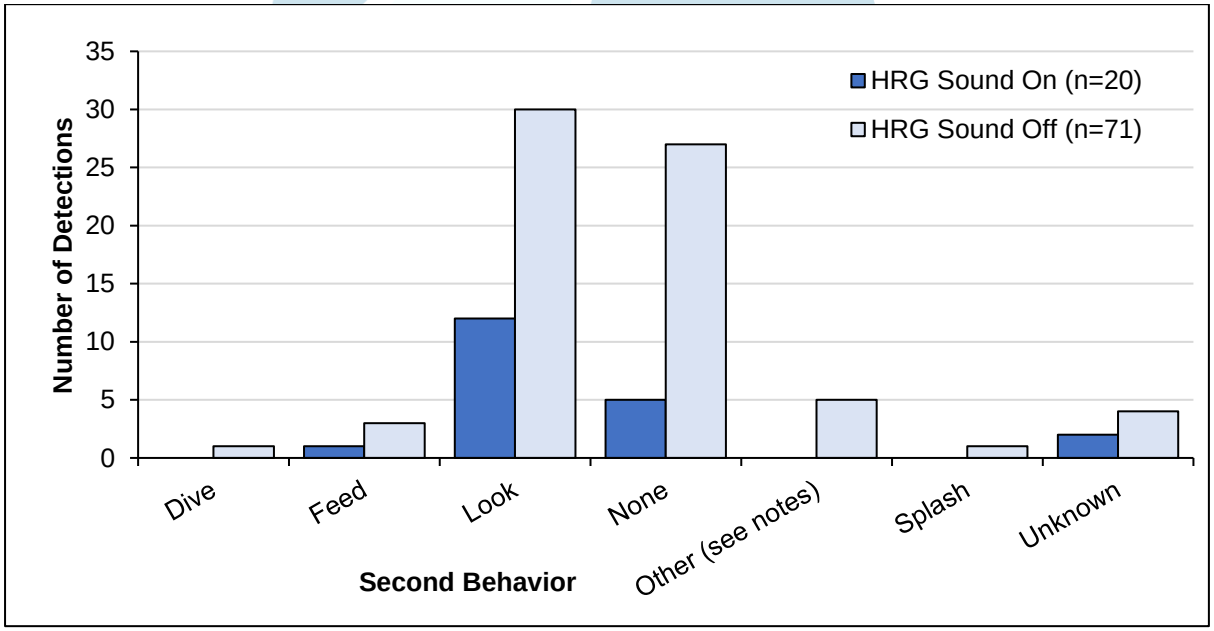

Figure 53. Second Behavior of all pinniped detections during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Table 22. Initial Behavior of all sea turtle detections during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Initial Behavior	HRG Sound On		HRG Sound Off		Total	
	No. of Detections	Percent	No. of Detections	Percent	No. of Detections	Percent
Dead	--	0%	1	4%	**1**	**2%**
Look	1	4%	--	0%	**1**	**2%**
Other[1]	--	0%	1	4%	**1**	**2%**
Rest	15	60%	13	52%	**28**	**56%**
Surface-active Mill	1	4%	--	0%	**1**	**2%**
Surface-active Travel	1	4%	--	0%	**1**	**2%**
Swim	7	28%	5	20%	**12**	**24%**
Travel	--	0%	2	8%	**2**	**4%**
Unknown	--	0%	3	12%	**3**	**6%**
Total	**25**	**100%**	**25**	**100%**	**50**	**100%**

[1] Other = dove about 2 seconds after sighted

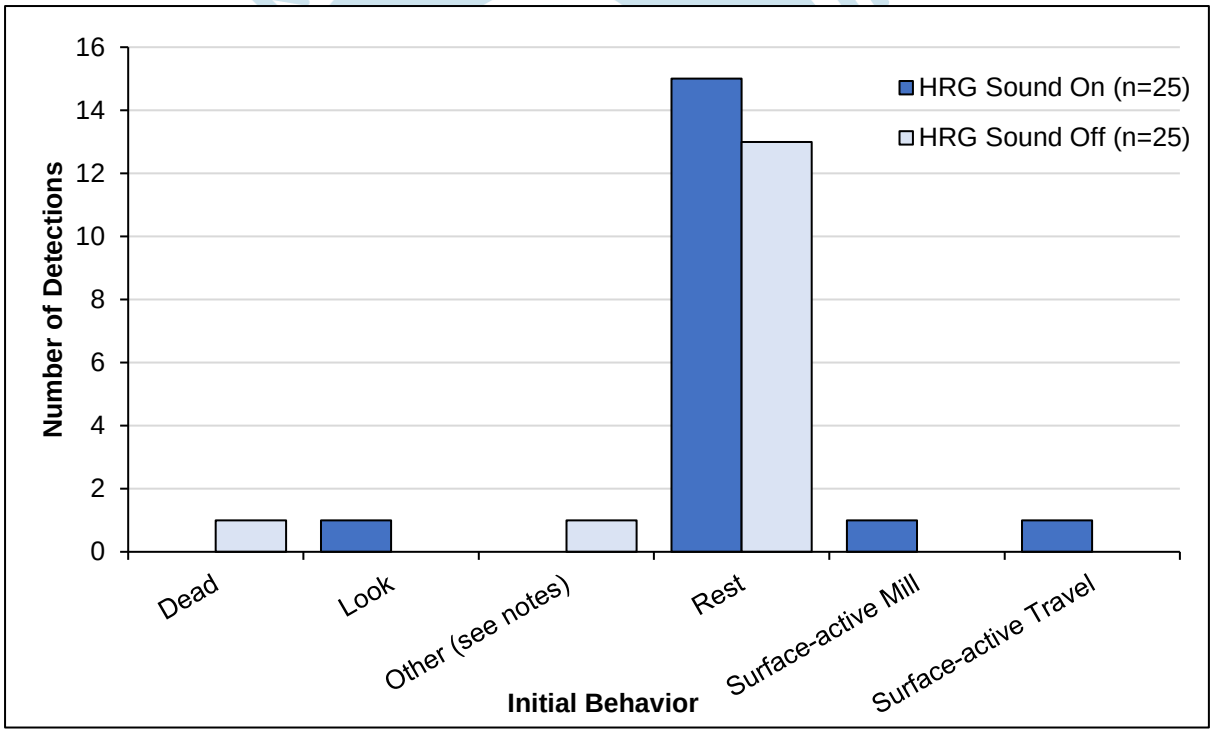

Figure 54. Initial Behavior of all sea turtle detections during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions. Other = dove about 2 seconds after sighted

Table 23. Second Behavior of all sea turtle detections during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Second Behavior	HRG Sound On		HRG Sound Off		Total	
	No. of Detections	Percent	No. of Detections	Percent	No. of Detections	Percent
Look	2	8%	1	4%	3	**6%**
Mill	--	0%	1	4%	1	**2%**
None	9	36%	12	48%	21	**42%**
Other[1]	--	0%	1	4%	1	**2%**
Splash	2	8%	--	0%	2	**4%**
Surface-active Travel	2	8%	--	0%	2	**4%**
Swim	6	24%	6	24%	12	**24%**
Travel	--	0%	2	8%	2	**4%**
Unknown	4	16%	2	8%	6	**12%**
Total	**25**	**100%**	**25**	**100%**	**50**	**100%**

[1] Other = swam along vessel and then dove

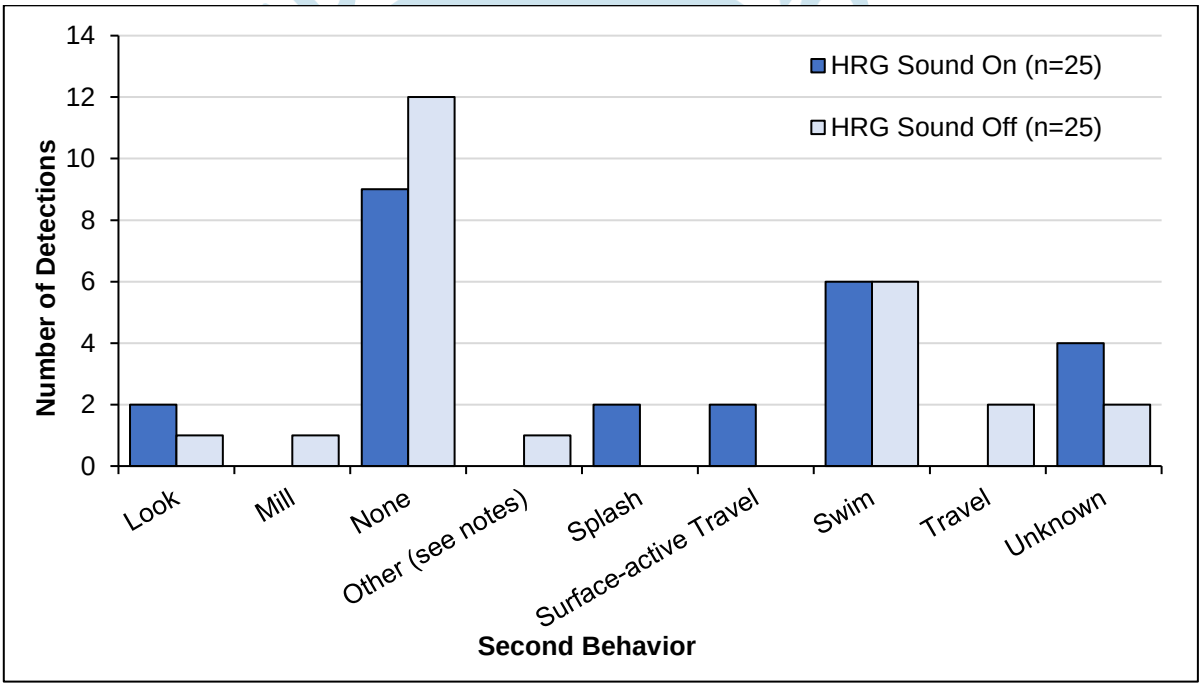

Figure 55. Second Behavior of all sea turtle detections during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions. Other = swam along vessel and then dove.

Behavior Reactions, an observed overt change in behavior considered a potential reaction to the vessel and/or Survey operations, were only observed in 8% of all marine mammal detections while HRG Sound was *On*, and in 14% detections while HRG Sound was *Off* (Table 24). Short-beaked common dolphins accounted for the majority of Behavior Reactions, which were primarily *change direction* (Table 24).

No Behavior Reaction was observed for almost half of all sea turtle detections (Table 25). The primary Behavior Reaction of sea turtles was to *dive*; 56% of detections *dove* while HRG Sound was *On*, and 47% *dove* while HRG Sound was *Off* (Table 25).

Table 24. Number of changes in marine mammal behavior detected during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Species	HRG Sound On										HRG Sound Off									
	Change Direction	Dive	Look	None	Other[1]	Slow Down	Speed Up	Splash	Unknown	Total	Change Direction	Dive	Look	None	Other[2]	Slow Down	Speed Up	Splash	Unknown	Total
Mysticete																				
Fin Whale	1	2	--	32	--	--	1	--	--	**36**	--	--	--	6	--	--	--	--	--	**6**
Humpback Whale	1	1	--	105	--	--	--	1	1	**109**	--	--	--	59	--	--	--	--	1	**60**
Long-Finned Pilot Whale	--	--	--	1	--	--	--	--	--	**1**	--	--	--	--	--	--	--	--	--	**--**
Minke Whale	--	--	--	23	--	--	--	--	2	**25**	1	1	--	23	--	--	--	--	1	**26**
North Atlantic Right Whale	--	--	--	3	--	--	--	--	--	**3**	--	--	--	1	--	--	--	--	--	**1**
Sei Whale	--	--	--	1	--	--	--	--	--	**1**	--	--	--	--	--	--	--	--	--	**--**
Sperm Whale	--	1	--	--	--	--	--	--	--	**1**	--	--	--	1	--	--	--	--	--	**1**
Unidentified Mysticete Whale	--	4	--	180	1	--	--	--	5	**190**	1	4	--	116	2	--	--	--	8	**131**
Odontocete																				
Atlantic Spotted Dolphin	--	--	--	--	--	--	--	--	--	**--**	1	1	--	--	--	--	--	--	--	**2**
Bottlenose Dolphin	--	--	--	16	1	--	--	--	--	**17**	2	--	--	44	--	--	--	1	--	**47**
Risso's Dolphin	--	--	--	1	--	--	--	--	--	**1**	--	--	--	1	--	--	--	--	--	**1**
Short-Beaked Common Dolphin	32	4	--	376	3	1	2	1	32	**451**	36	4	--	282	1	4	1	1	12	**341**
Unidentified Dolphin or Porpoise	9	4	--	88	1	--	--	1	19	**122**	10	6	--	71	--	--	1	--	9	**97**
Pinniped																				
Gray Seal	--	1	1	5	--	--	--	--	2	**9**	--	12	1	23	--	1	--	--	--	**37**
Harbor Seal	--	--	1	2	--	--	--	--	--	**3**	--	1	7	9	1	--	--	--	--	**18**
Unidentified Pinniped	--	--	1	7	--	--	--	--	--	**8**	--	7	--	7	--	--	--	--	2	**16**
Total	**43**	**17**	**3**	**840**	**6**	**1**	**3**	**3**	**61**	**977**	**51**	**36**	**8**	**643**	**4**	**5**	**2**	**2**	**33**	**784**
	Percent of HRG Sound On										**Percent of HRG Sound Off**									
Total (%)	**4**	**2**	**0**	**86**	**1**	**0**	**0**	**0**	**6**	**100**	**7**	**5**	**1**	**82**	**1**	**1**	**0**	**0**	**4**	**100**

[1] Other = full-body breaches, leaping; possible direction change; milling, then slowly paralleling vessel; milling; change direction; unknown
[2] Other = swim; dive under vessel; unknown; possible direction change

Table 25. Number of changes in sea turtle behavior detected during periods of HRG Sound *On* versus *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). See Appendix A (All Appendices provided in separate document) for behavior definitions.

Species	HRG Sound On						HRG Sound Off					
	Dive	Look	None	Speed Up	Other[1]	Total	Dive	Look	None	Speed Up	Other	Total
Green Sea Turtle	--	--	1	--	--	**1**	1	--	1	--	--	**2**
Hawksbill Sea Turtle	--	--	--	--	--	**--**	--	--	1	--	--	**1**
Kemp's-Ridley Sea Turtle	--	--	--	--	--	**--**	--	--	1	--	--	**1**
Leatherback Sea Turtle	3	--	4	--	--	**7**	3	--	5	1	--	**9**
Loggerhead Sea Turtle	8	--	2	--	--	**10**	3	--	1	--	--	**4**
Unidentified Sea Turtle	3	--	3	--	1	**7**	4	1	3	--	--	**8**
Total	**14**	**--**	**10**	**--**	**1**	**25**	**11**	**1**	**12**	**1**	**--**	**25**
	Percent of HRG Sound On						**Percent of HRG Sound Off**					
Total %	**56**	**--**	**40**	**--**	**4**	**100**	**44**	**4**	**48**	**4**	**--**	**100**

[1] Other = unknown

5.6 *Closest Observed Point of Approach (CPA)*

The closest observed point of approach (CPA) was estimated by PSOs for all visual detections but could not be determined for most PAM detections without visual corroboration. Detection distance was determined for 33 of 294 (11%) PAM detections. *N/A PAM* in the following figures accounts for the remaining 89% of PAM detections with no detection distance. Marine mammals were more likely to approach the vessels within 50 m *Outside* the Lease Areas (Figure 56). A Wilcoxon signed-rank test showed that median CPA was further when HRG Sound was *On* (200 m) versus *Off* (50 m; W = 342,806, p = 0.00014; Figure 57), suggesting possible localized avoidance of active HRG sources.

A Kruskal-Wallis rank sum test showed that median CPA differed by species group. Most odontocetes approached the vessels within 50 m with a median CPA of 10 m; median CPA of pinnipeds was 100 m; mysticetes rarely approached within 200 m, with a median CPA of 922 m (X^2 = 828.1, p < 2.2e-16, df = 2; Figure 58; Figure 59).

Most sea turtles were detected within 50 m of the vessels (Figure 60; Figure 61; Figure 62). Taking into account that few sea turtles were detected *Inside* the Lease Areas, sea turtles appeared to approach vessels, or be sighted closer, *Outside* the Lease Areas (Figure 60). HRG Sound appeared to have no influence on sea turtle CPA (Figure 61).

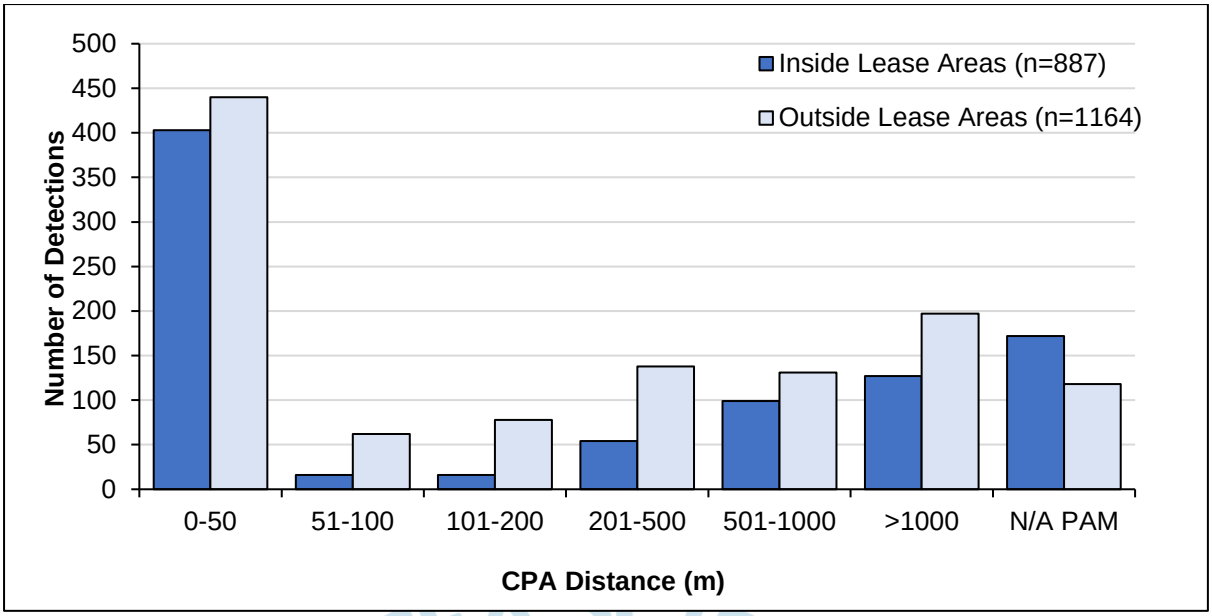

Figure 56. Closest observed point of approach (CPA) of all marine mammal detections *Inside* compared to *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

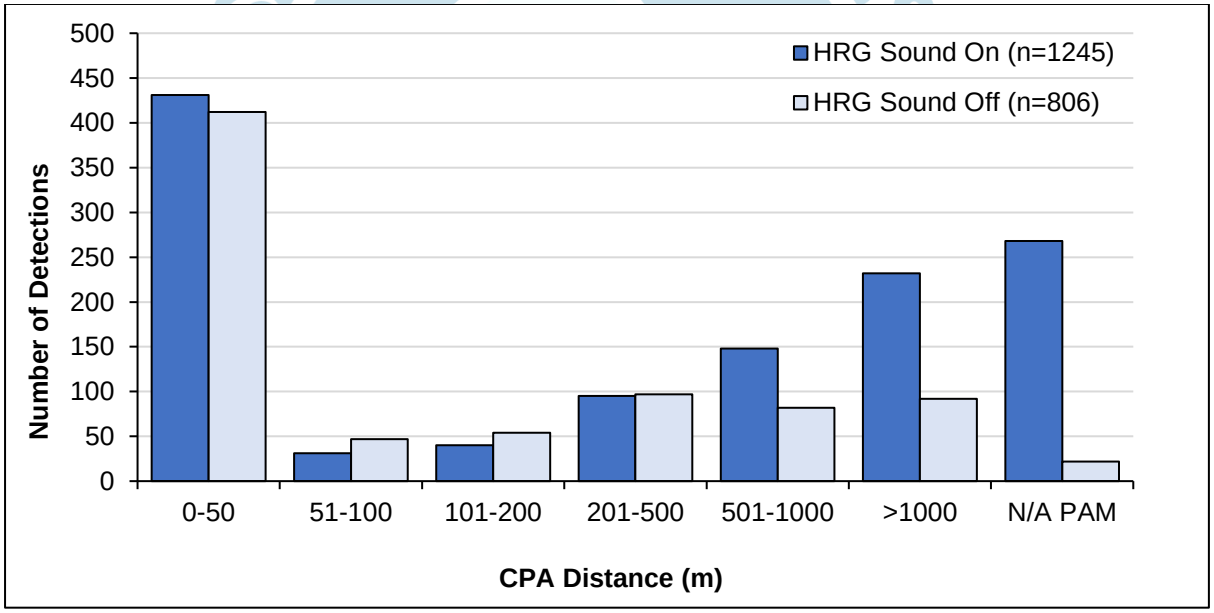

Figure 57. Closest observed point of approach (CPA) of all marine mammal detections during periods of HRG Sound *On* and *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

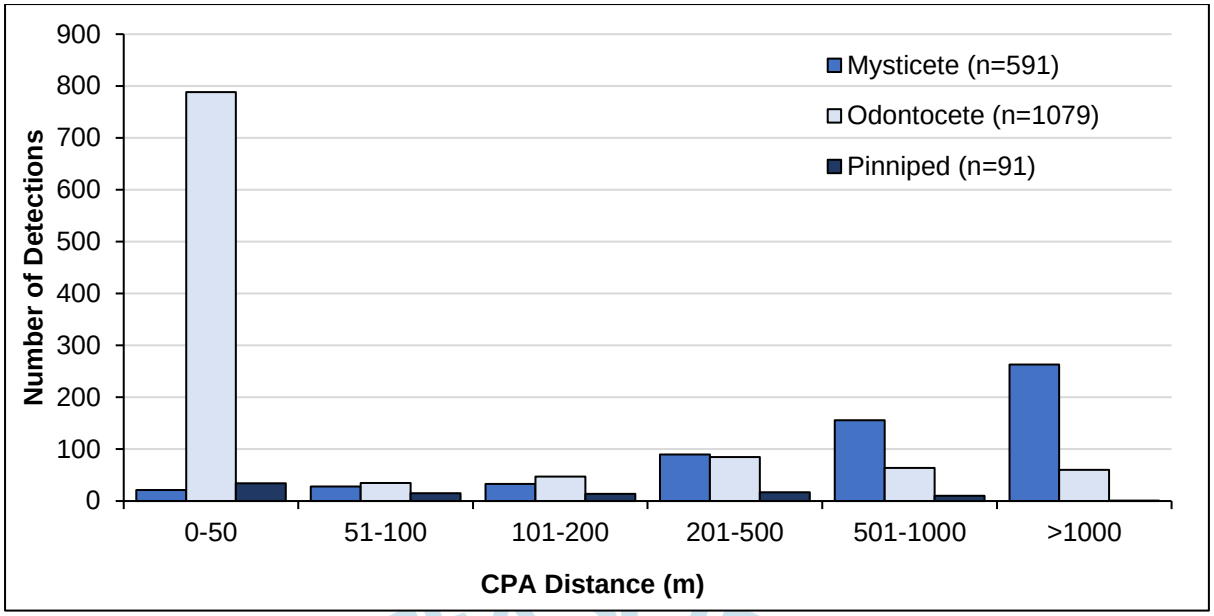

Figure 58. Closest observed point of approach (CPA) of all marine mammal detections during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Passive acoustic monitoring (PAM) detections with no distance associated are omitted (n=261).

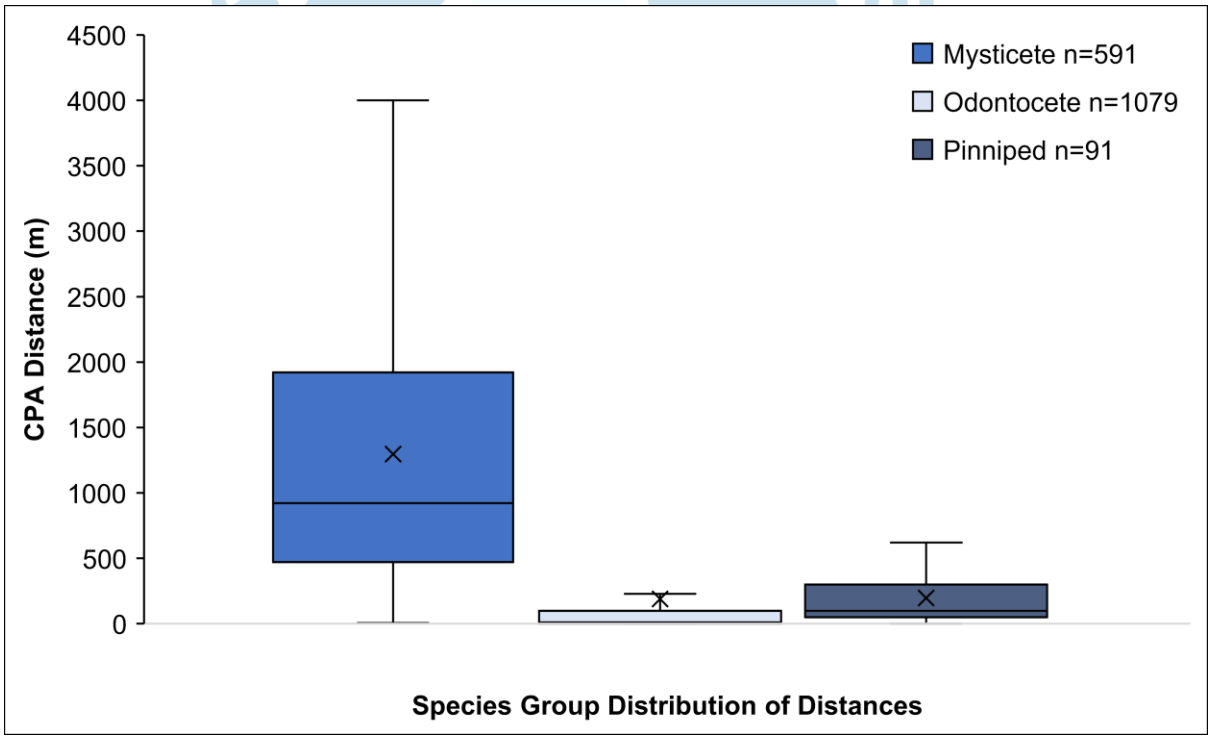

Figure 59. Box and whiskers plot of closest observed point of approach (CPA) of all marine mammal detections during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). The horizonal line within the box indicates the median, "X" indicates the mean, boundaries of the box indicate the 25th and 75th quartiles, and the whiskers indicate the full range of the results. Passive acoustic monitoring (PAM) detections with no distance associated are omitted (n=261).

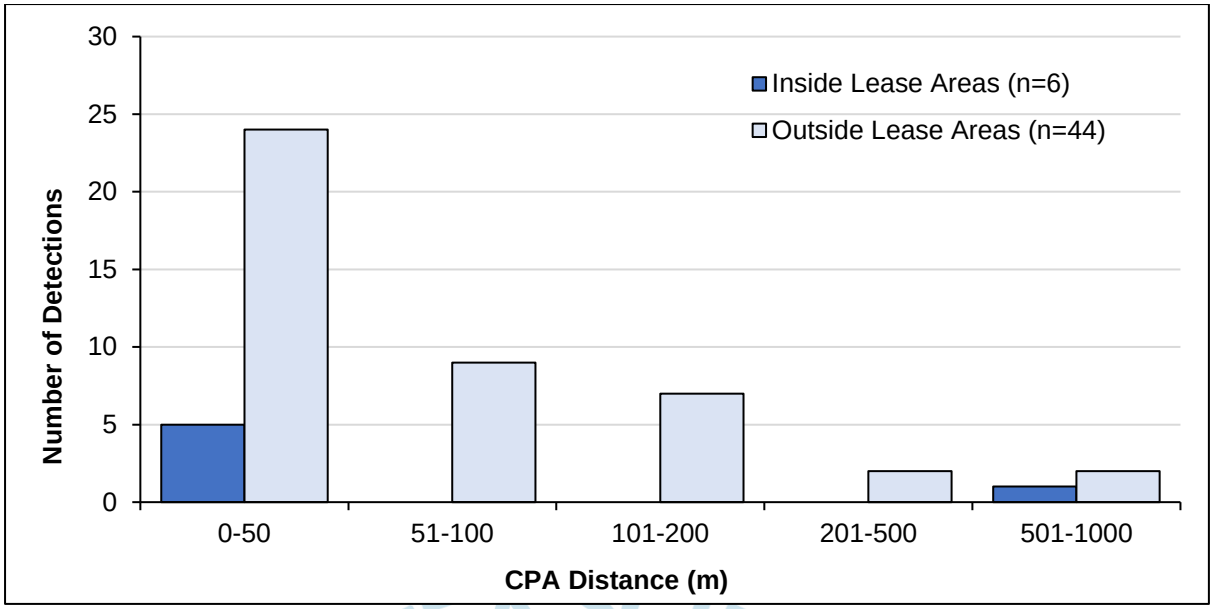

Figure 60. Closest observed point of approach (CPA) of all sea turtle detections *Inside* compared to *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Passive acoustic monitoring (PAM) detections with no distance associated are omitted (n=261).

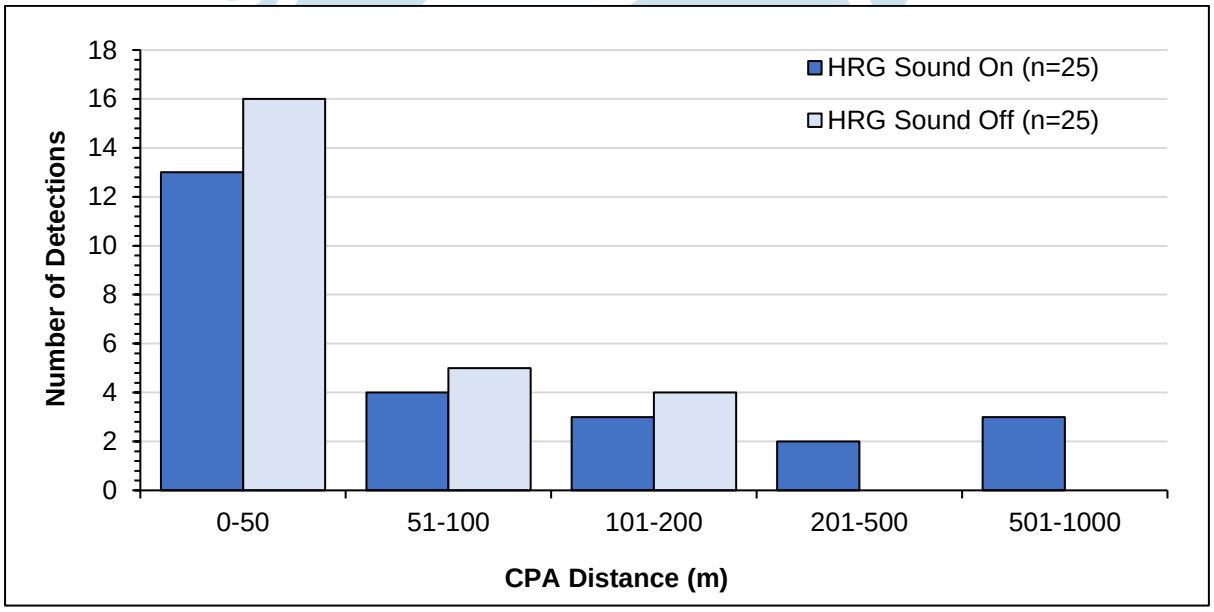

Figure 61. Closest observed point of approach (CPA) of all sea turtle detections during periods of HRG Sound *On* and *Off* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Passive acoustic monitoring (PAM) detections with no distance associated are omitted (n=261).

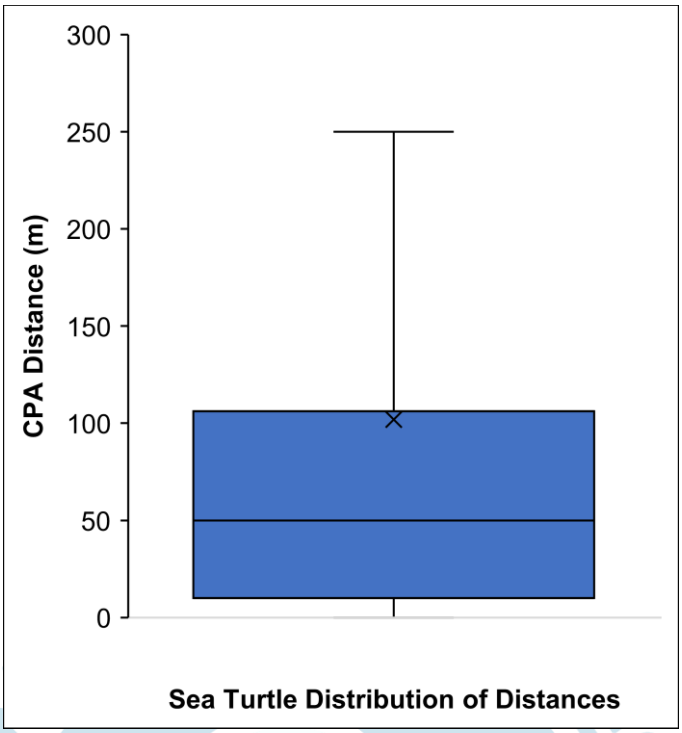

Figure 62. Box and whiskers plot of closest observed point of approach (CPA) of all sea turtle detections (n=50) during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). The horizonal line within the box indicates the median, "X" indicates the mean, boundaries of the box indicate the 25th and 75th quartiles, and the whiskers indicate the full range of the results.

5.7 Protected Species Exposures

As discussed in Section 4.7.1, the potential for behavioral responses to HRG survey activities to rise to the level of take as defined and determined by NMFS exists any time HRG sound sources with frequencies below 200 kHz and source levels above Level B acoustic thresholds are active. HRG sound sources with the potential to result in Level B exposures to marine mammals from this Survey in order from greatest to least amount of sound energy produced per source were the Sparker, Sub-bottom Profiler (SBP), and Ultra-short Baseline (USBL) positioning device (Table 10).

The 2019 Ørsted IHA for offshore New England renewable Leases defined 180 m from any of the active survey sources with frequencies below 200 kHz as the Level B harassment zone (NMFS 2019) as the threshold used to estimate the number of animals potentially exposed to received sound levels at or above NMFS Level B criteria for impulsive sounds; however, this approach likely overestimated the total number of individual marine mammals exposed to Level B sounds. The estimated Level B distances for specific Survey equipment assessed in the 2019 IHA application were considerably less than 180 m. Estimated Level B isopleths applied within the 2019 Ørsted IHA application for the Sparker, SBP, and USBL were 141, 63, and 2 m, respectively. For these reasons, we also assessed potential exposure estimates as a function of the "maximum" source type operating at the time each marine mammal was detected by PSOs and/or PAM operators.

Forty-one percent of all individual marine mammals detected during the Survey were detected during periods when regulated sound sources below 200 kHz were *not* active (Table 26). Of the 15,695 total individual marine mammals detected during the Survey, 59% (9,192 individuals) were detected while at least one sound source was operational at frequencies below 200 kHz; 47% (4,283 individuals) of these were detected further than 180 m from sound sources and therefore outside the 180 m Level B isopleth established by NMFS in the IHA (Table 26).

An estimated 4,909 individual marine mammals were detected within 180 m of an active sound source operating below 200 kHz (Table 26). It is likely this total is an overestimation of individual animal numbers as some individuals likely were detected repeatedly over the Survey period. In particular, PSOs suspected many of the same individuals and groups of short-beaked common dolphins were detected on multiple occasions across the Survey period, including within a 24-hr period.

It is difficult for PSOs to identify marine mammals to the individual level during monitoring, particularly delphinids. Therefore, we conservatively present PSO "best count" estimates here, assuming all individuals for each and every detection event were unique. It is therefore likely that "best count" estimates presented here are greater than the actual number of different individuals present.

An estimated 4,909 individual marine mammals were detected within 180 m of active sources. Of these individuals, however, the vast majority (99%, or 4,848 individuals) were identified as dolphins, which were granted a shutdown exemption in the 2019 Ørsted IHA. The remaining 61 individual marine mammals detected within 180 m of active sources consisted of 14 fin whales, 24 humpback whales, eight minke whales, 11 unidentified mysticete whales, and four seals. Of these 61 non-delphinid individuals detected within 180 m of an active HRG source, all but nine of them resulted in a shutdown of regulated HRG sources operating below 200 kHz, as requested by PSOs.

Excluding dolphins, an estimated nine individual marine mammals were detected within 180 m of an active HRG sound source operating below 200 kHz for which a shutdown was not implemented: four humpback whales, three minke whales, and two unidentified mysticete whales. However, the CPA for all of these individuals was between 100 m and 180 m. Because the EZ stipulated by the IHA was 100 m, no mitigation was required or requested by PSOs. Although all appropriate mitigation and shutdown protocols were followed, it is possible these nine individuals were exposed to sounds above 160 dB RMS for brief durations.

5.7.1 Total Estimated Exposures Considering Specific Equipment

As noted above, it is useful to consider potential marine mammal exposures in the context of a "maximum" active source at the time of detection and the associated, source-specific Level B radius. Table 26 presents the estimated numbers of individual marine mammals detected by "maximum" active source and the corresponding Level B isopleth.

Table 26. Estimated numbers of individual marine mammals detected by equipment status and distance from HRG equipment during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).Estimated numbers of individual marine mammals detected by equipment status and distance from HRG equipment during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Species	Total No. Individuals Detected by PSOs	Total No. Individuals Detected While HRG Source <200 kHz Active	Total No. Individuals w/in 180 m of Active Source	Total No. Individuals w/in 180 m of Active Source w/ Shutdown	Total No. Individuals w/in 180 m of Active Source w/out Shutdown
Mysticete					
Fin Whale	90	79	14	14	--
Humpback Whale	245	160	24	20	4
Long-Finned Pilot Whale	1	1	--	--	--
Minke Whale	54	28	8	5	3
North Atlantic Right Whale	7	5	--	--	--
Sei Whale	1	1	--	--	--
Sperm Whale	2	1	--	--	--
Unidentified Mysticete Whale	410	255	11	9	2
Odontocete					
Atlantic Spotted Dolphin	20	--	--	--	--
Bottlenose Dolphin	1,175	328	190	50	140
Harbor Porpoise	1	1	--	--	--
Risso's Dolphin	14	4	4	--	4
Short-Beaked Common Dolphin	10,760	6,445	4,457	1,140	3,317
Unidentified Dolphin or Porpoise	2,624	1,860	197	28	169
Pinniped					
Gray Seal	58	13	1	1	--
Harbor Seal	201	3	2	2	--
Unidentified Pinniped	32	8	1	1	--
Total	**15,695**	**9,192**	**4,909**	**1,270**	**3,639**

An estimated 2,625 individual marine mammals were detected within source-specific Level B radii that did not require a shutdown (Table 27). The vast majority of these individuals would have potentially been exposed to the Sparker while it was operational (n=2,083), followed by smaller numbers of individuals detected within source-specific Level B radii for the SBP (n=426) and USBL (116).

After excluding all individual marine mammal detections within the 180 m Level B isopleth that resulted in an immediate shutdown, as well as other individuals exposed to lower-energy sounds sources, *the number of estimated Level B exposures for each species was less than the number of Level B incidental takes authorized by NMFS in Ørsted's IHA* (NMFS 2019, Table 26). Additionally, it is useful to note PSO data reflect the assumption that all marine mammals detected by observers were unique (i.e., no recurrent sightings of the same individuals) due to the difficulty of distinguishing individuals within many marine mammal species. It is therefore likely in actuality that PSO teams recorded multiple detections of the same individuals for species that were encountered frequently. This likely occurred for individual common dolphins within the

same calendar day and possibly across numerous days given this species' known attraction to vessels.

Estimates of take as modeled in the Ørsted IHA application and authorized by the NMFS IHA did not consider repeated exposures of unique individuals within the same calendar day. These take estimates do, however, include a "re-set" of potential exposures every 24 hr using the best available densities for the area (Curtice et al. 2018; Roberts et al. 2016a,b, 2017, 2018) coupled with upward adjustments of exposure based on PSO reports from recent Ørsted surveys in the region. Take estimates based solely on the best available densities and a 24-hr re-set period may have underestimated total exposures, thus highlighting the value and incorporation of recent PSO data as an upward correction factor. For future authorizations it would benefit the take authorization process to further consider repeated takes within a day and between days for frequently-observed, ship-attracted species such as common dolphins.

Table 27. Estimated numbers of individual marine mammals detected within source-specific Level B radii without a shutdown by "maximum" source status during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Species	Total No. Individuals w/in 2 m of Active USBL only (No Sparker or SBP) w/out Shutdown	Total No. Individuals w/in 63 m when SBP or USBL Active (No Sparker) w/out Shutdown	Total No. Individuals w/in 141 m when Sparker Active w/out Shutdown	Total No. Individuals w/in Source-Specific Level B Isopleths w/out Shutdown	Numbers of Level B Incidental Takes Authorized per Ørsted's IHA
Mysticete					
Fin Whale	--	--	--	**--**	**52**
Humpback Whale	--	--	--	**--**	**58**
Long-Finned Pilot Whale	--	--	--	**--**	**235**
Minke Whale	--	--	--	**--**	**19**
North Atlantic Right Whale	--	--	--	**--**	**10**
Sei Whale	--	--	--	**--**	**2**
Sperm Whale	--	--	--	**--**	**5**
Unidentified Mysticete Whale	--	--	1	**1**	**N/A**
Odontocete					
Atlantic Spotted Dolphin	--	--	--	**--**	**50**
Bottlenose Dolphin	--	--	3	**3**	**2,357**
Harbor Porpoise	--	--	--	**--**	**2,177**
Risso's Dolphin	--	--	--	**--**	**30**
Short-Beaked Common Dolphin	112	386	2,007	**2,505**	**2,892**
Unidentified Dolphin or Porpoise	4	40	72	**116**	**N/A**
Pinniped					
Gray Seal	--	--	--	**--**	**4,509**
Harbor Seal	--	--	--	**--**	**4,509**
Unidentified Pinniped	--	--	--	**--**	**N/A**
Totals	**116**	**426**	**2,083**	**2,625**	**N/A**

5.8 Protected Species Incident Reports

During the Surveys, six protected species incident reports (Table 28) were filed by PSOs per Appendix A to Addendum "C" of the BOEM Leases. All incident reports filed by PSOs are included in Appendix E (All Appendices provided in separate document).

Table 28. Protected species injury, mortality, and incident reports filed by PSOs during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Date	Vessel	Injury or Mortality Event
07 July 2020	*Searcher*	Potential exposure of humpback whales–80-sec delay turning off the SBP after a shutdown was requested by PSOs
18 July 2020	*Westerly*	Dead unidentified whale
19 July 2020	*Searcher*	Loggerhead entangled in plastic bin and other debris
07 August 2020	*Searcher*	Potential exposure of short-beaked common dolphins by Sparker for 90 sec
17 August 2020	*Searcher*	Dead unidentified whale
11 September 2020	*Dolphin*	Unhealthy whale

Two of the incident reports were for brief, potential exposures of marine mammals (humpback whales and short-beaked common dolphins) to HRG sound below 200 kHz due to miscommunication following shutdown requests by PSOs (Table 28). Two incident reports were for observed dead unidentified whales (Table 28). One non-project-related incident report was filed for an unhealthy humpback whale observed at sea. One incident report was for an unidentified sea turtle entangled in debris.

5.9 Summary of Mitigation Measures

Mitigation measures were implemented for 257 (14%) of the 1,795 marine mammal detections (Table 29). *Shutdown* of HRG sound sources operating below 200 kHz was the most common mitigation measure requested by PSOs and implemented by vessel crews, followed by *detection delay* prior to activation of regulated HRG sources until EZs were deemed clear by PSOs (Table 29). Short-beaked common dolphins were the primary cause of both of these mitigation types (Table 29). One *shutdown* was implemented for a sunfish ("Other" in Table 29); PSOs proactively requested a shutdown for what they originally thought was a sea turtle seen in an area with glare on the water, but cancelled the request when they realized it was a sunfish.

Sixty percent of sea turtle detections required mitigation (Table 30). *Shutdowns* were the primary mitigation measure: 42% of sea turtle detections required a *shutdown* (Table 30).

Table 29. Summary of mitigation measures implemented for marine mammal detections during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Species	Alter Course	Detection Delay	Engine Neutral	Reduce Speed	Shut-down	Other	Total Mitigations	No Mitigation Required
Mysticete								
Fin Whale	1	1	--	--	5	--	**7**	35
Humpback Whale	3	3	1	4	16	--	**27**	142
Long-Finned Pilot Whale	--	--	--	--	--	--	**0**	1
Minke Whale	2	4	1	--	10	--	**17**	34
North Atlantic Right Whale	--	--	--	--	1	--	**1**	3
Sei Whale	--	--	--	--	--	--	**0**	1
Sperm Whale	1	--	--	--	--	--	**1**	1
Unidentified Mysticete Whale	6	4	--	3	10	--	**23**	298
Odontocete								
Atlantic Spotted Dolphin	--	--	--	--	--	--	**0**	2
Bottlenose Dolphin	6	2	--	--	1	--	**9**	55
Harbor Porpoise	--	--	--	--	--	--	**0**	1
Risso's Dolphin	--	--	--	--	--	--	**0**	2
Short-Beaked Common Dolphin	--	59	--	--	62	1	**122**	671
Unidentified Dolphin or Porpoise	--	10	--	--	15	--	**25**	482
Pinniped								
Gray Seal	--	3	--	--	2	--	**5**	41
Harbor Seal	--	10	--	--	2	--	**12**	9
Unidentified Pinniped	1	3	--	--	3	--	**7**	17
Other[1]	--	--	--	--	1	--	**1**	--
Total	**20**	**99**	**2**	**7**	**128**	**1**	**257**	**1,795**

[1] Other = Sunfish. See text for details.

Table 30. Summary of mitigation measures implemented for sea turtle detections during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Species	Alter Course	Detection Delay	Reduce Speed	Shutdown	Total Mitigations	No Mitigation Required
Green Sea Turtle	--	--	--	2	**2**	1
Hawksbill Sea Turtle	--	--	--	--	**0**	1
Kemp's-Ridley Sea Turtle	--	1	--	--	**1**	--
Leatherback Sea Turtle	1	1	3	5	**10**	6
Loggerhead Sea Turtle	--	1	--	10	**11**	3
Unidentified Sea Turtle	--	2	--	4	**6**	9
Total	**1**	**5**	**3**	**21**	**30**	**20**

5.10 Unusual Biological Events

There were no unusual biological events reported by PSOs during the Survey.

6 Monitoring Device Effectiveness

Marine mammal detection and PSO Effort data were combined in this section for analysis of the relative effectiveness of monitoring devices during Surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Data were analyzed by monitoring device and by species group. Analysis is presented separately for offshore and nearshore vessels because the two nearshore vessels (*Westerly* and *Dolphin*) surveyed only in *Daylight* and used only the UE and RB; no additional monitoring devices were necessary. Therefore, no analysis of monitoring devices is appropriate for the nearshore vessel data.

It is important to note that pooled detection and effort data for all vessels summarized herein were not collected across the same temporal or spatial scales. Rather, data were collected opportunistically by PSOs as Survey vessels rotated in and out of the Surveys across multiple seasons in different, localized environments. Additionally, a host of vessel-specific variables, from platform height above the water to configuration of monitoring and Survey equipment, could not be controlled for in the following analyses. The lack of standardized, systematic sampling across numerous Survey vessels precludes the ability to make robust, quantitative comparisons between different monitoring methods and devices. All results presented below should be interpreted as a relative assessment of the effectiveness of each monitoring device, as required by regulatory reporting stipulations.

Please note that any discrepancies in table totals are due to rounding.

6.1 Monitoring Techniques Overview

During the offshore Surveys, five complementary methods were used to monitor for protected species, some of which were used simultaneously (see Section 4 for more detail on devices and monitoring protocol):

1) Unaided Eye (UE):
    a. During *Daylight*: UE (with systematic use of reticle binoculars [RB]),
    b. During *Darkness*: UE via artificial illumination from the vessel lights,
2) Handheld night vision devices (NVDs) during *Darkness*,
3) Handheld infrared (HH IR) devices during *Darkness* (and some periods of *Daylight* at twilight),
4) Passive acoustic monitoring (PAM) during *Darkness*, and
5) Mounted IR devices during *Darkness* (and some periods of *Daylight* at twilight). Data for the three mounted IR camera systems (Current Corp IR, NVTS IR, and Seiche IR) were combined for analysis and are referred to here as "mounted IR."

Only the UE and RB were used on the nearshore Surveys, as they were conducted only in *Daylight*.

The monitoring method in use when a marine mammal was first detected (i.e., Initial Detection Method) was recorded by PSOs, as well as any subsequent methods used to confirm the initial detection. All detection rates presented herein are based on the monitoring method used at the time of initial detection; thus, "detections" here refer to initial detections and not subsequent detections, unless otherwise noted. A comprehensive list of all marine mammal and sea turtle detections during the Survey,

along with the monitoring method used to detect each of them, is presented in Appendix G (All Appendices provided in separate document) as required by the BOEM Leases and 2019 Ørsted IHA. However, only detections of marine mammals were used to analyze device monitoring effectiveness in this section.

6.1.1 Initial Detection Distance

A wide range of factors is known to influence the "detectability" of, and distance at which, a marine mammal is most likely to be detected. These include environmental and operational variables, animal behavior, and the type of monitoring method.

6.1.1.1 *Offshore Surveys*

There was a total of 1,904 initial detections of marine mammals during the offshore Surveys (Figure 63). The majority of detections (64%) were made initially with a combination of the UE and RB, corresponding with most PSO Effort conducted with the UE (Figure 63). Relatively few detections were made initially with HH IR devices and mounted IR camera systems (Figure 63).

- Initial detection distance ranged from 0.5 to 7,941 m, with a median of 541 m (Figure 64).
- The greatest proportion of detections by each monitoring device except PAM was made within 100 m of the vessels (Figure 64).
- The maximum initial detection distance was 7,500 m using the UE, 7,941 m with RBs, 1,000 m with NVDs, 400 m with HH IR, and 1,500 m with mounted IR (Figure 64).
- Fifteen odontocetes were initially detected by Auditory means (i.e., PSOs heard a blow or splash); Auditory detections are classified as Other in Figure 63. All auditory detections were within 50 m of the vessels (Figure 64).
- The majority of detections during *Darkness* were within 50 m of the vessels (Figure 65; Figure 66).
- Combining all detection methods, marine mammals were detected notably closer to the vessels during *Darkness* than during *Daylight* (Figure 65; Figure 66).
- Mysticetes were initially detected significantly further from the vessels than odontocetes and pinnipeds. A Kruskal-Wallis test showed that at the 0.05 confidence level there was a statistically significant difference in initial detection distance between the three species groups, $\chi^2(2) = 620.51$, $p < 2.2e\text{-}16$. A post hoc analysis comparing the groups found a significant difference between the initial detection distance of mysticetes compared to odontocetes (unadjusted p = 2.71e-135) and mysticetes compared to pinnipeds (unadjusted p = 2.74e-19), but not for odontocetes compared to pinnipeds (unadjusted p = 0.36).

6.1.1.2 *Nearshore Surveys*

The *Westerly* and *Dolphin* conducted daytime-only surveys in nearshore waters without the use of alternative monitoring devices (e.g., no NVDs, IR, or PAM). Of the 90 detections made from the *Westerly*, only one was detected initially with RB; the rest were detected with the UE. All 52 detections made from the *Dolphin* were made with the UE, so no meaningful analysis of monitoring devices is possible for nearshore surveys.

Initial detection distances of all marine mammal species combined from the two nearshore Survey vessels were fairly evenly distributed throughout the 500-m EZ (Figure 69). Pinnipeds were detected primarily within 300 m of the vessels, notably closer than mysticetes or odontocetes; mysticetes were detected farther on average than pinnipeds or odontocetes (Figure 70; Figure 71). Odontocetes were detected primarily between 200 and 500 m (Figure 70; Figure 71).

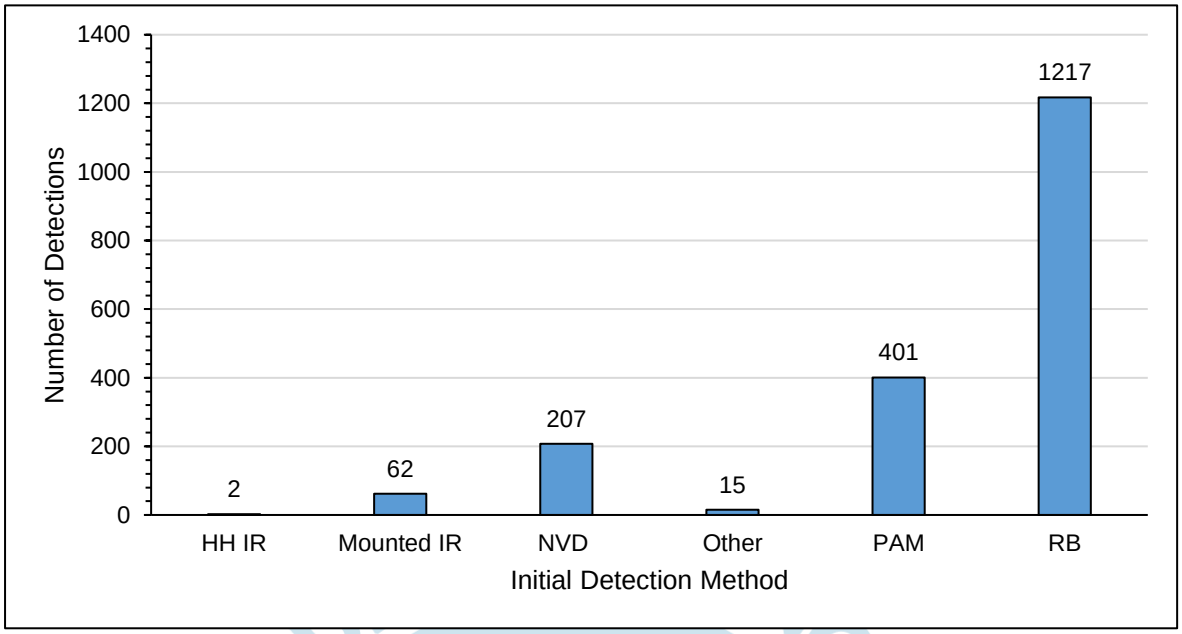

Figure 63. Number of initial detections of marine mammals by monitoring method from *offshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Monitoring methods included handheld infrared devices (HH IR), ship-mounted infrared camera systems (mounted IR; includes Current Corp IR, NVTS IR, and Seiche IR), night vision devices (NVDs), passive acoustic monitoring (PAM; only PAM detections subsequently detected by another method are included in distance data), and reticle binoculars (RB; includes initial detections made with the unaided eye [UE]).

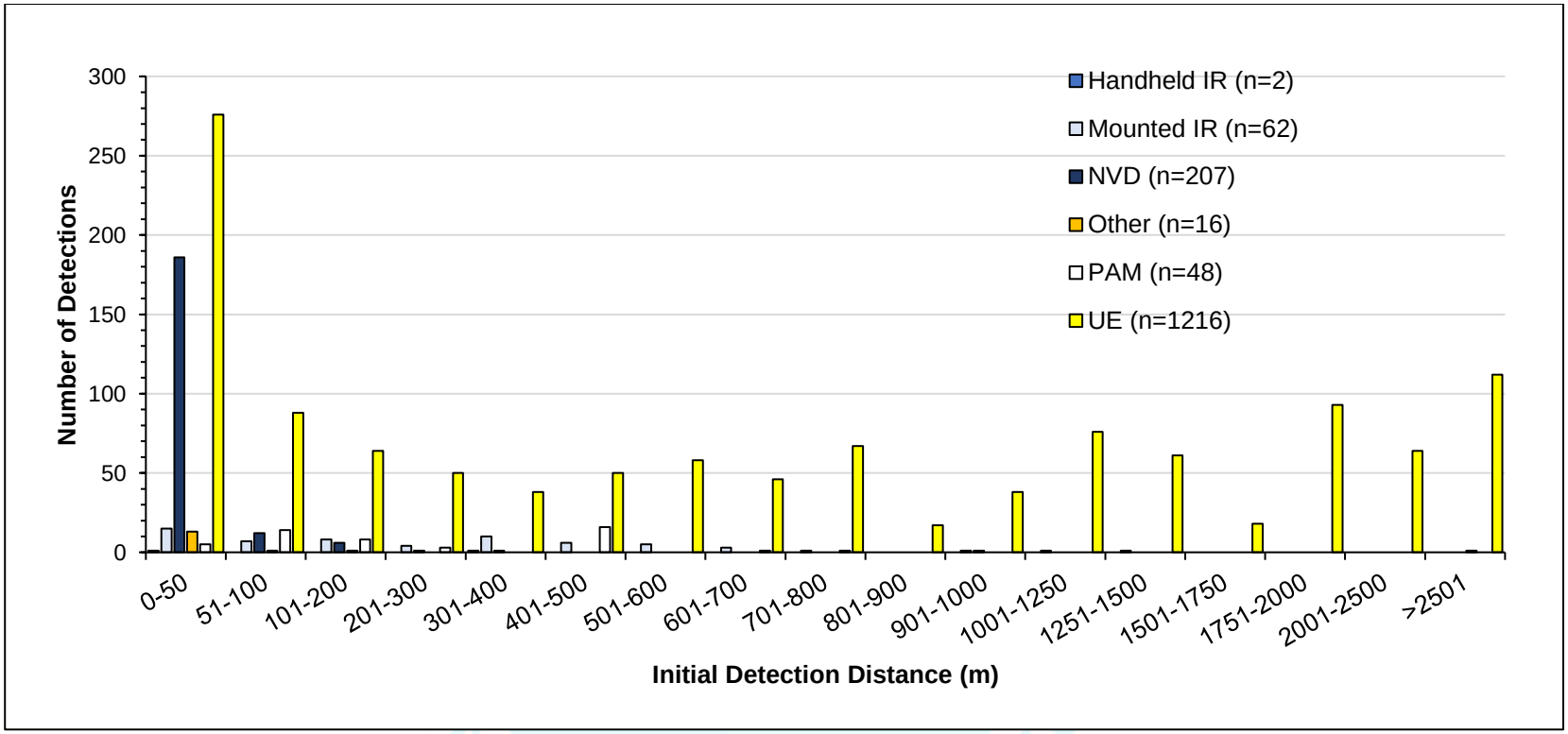

Figure 64. Initial detection distance of marine mammals by monitoring method from *offshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Monitoring methods included handheld infrared devices (handheld IR), ship-mounted infrared camera systems (mounted IR; includes Current Corp IR, NVTS IR, and Seiche IR), night vision devices (NVDs), passive acoustic monitoring (PAM; only PAM detections subsequently detected by another method are included in distance data), unaided eye (UE; includes initial detections made with reticle binoculars), and Other (methods not categorized elsewhere, including Auditory).

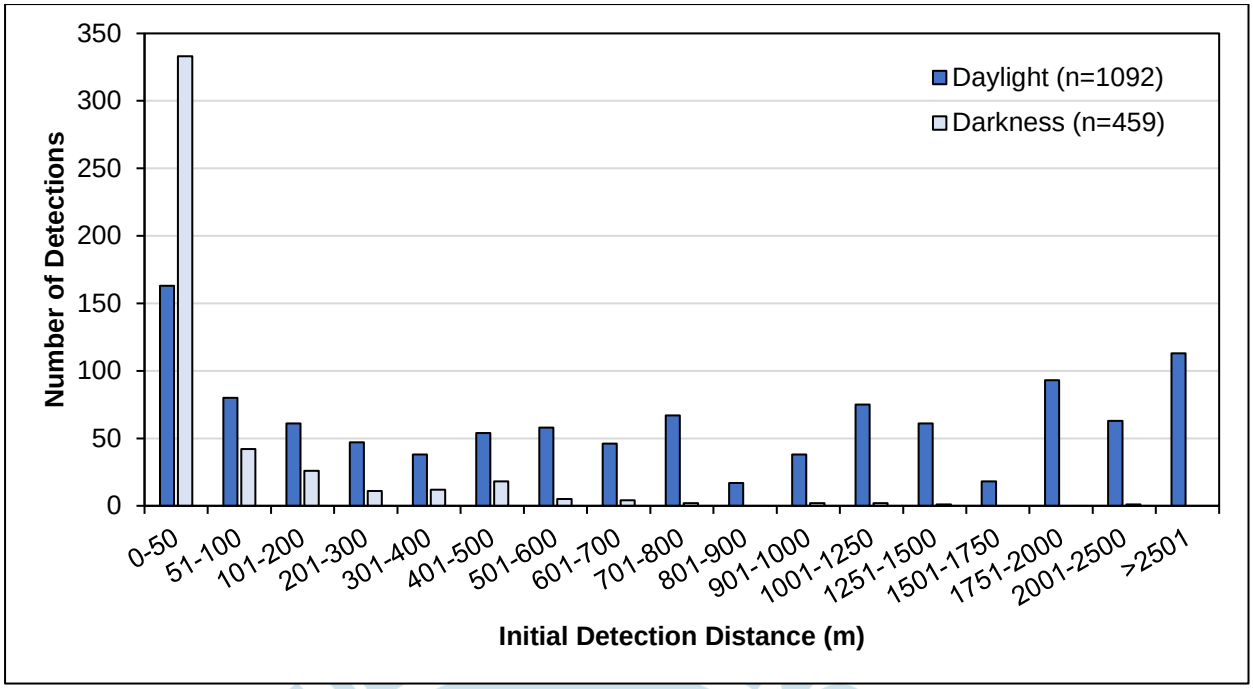

Figure 65. Initial detection distance of marine mammal detections from *offshore* vessels during periods of *Daylight* and *Darkness* during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Passive acoustic monitoring (PAM) detections with no distance associated are omitted.

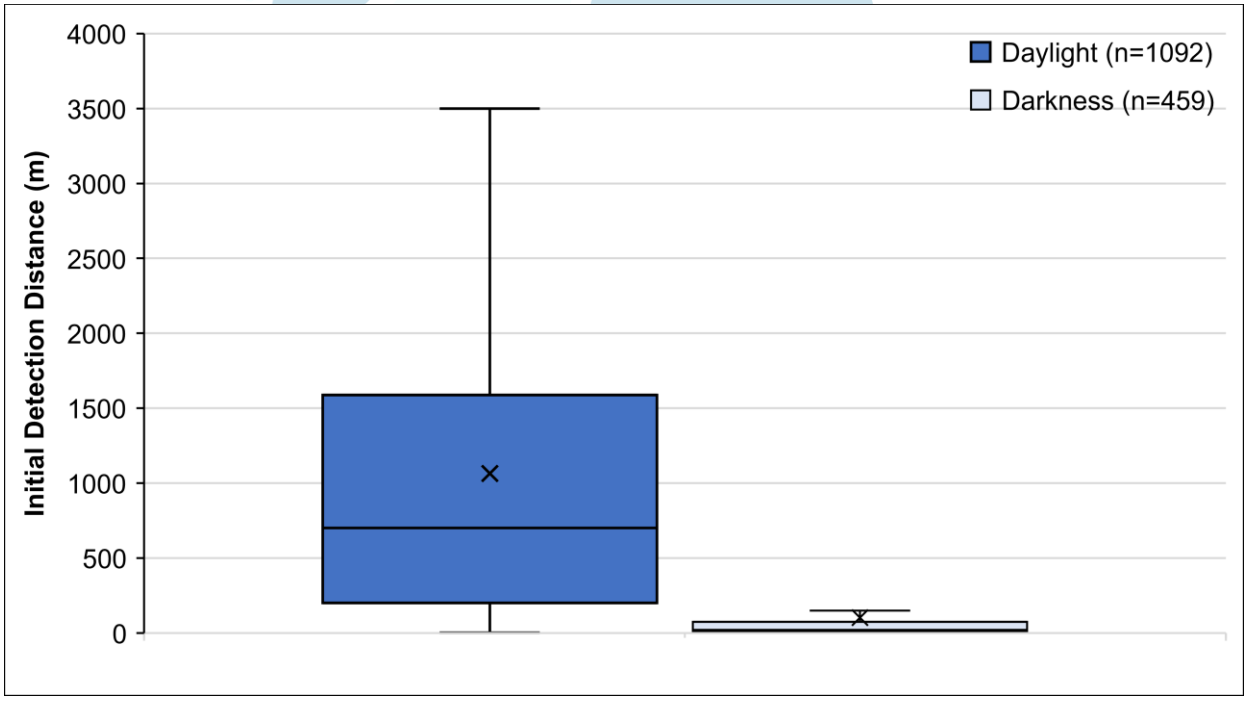

Figure 66. Box and whiskers plot of initial detection distances of marine mammal detections from *offshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). The horizontal line within the box indicates the median, the "X" within the box indicates the mean, boundaries of the box indicate the 25th and 75th quartiles, and the whiskers indicate the full range of the results. Passive acoustic monitoring (PAM) detections with no distance associated are omitted.

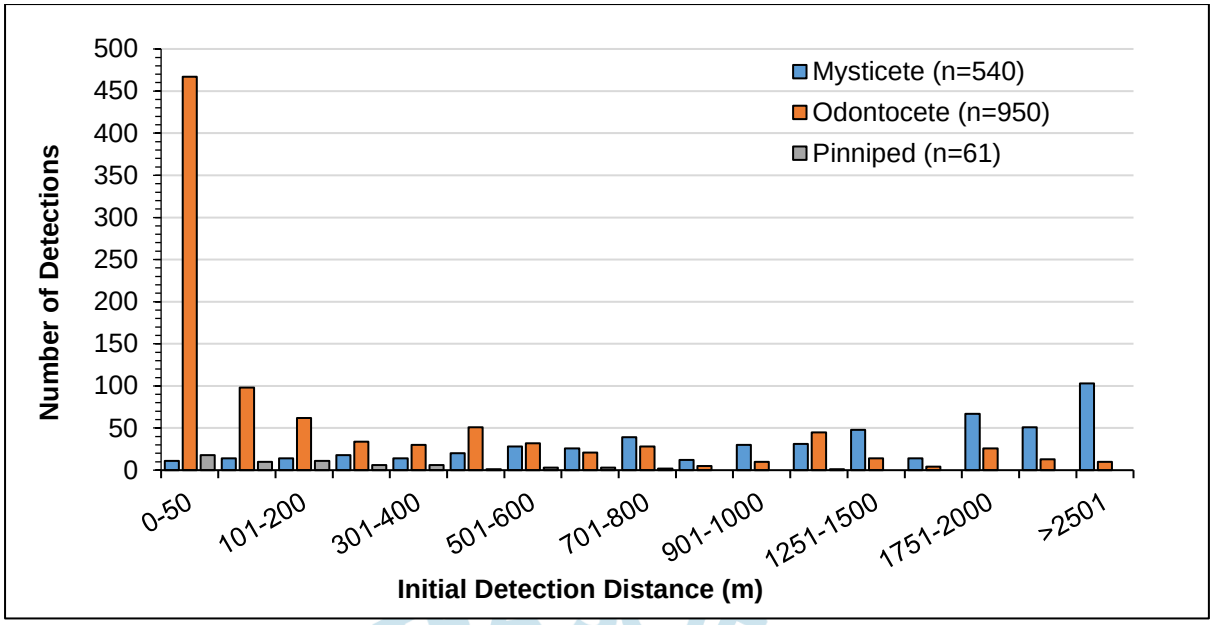

Figure 67. Initial detection distance of marine mammal detections by species from *offshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Passive acoustic monitoring (PAM) detections with no distance associated are omitted.

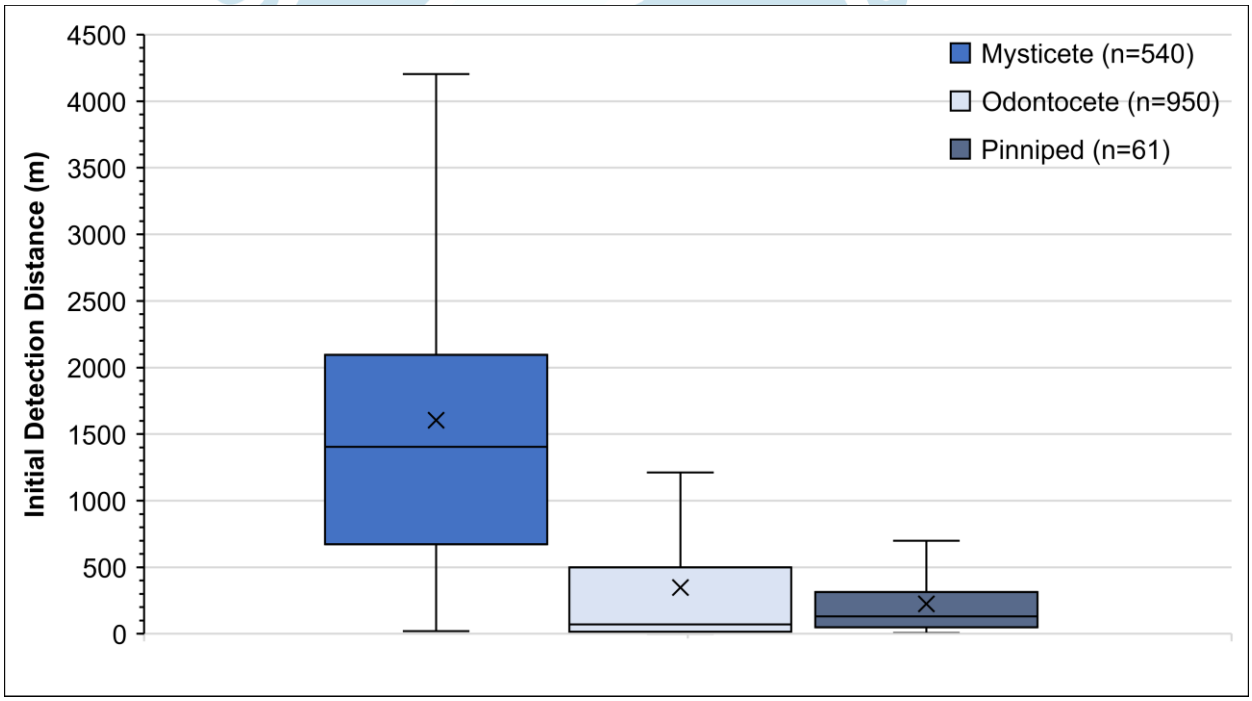

Figure 68. Box and whiskers plot of initial detection distances of all marine mammal detections by species from *offshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). The horizontal line within the box indicates the median, the "X" within the box indicates the mean, boundaries of the box indicate the 25th and 75th quartiles, and the whiskers indicate the full range of the results. Passive acoustic monitoring (PAM) detections with no distance associated are omitted.

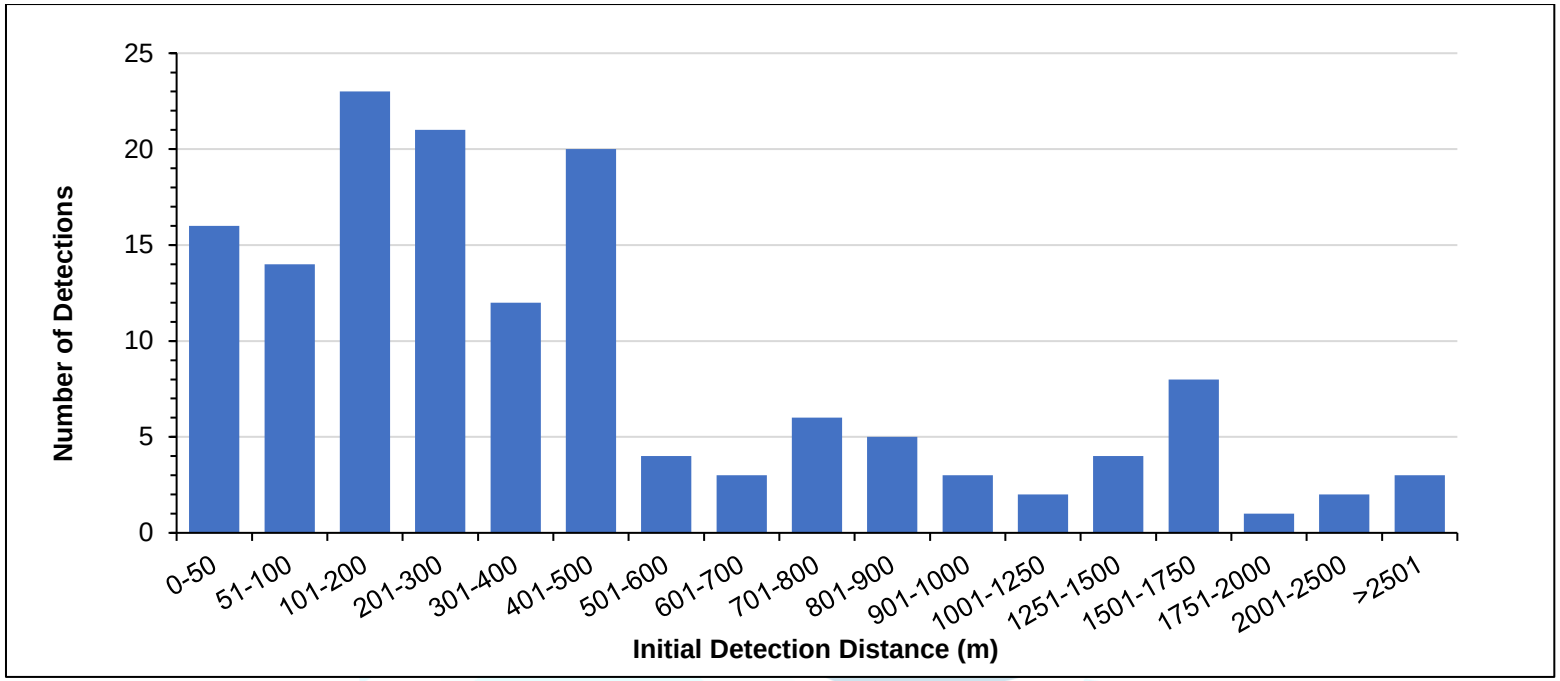

Figure 69. Initial detection distance of marine mammal detections from *nearshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Monitoring methods included only the unaided eye (UE) and reticle binoculars (RB), combined here (n=1,216).

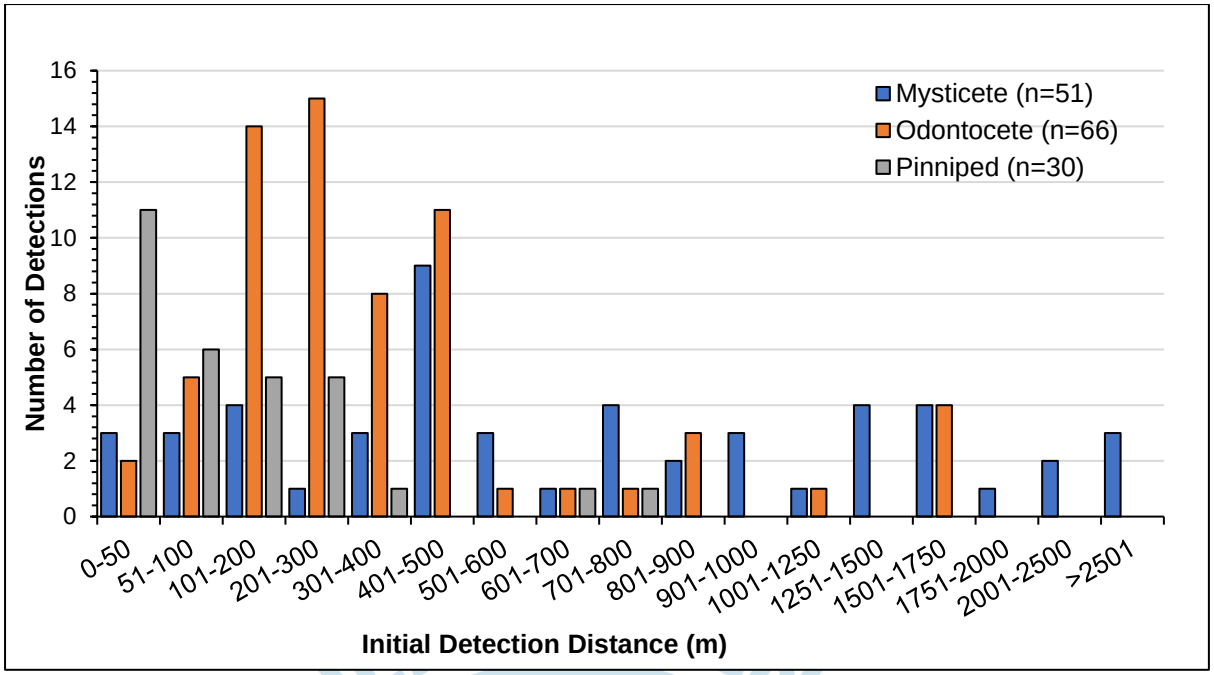

Figure 70. Initial detection distance of marine mammal detections by species from *nearshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

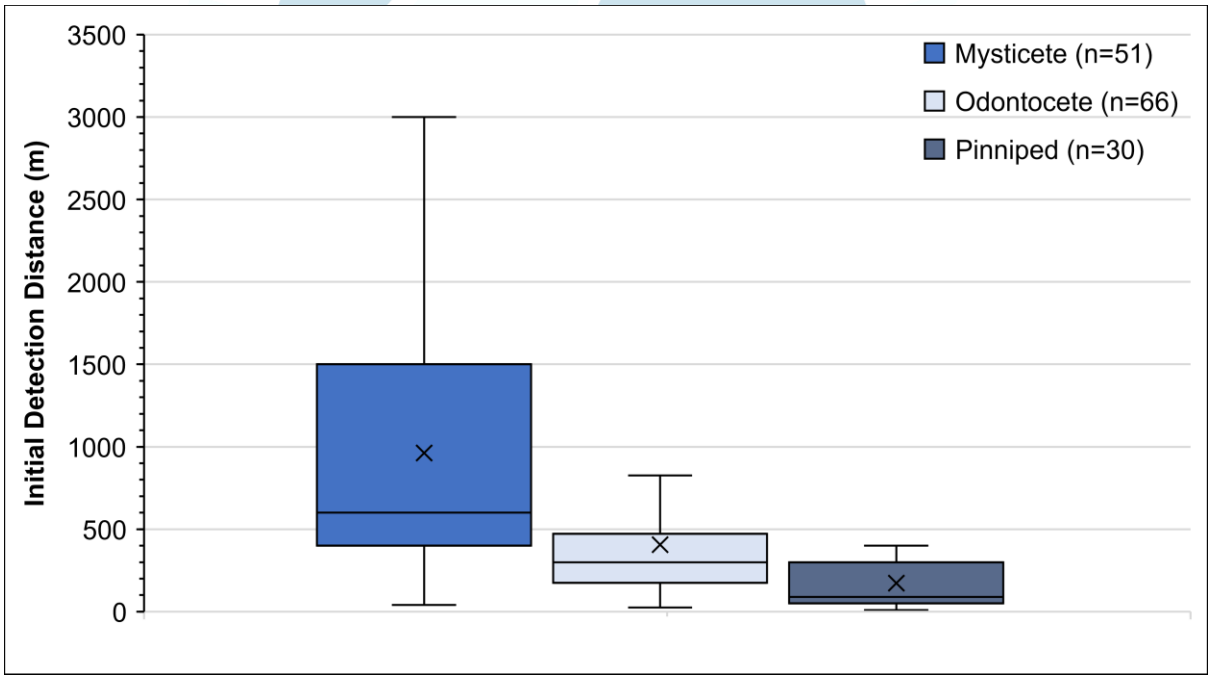

Figure 71. Box and whiskers plot of initial detection distances of all marine mammal detections by species from *nearshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). The horizontal line within the box indicates the median, the "X" within the box indicates the mean, boundaries of the box indicate the 25th and 75th quartiles, and the whiskers indicate the full range of the results.

6.1.2 Detection Rates by Device

To assess the effectiveness of the monitoring devices and standardize for different amounts of PSO Effort by device, we compared detection rates per 1,000 h of PSO Effort for each device. When PSOs enter monitoring method as NVD or HH IR into *Mysticetus* for an effort entry, the full period of that PSO Effort is attributed to that detection method. However, PSOs only use NVDs and HH IRs for a proportion of the PSO Effort period. For the purposes of analysis herein, 50% of every NVD and HH IR hour is apportioned to UE effort. Therefore, total PSO Effort hours for the different monitoring methods do not match PSO Effort hours in previous sections. Animals initially detected with RB or UE are combined into a single "RB" category for the purpose of detection rate calculations and comparison with other monitoring devices.

6.1.2.1 *Offshore Surveys*

In addition to the five monitoring methods listed in Section 6.1, there were times when PSOs monitoring outside in favorable conditions first *heard* marine mammals adjacent to the vessel before confirming them visually (Auditory detections were grouped into "Other" in Figure 64). These 15 auditory detections occurred in *Darkness*, all within 50 m of the vessels. It is difficult to accurately quantify PSO "listening effort" necessary to calculate an "auditory detection rate." Therefore these 15 auditory detections have been excluded from analysis of detection rates. It is worth noting, however, that PSOs may occasionally first detect a marine mammal aurally when conditions are favorable and animals are close enough to the vessel to be heard before they are seen. Bowriding dolphins near the vessel were the most commonly "heard" marine mammals by visual PSOs monitoring outside.

General results include:

- Overall and during *Darkness*, PAM had the highest detection rate (Table 31). NVDs were half as effective as PAM in making detections during *Darkness*; HH IR devices were the least effective (Table 31).
- During *Daylight*, PAM was nearly as effective as the UE.
- There were no detections with HH IR devices, mounted IR, or NVDs during *Daylight* (periods of twilight), but there was very little PSO Effort with these devices during this time; Table 31).
- Mounted IR camera systems (pooling data for Current Corp IR, NVTS IR, and Seiche IR) detected marine mammals at a relatively low rate despite more PSO Effort with the mounted IR systems than with NVDs or PAM (Table 31).
- Odontocetes, short-beaked common dolphins in particular, had the highest detection rate of marine mammals (Table 32).
- Short-beaked common dolphins had the highest detection rate of any marine mammal with every monitoring device (Table 32).

Further analysis of detection distance and detection rates follows in Section 6.2 through 6.5.

6.1.2.2 *Nearshore Surveys*

As the nearshore surveys were specifically daytime-only, there was only one hour of PSO Effort conducted in *Darkness* (Table 33). The overall detection rate of 147 detections per 1,000 PSO Effort hours was therefore that of the UE and RB during *Daylight*. Bottlenose dolphins had the highest detection rate with UE/RB, followed by humpback whales (Table 34).

Table 31. Detection rates (number of initial detections per 1,000 PSO Effort hours) of all marine mammal detections by detection method during periods of *Daylight* and *Darkness* from *offshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Initial Detection Method	Daylight			Darkness			Overall		
	PSO Effort Hours[1]	No. Initial Detections	Detection Rate	PSO Effort Hours	No. Initial Detections	Detection Rate	PSO Effort Hours	No. Initial Detections	Detection Rate
HH IR[2]	4	--	--	573	2	3	**577**	**2**	**3**
Mounted IR[3]	199	--	--	3,697	62	17	**3,896**	**62**	**16**
NVD[4]	8	--	--	3,268	207	63	**3,275**	**207**	**63**
PAM[5]	286	26	91	2,960	375	127	**3,246**	**401**	**124**
RB[6]	10,806	1,087	101	3,917	129	33	**14,722**	**1,216**	**83**
Total	**11,302**	**1,113**	**99**	**14,415**	**775**	**54**	**25,717**	**1,888**	**73**

[1] PSO Effort includes simultaneously occurring effort, representing totals for each person on watch by method.
[2] HH IR = handheld infrared device
[3] Mounted IR = ship-mounted IR camera systems. Includes combined data for Current Corp IR, NVTS IR, and Seiche IR.
[4] NVD = handheld night vision device
[5] PAM = passive acoustic monitoring
[6] RB = unaided eye with systematic use of reticle binoculars

Table 32. Detection rates (number of initial detections per 1,000 PSO Effort hours) of all marine mammal detections by detection method, pooled for *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 and for *Daylight* and *Darkness* from *offshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). Excludes Auditory and Other detection methods for which PSO Effort could not be measured.

Species	Mounted IR[1] (3,896 Effort Hours[2])		HH IR[3] (577 Effort Hours)		NVD[4] (3,275 Effort Hours)		PAM[5] (3,246 Effort Hours)		RB[6] (14,722 Effort Hours)		Overall (21,821 Effort Hours)	
	No. Detections	Detection Rate	No. Detections	Detection Rate	No. Detections	Detection Rate	No. Detections	Detection Rate	No. Detections	Detection Rate	No. Detections	Detection Rate
Mysticete												
Fin Whale	--	--	--	--	--	--	--	--	42	3	**42**	**2**
Humpback Whale	--	--	--	--	1	0	--	--	134	9	**135**	**5**
Long-Finned Pilot Whale	--	--	--	--	--	--	--	--	1	0	**1**	**0**
Minke Whale	--	--	--	--	1	0	--	--	45	3	**46**	**2**
North Atlantic Right Whale	--	--	--	--	--	--	--	--	4	0	**4**	**0**
Sei Whale	--	--	--	--	--	--	--	--	1	0	**1**	**0**
Sperm Whale	--	--	--	--	--	--	--	--	2	0	**2**	**0**
Unidentified Mysticete Whale	2	1	--	--	1	0	--	--	305	21	**308**	**12**
Odontocete												
Atlantic Spotted Dolphin	--	--	--	--	--	--	--	--	2	0	**2**	**0**
Bottlenose Dolphin	--	--	--	--	--	--	--	--	15	1	**15**	**1**
Harbor Porpoise	--	--	--	--	--	--	1	0	0	0	**1**	**0**
Risso's Dolphin	--	--	--	--	--	--	--	--	2	0	**2**	**0**
Short-Beaked Common Dolphin	23	6	1	2	169	52	99	30	492	33	**784**	**30**
Unidentified Dolphin or Porpoise	36	9	1	2	34	10	301	93	112	8	**484**	**19**
Pinniped												
Gray Seal	1	0	--	--	--	--	--	--	44	3	**45**	**2**
Harbor Seal	--	--	--	--	1	0	--	--	5	0	**6**	**0**
Unidentified Pinniped	--	--	--	--	--	--	--	--	10	1	**10**	**0**
Total	**62**	**16**	**2**	**3**	**207**	**63**	**401**	**124**	**1,216**	**83**	**1,888**	**73**

[1] Mounted IR = ship-mounted IR camera systems. Includes combined data for Current Corp IR, NVTS IR, and Seiche IR.
[2] PSO Effort includes simultaneously occurring effort, representing totals for each person on watch by method.
[3] HH IR = handheld infrared device
[4] NVD = handheld night vision device
[5] PAM = passive acoustic monitoring
[6] RB = unaided eye with systematic use of reticle binoculars.

Table 33. Detection rates (number of initial detections per 1,000 PSO Effort hours) of all marine mammal detections by detection method during periods of *Daylight* and *Darkness* from *nearshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019).

Initial Detection Method	Daylight			Darkness			Overall		
	PSO Effort Hours[1]	No. Initial Detections	Detection Rate	PSO Effort Hours	No. Initial Detections	Detection Rate	PSO Effort Hours	No. Initial Detections	Detection Rate
RB[2]	1,172	147	125	1	0	0	**1,173**	**147**	**125**
Total	**1,172**	**147**	**125**	**1**	**0**	**0**	**1,173**	**147**	**125**

[1] PSO Effort includes simultaneously occurring effort, representing totals for each person on watch by method.
[2] RB = unaided eye with systematic use of reticle binoculars

Table 34. Detection rates (number of initial detections per 1,000 PSO Effort hours) of all marine mammal detections by detection method, for *Inside* and *Outside* the Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500 from *nearshore* vessels during surveys conducted under the 2019 Ørsted Incidental Harassment Authorization (NMFS 2019). All detections were made during *Daylight* with the unaided eye (UE) with systematic use of reticle binoculars (RB).

Species	UE (1,173 Effort Hours)	
	No. Detections	Detection Rate
Mysticete		
Humpback Whale	34	29
Minke Whale	5	4
Unidentified Mysticete Whale	12	10
Odontocete		
Bottlenose Dolphin	49	42
Unidentified Dolphin or Porpoise	17	14
Pinniped		
Gray Seal	1	1
Harbor Seal	15	13
Unidentified Pinniped	14	12
Total	**147**	**125**

6.2 *Unaided Eye (UE) with Binoculars during* Daylight *versus* Darkness

6.2.1 During Daylight: UE (with Systematic Use of Reticle Binoculars [RB])

PSOs primarily used the UE with binoculars during *Daylight* (96% of PSO Effort in *Daylight*; Table 31). Only the UE and PAM made detections during *Daylight* (Table 31).

The UE combined with RBs made 64% of all detections (Table 31), primarily at distances greater than 200 m. RBs were the most useful for obtaining more detail on detections including taxonomic identification, group size and composition, behavior, and for distance estimation.

6.2.2 During *Darkness*: UE via Artificial Illumination from Vessel Lights

PSOs occasionally monitored with the UE during *Darkness* when the water around the vessels was illuminated by the vessels' lights or strong moonlight. The UE during these times yielded a detection rate of 33 marine mammals per 1,000 h of PSO Effort, much lower than the detection rate of 101 animals per 1,000 h for UE during *Daylight* (Table 31). Overall, the PSOs reported the following conditions reduced effectiveness of the UE:

- High sea state (Bft higher than 4)
- Darkness with no ambient light
- Moisture in the air (e.g., fog or severe haze)

6.3 *Night Vision Devices (NVDs) during* Daylight *versus* Darkness

NVDs enhance small amounts of light to project an image. As such, they are very sensitive to just the right amount of ambient light: too much and the image is whited out, too little and no image can be projected.

NVDs were used for only 8 h during *Daylight* (i.e., twilight) with no detections. However, during *Darkness*, NVDs resulted in a moderate detection rate of 63 animals per 1,000 h of PSO Effort, the highest detection rate for visual/optical devices (Table 31). NVDs were thus considered relatively very effective at monitoring in darkness.

PSOs reported the following conditions reduced their perceived effectiveness of the NVDs:

- Degree of background light: Effective scanning with the NVDs within the area strongly illuminated by the vessel's floodlights (abeam and astern) was less effective than scanning with the UE in those areas–the strong floodlights resulted in a grainy field of view due to substantial light interference.
- Ambient light: The clearest images through the NVDs occurred during clear skies with no or minimal clouds and full- or nearly full-moon conditions. New moon phases were considered less effective conditions for NVD use as were overcast skies due to low ambient light.
- Reflectivity of the windows inside the bridge: PSOs on previous surveys reported that NVDs had reduced effectiveness inside the bridge at night when the interior bridge

lights and/or computer monitors were on full brightness. These bright interior lights reflected in the bridge windows, causing the image seen through the NVDs to be compromised or interfered by other images. PSOs on this survey either asked the bridge that all interior lights be turned off, or placed the NVDs directly against the window, cupping their hands around it to reduce reflection. Both solutions made the NVDs effective from inside the bridge.

- Poor weather conditions: High Bft (higher than Bft 4), fog, rain, and severe haze made it difficult to differentiate detections among the whitecaps or through the moisture in these weather conditions.

6.4 Infrared (IR) Devices during Daylight *and* Darkness

IR devices detect infrared light emitted by objects and convert this temperature pattern into an image. IR devices are not very light sensitive unless the light source emits heat. Thus, IR devices are useful for viewing waters lit by vessel lights and very dark conditions that cannot be viewed with NVDs.

6.4.1 Handheld Infrared (HH IR) Devices

There were no detections made with HH IR devices in *Daylight* and a detection rate of only four marine mammals per 1,000 PSO Effort hours during *Darkness* (Table 31), resulting in very low perceived effectiveness of HH IRs by PSOs. PSOs reported the following conditions reduced the effectiveness of HH IRs and pointed to these issues as the reasons they were used for only 577 h overall (2% of PSO Effort; Table 31):

- Reflectivity of the windows inside the bridge: During *Darkness*, in inclement weather and other periods when monitoring from outside on the bridge wings was deemed unsafe, the HH IR devices had reduced effectiveness from inside the bridge because heat reflected off the inside of the windows compromised the IR image.
- Poor weather conditions: High Bft, fog, rain, and severe haze. The HH IR device was difficult to keep steady during rough sea conditions (e.g., Bft higher than 4, large swells) given its narrow field of view and its relatively heavy weight. The optics were compromised by moisture in the air.
- The FLIR BHM XR+ bi-ocular used on the *Ocean Researcher* had a slow update rate which made it difficult to find and track animals.
- The FLIR Scout 640 monocular used on the *Searcher*, *Enterprise*, *Discovery*, and *Kommandor Iona* had a narrow FOV and the image tended to blur while PSOs scanned. These two constraints rendered the HH IR ineffective for viewing smaller, faster odontocetes near the vessels.

6.4.2 Mounted Infrared (IR) Camera Systems

Data for the Current Corp IR, NVTS IR, and Seiche IR mounted camera systems were combined for analysis of monitoring effectiveness, but PSOs gave feedback on the particular mounted IR camera system they used on their vessel.

Mounted IR camera systems did not detect any marine mammals during *Daylight*, but were used for only 199 h outside of *Darkness* (Table 31). The detection rate of 17 marine mammals per 1,000 PSO Effort hours during *Darkness* was the second lowest detection rate (above HH IR), and almost four times lower than that for NVDs in *Darkness* (Table 31). Mounted IR systems were, however, able to detect marine mammals across a wide range of distances from 1 to 1,500 m, which proved useful for monitoring exclusion zones (EZ) near

the vessel as well as areas ahead of the vessel while transiting to reduce the potential of a vessel strike.

PSOs reported the following limitations aboard some vessels when using mounted IR systems (note that these limitations were not consistent across all three camera systems or even among vessels with the same camera system, as each vessel layout was unique):

- Blind spots, due in part to objects on some vessels (e.g., exhaust stacks).
- Need to shut down and reboot systems periodically.
- Zoom and focus were difficult to use at times (Current Corp IR); had to be monitored and calibrated.
- No zoom function and limited focus control (Seiche IR).
- Joystick sensitivity: Could alternately be too sensitive or lagging in response (Current Corp IR).
- Limited field of view: Panning the cameras down too far to view animals close to the hull meant that the horizon could not be seen at the same time. Without a visible horizon, the Seiche IR system lost range-finding capabilities of the RADES software.
- Software/Hardware glitches: In high waves and/or swells, it was sometimes difficult to view the displayed EZ line plotted by the RADES software, and occasional software/hardware glitches compromised the functionality of the EZ line display (Seiche IR). Because the cameras were on a fixed mount, they didn't account for vessel pitch and roll in high seas, so the image could be blurry and hard to focus (Seiche IR, NVTS IR). Occasionally the image would freeze or invert, and the system would have to be reset (Seiche IR).
- Large video file size: So large as to be cumbersome and not easily transferable.

6.5 PAM during Daylight *and* Darkness

PAM had almost as high of a detection rate during *Daylight* as the UE (plus binoculars), and was by far the most effective monitoring device during *Darkness* (detection rate of 127 marine mammals per 1,000 PSO Effort hours; Table 31). PAM only detected odontocetes during the Surveys, although it did so at a higher detection rate than any other monitoring method (Table 32). However, as it is generally not possible to determine distance to a PAM detection (i.e., localize), a subsequent, visual detection method was needed to confirm if it was within the EZ. Eleven percent (33 detections) of PAM detections were subsequently detected using a visual monitoring method, and consequently could be associated with a detection distance.

6.6 Comparison of Detection Method Effectiveness

A wide range of factors is known to influence the "detectability" of, and distance at which, a marine mammal is most likely to be detected. These include environmental and operational variables, animal behavior, and the type of monitoring method. As noted above, the following results summary is intended to provide a relative assessment of detection methods across a wide range of non-standardized temporal and spatial sampling scales, as well as across a wide range of environmental and operational conditions, to address regulatory reporting requirements and inform future management decisions. Because vastly more data and types of monitoring devices were available for offshore vessels compared to the two nearshore vessels, results here address only offshore monitoring results unless

specifically noted.

Given the caveats addressed above, PAM and the UE were the most effective monitoring methods during *Daylight* during the offshore Surveys. UE during *Darkness* (limited to areas illuminated by vessel operating lights and clear nights with strong moonlight) was less effective than during *Daylight*, as expected: it is easier to see more marine mammals and at farther distances in *Daylight*. Thus, PSOs primarily used alternate monitoring devices in *Darkness* (i.e., NVDs, HH IR, mounted IR, and PAM).

Both NVDs and HH IR devices were sensitive to reflections (light or heat, respectively) off the inside of the bridge windows. In addition, both types of device (including mounted IR cameras) were compromised by adverse weather conditions (high sea state or moisture in the air), as was the UE. During *Darkness*, when conditions made monitoring with the UE ineffectual (i.e., in areas with little or no illumination by vessel lights), NVDs appeared to be more useful than HH IR devices. The image seen through NVDs was consistently clearer than that seen through HH IR devices under the same environmental conditions and, under some circumstances, allowed PSOs to detect color gradations on animal skin, sometimes facilitating species identification of close detections (within 100–150 m). The larger FOV of the NVDs was considered more effective than the narrower FOV of the HH IR devices. NVDs were also easy to maneuver and quick to focus. The HH IR devices did, however, prove superior to the NVDs under one condition: in areas adjacent to the vessel lit by the vessel's floodlights, the ambient light rendered the NVDs almost completely ineffective, whereas the HH IR devices were unaffected. These results underscore the importance of providing PSOs with multiple device types for pairing with appropriate environmental and operational conditions.

The HH IR device was used for only 577 h (2% of PSO effort) during the Survey; this limited effort precludes robust analysis of its effectiveness relative to other devices; however, HH IR was used very infrequently because PSOs chose other monitoring devices due to the limitations of HH IR devices discussed above. These results suggest HH IR devices are not preferred by PSOs except in cases when excessive ambient light renders NVDs ineffective.

Some models of ship-mounted IR cameras have been shown to be very effective monitoring devices in *Darkness* for marine mammals (Gauthier-Barrette et al. 2019), as results from these Surveys also demonstrate. As in past surveys, the mounted IR camera systems demonstrated a wide range of detection distances (1 to 1,500 m). The 1,500-m detection demonstrates that the mounted IR camera systems are capable of detecting whales and dolphins at much greater distances than other visual monitoring methods used in *Darkness* on these Surveys (i.e., NVDs and HH IR devices). Previous surveys (e.g., Smultea et al. 2019) have indicated that the Seiche IR camera system rarely detected sightings within 100–200 m of the vessel during US Atlantic G&G surveys. However, the effective field of view of the Seiche IR system onboard the *Discovery* and *Kommandor Iona* appeared to be as close as 1 m from the vessel. This is most likely due to the difference in vessel configuration and mounting location of the cameras.

Feedback from the PSOs was mixed regarding the functionality of the two mounted IR systems. Some preferred the Seiche IR system for its user-friendly interface, integrated unit of electronics, autofocus capabilities, EZ line demarcated on the screen (although this was often problematic in high seas, as discussed above), and ease of video playback to confirm

sightings. However, the Seiche IR did not have zoom capability. Some PSOs preferred the Current Corp IR system for its optical zoom and learned how to streamline the potentially complicated start-up processes. As the Current Corp IR system lacked the EZ demarcation line, some PSOs made a "demarcation stick" that they physically held up to the screen to measure generally if the animal was inside or outside the EZ. However, the Current Corp IR system uniquely indicated the declination angle of a sighting, which, when entered into *Mysticetus*, was automatically converted to distance. PSOs agreed that both systems would benefit from better resolution. PSOs using the NVTS IR camera system on the *Ocean Researcher* found that heavy rain from certain directions covered the camera lens and reduced its effectiveness, but the camera system was waterproof so unharmed. PSOs found that images from all three camera systems were compromised by high sea states. As the cameras were on a fixed mount, they could not compensate for vessel movement in high seas and the image became blurry and difficult to focus.

PAM had a higher detection rate overall than the mounted IR camera systems and was very effective in detecting odontocetes during these Surveys. As mentioned above, the drawback of PAM is that it is generally not possible to localize a call or determine the distance to a detection. In case of a PAM detection, the PAM operator would radio the visual PSOs on duty and one would scan with mounted IR while the other scanned with NVDs to try to locate the PAM detection. Additionally, PAM did not appear to be effective at detecting lower-frequency marine mammal vocalizations (e.g., mysticete whales); all PAM detections were of higher-frequency delphinids.

In general, the combination of detection methods used during the Surveys complemented one another, depending on operational and environmental conditions, and also on the distance of protected species from the vessel. PAM, the UE, and NVDs were found to be the most effective detection devices for monitoring within a 500-m EZ. On previous surveys, ship-mounted IR cameras have also been shown to be very effective to monitor for marine mammals in *Darkness* (Gauthier-Barrette et al. 2019), and, as shown here, to detect marine mammals at much farther distances than other methods (Smultea et al. 2019). Smultea Sciences therefore recommends a combination of ship-mounted IR cameras, NVDs, the UE, and PAM to monitor and mitigate the 500-m EZ and more distant areas.

The difference in nearshore versus offshore initial detection distance and detection rate supports our decision to analyze these two datasets separately. Initial detection distance of marine mammals on nearshore surveys was fairly evenly distributed throughout the 500-m EZ, whereas initial detections were clustered within 50 m of offshore vessels. The *Daylight* detection rate with UE and RB was nearly 50% higher from nearshore compared to offshore vessels. The most common marine mammal species detected from nearshore vessels was bottlenose dolphin, compared to short-beaked common dolphin from offshore vessels. These differences highlight the fact that several variables affect nearshore versus offshore marine mammal detection rates, such as platform height above water, different environmental variables, overall sightability, and differential distributions/densities of species and their associated behaviors.

The use of NVDs, HH IR devices, and mounted IR cameras for detecting protected species at sea is still a relatively new approach, and efficacy and availability of such devices are rapidly increasing. There are few systematic studies or robust data sets on the effectiveness of

available devices under various field conditions with the exception of a handful of studies with very expensive military-grade devices, and that by Smultea et al. (2019). Systematic comparative studies of the various devices available for detecting marine mammals and sea turtles at sea during *Darkness* are needed to better inform and understand relative efficacy of these methods under different conditions. Information herein contributes to the accumulation and assessment of such information under the conditions of these particular Surveys.

7 Summary

7.1 Interpretation of Results

As is expected for surveys conducted year-round in the Northwest Atlantic Ocean, environmental conditions varied throughout the Surveys. Wind and sea state were favorable for most of the Surveys, with Bft rarely above 4 (11–16 kt winds, waves become longer, fairly frequent whitecaps), although environmental and sea state conditions were more likely to be adverse in fall and winter compared to spring and summer. Atmospheric conditions were also generally favorable with clear or overcast conditions and relatively few hours with fog or precipitation. PSOs considered the visibility good for most of *Daylight* effort, and poor for most of the effort in *Darkness* by default, due to visibility estimated at 500 m or less. Overall environmental conditions were favorable and most, if not all, protected species were expected to have been detected.

Approximately one-third of all detections could not be identified to species, but the majority of these were distant cetacean exhalations (blows), and odontocetes visually detected during *Darkness* or by PAM which were not subsequently detected by visual PSOs.

There were more protected species detections *Outside* the Lease Areas and with HRG sound sources (i.e., SBP, sparker, and USBL) *On*. Much of the Surveys were conducted along export cable route (ECR) corridors which were technically not considered *Inside* the Lease Areas, which accounts for the large proportion of Monitoring Effort and detections *Outside* the Lease Areas.

HRG Sound *On* or *Off* did not appear to adversely affect the Initial or Second Behavior of protected species. Odontocetes, primarily short-beaked common dolphins, *porpoised* more often as a Second Behavior when HRG Sound was *On*, and *breached* more when HRG Sound was *Off*. Short-beaked common dolphins are known to be curious, and *porpoising* and *breaching* often indicates fast travel towards an object of interest; in this case, perhaps the surveying vessels. The vessels were mostly traveling at higher speeds when HRG Sound was *Off*, pushing a bow wave attractive to dolphins to *bow ride*, and supported by a CPA often less than 50 m for odontocetes. Mysticetes were observed to secondarily blow more when HRG Sound was *On*, possibly indicating a localized avoidance of active sound sources by large whales.

Behavior Reactions, or an observed overt change in behavior perceived by PSOs to be a potential reaction to the vessel and/or Survey operations, were only observed in 8% of marine mammal detections while HRG Sound was *On*, and in 14% of detections while HRG Sound was *Off*. Short-beaked common dolphins accounted for the majority of Behavior Reactions, which were primarily *change direction*, a behavior not considered to be an avoidance or disturbance behavior (Bowles and Anderson 2012). These results together indicate that HRG Sound *On* did not appear to affect observable marine mammal behavior.

Sea turtles are cryptic animals that are difficult to detect on the open ocean; all but five of 50 total sea turtle detections were seen within 200 m. Almost all sea turtles were detected *Inside* the Lease Areas, possibly because vessels were surveying slowly, making turtles

more visible to PSOs. Based on all behavior metrics observed, HRG Sound had no apparent effect on sea turtle behavior.

Odontocetes and pinnipeds were initially detected closer to vessels and had closer CPAs than mysticetes. Mysticetes were more likely to have a CPA more than 500 m from the vessels, probably due to their blows being visible at distances greater than detection cues of smaller species. Additionally, dolphins tend to be curious about vessel operations and will often approach to bow ride. For all marine mammal species groups the median CPA was greater when HRG Sound was *On* compared to HRG Sound *Off*, indicating a possible localized avoidance of vessels during periods with active sound sources.

Four NARW Sighting Reports (composed of a total of five NARWs) and six Protected Species Injury or Mortality Incident Reports were filed by PSOs across all Survey vessels.

The 259 mitigation requests were primarily for a total *shutdown* of electromechanical equipment operating below 200 kHz or a *delay* to energizing this equipment. A few additional requests for vessel strike-avoidance measures (*course alteration*, *speed reduction*, or *engine neutral*) were also requested. These requests were implemented quickly and effectively, helping to safeguard protected species from vessel strikes and potential physical harm, as well as from behavioral disturbance from HRG equipment noise. Short-beaked common dolphins were the primary cause of *shutdowns* and *delays during pre-clearance*, likely due to their curiosity about vessel activity.

An estimated nine individual marine mammals were detected within the 180-m Level B harassment zone while HRG sound sources were operating below 200 kHz and for which a *shutdown* was not implemented. However, none of these individuals came closer than 100 m. Because the EZ was 100 m, it was appropriate that no mitigation was requested by PSOs. Although all appropriate mitigation and shutdown protocols were followed, it is possible these nine individual marine mammals were exposed to sounds above 160 dB RMS for brief durations, although 180-m for the Level B zone is a conservative distance based on actual measurements of sound produced by HRG sources.

7.2 Summary of Effectiveness of All Monitoring Tasks

Based on results of these Surveys and other studies, a combination of the UE, NVD, mounted IR camera systems, and PAM appears to be the most effective approach to monitor and mitigate for protected species within a 500-m EZ and in some conditions, at distances out to over 1,000 m. Each of these devices is most effective at detecting protected marine species at different distances, under different environmental and operational conditions, and for different species groups, as indicated here (see Section 6 and Smultea et al. 2019).

All mitigation measures were implemented quickly and effectively due to constant clear communication between PSOs and vessel crews. There were no vessel strikes of protected species or near misses during the Surveys. Mitigation and monitoring measures defined in the Regulatory Documents were properly implemented by PSOs and considered effective to safeguard protected species. Overall, there were no known measurable impacts to Endangered Species Act-listed protected species during surveys conducted under the 2019

Ørsted IHA. We conclude that implementation of all monitoring tasks during all Survey conducted under the IHA was effective. We believe that PSO presence on the vessel during the Surveys measurably reduced the chances of adverse impacts on protected species, particularly compared to the absence of PSOs. The dedicated, around-the-clock, focused efforts of PSOs facilitate this effectiveness.

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Appendices

Appendices A through G (listed below) are provided as an independent document titled, "*Appendices for Protected Species Observer Technical Report for the Ørsted New England IHA, BOEM Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500; 2019–2020*."

Appendix A: Mysticetus™ Data Definitions

Appendix B: Night Vision Equipment Specifications

Appendix C: Mitigation Summary Graphics

Appendix D: North Atlantic Right Whale Sighting Reports

Appendix E: Protected Species Incident Reports

Appendix F: Protected Species Photographs

Appendix G: Summary of All Protected Species Detections during HRG Surveys conducted under Ørsted's 2019-2020 New England IHA