Protected Species Observer Technical Report
Kitty Hawk North BOEM Lease OCS-A 0508
(M/V *Deep Helder*)

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CONTENTS

Page

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 3
2.1 Background 3
2.2 Survey Overview 6
2.2.1 UHR sparker medium penetration SBP survey 6
2.2.2 Multibeam echo sounder (MBES) Survey 7

3.0 REGULATORY REQUIREMENTS 8
3.1 NMFS and BOEM Reporting Requirements 9

4.0 MONITORING AND MITIGATION PROGRAM 14
4.1 Monitoring and Mitigation Measures 14
4.1.1 Pre-Clearance Monitoring and Buffer Zones 15
4.1.2 Ramp Up Procedures 16
4.1.3 Delay to Source Activation or Ramp Up 16
4.1.4 Species/Group Specific Exclusion Zones 16
4.1.5 Protected Species Shutdown 17
4.1.6 Non-Biological and Mechanical Pauses in HRG Equipment 17
4.1.7 Vessel Strike Avoidance Measures 17
4.1.8 NARW Mitigation Measures 18
4.2 Observer Methodology 18
4.2.1 Visual Observation 18
4.2.1.1 Visual Observations in Daylight – Unaided Eye and Reticle Binoculars 20
4.2.1.2 Visual Observations in Darkness – NVDs 20
4.2.2 IR Observation Methods 20
4.2.3 Acoustic Monitoring Methods 20
4.3 Periods of Reduced Visibility During Daylight 22
4.4 Mysticetus™ Observation Software 22
4.4.1 Cross-Vessel Detection Coordination 23
4.5 Data Collection and Analysis Methods 23
4.5.1 Estimating Number of Exposures 24

5.0 UHR SPARKER MEDIUM PENETRATION SBP SURVEY RESULTS 26
5.1 Monitoring Effort 26
5.2 Monitoring Conditions 28
5.3 PSO Effort 30
5.4 Protected Species Detections 31
5.4.1 NARW Detections 34
5.4.2 Sea Turtle Detections 35
5.4.3 Protected Species Behavior 36
5.5 Mitigation Measures 37
5.5.1 Protected Species Mitigation 37
5.5.1.1 Strike Avoidance Measures 38
5.5.2 Weather Related Mitigation 38

5.6 Protected Species Exposures 38
5.7 Protected Species Incident Reports 39

6.0 MULTIBEAM ECHO SOUNDER (MBES) SURVEY RESULTS 40
6.1 Monitoring Effort 40
6.2 Monitoring Conditions 41
6.3 PSO Effort 43
6.4 Protected Species Detections 44
6.4.1 NARW Detections 47
6.4.2 Sea Turtle Detections 47
6.4.3 Protected Species Behavior 47
6.5 Mitigation Measures 48
6.5.1 Protected Species Mitigation 48
6.5.1.1 Strike Avoidance Measures 48
6.5.2 Weather Related Mitigation 48
6.6 Protected Species Exposures 48
6.7 Protected Species Incident Reports 49

7.0 MONITORING METHODS AND DEVICE EFFECTIVENESS 50
7.1 Initial Detection Method 50
7.2 Detection Rates by Device 52
7.3 Detection Method Strengths and Limitations 52
7.3.1 UE and Reticle Binoculars 52
7.3.2 NVD 53
7.3.3 IR Attachment and HH IR 53
7.3.4 PAM 53
7.4 Summary of Detection Methods Effectiveness 54

8.0 CONCLUSIONS 55

9.0 LITERATURE CITED 57

9.0 APPENDICES 1

Appendix A A-1

Appendix B B-1

LIST OF TABLES

Table **Page**

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 3
2.1 Background 3
2.2 Survey Overview 6
2.2.1 UHR sparker medium penetration SBP survey 6
2.2.2 Multibeam echo sounder (MBES) Survey 7

3.0 REGULATORY REQUIREMENTS 8
3.1 NMFS and BOEM Reporting Requirements 9

4.0 MONITORING AND MITIGATION PROGRAM 14
4.1 Monitoring and Mitigation Measures 14
4.1.1 Pre-Clearance Monitoring and Buffer Zones 15
4.1.2 Ramp Up Procedures 16
4.1.3 Delay to Source Activation or Ramp Up 16
4.1.4 Species/Group Specific Exclusion Zones 16
4.1.5 Protected Species Shutdown 17
4.1.6 Non-Biological and Mechanical Pauses in HRG Equipment 17
4.1.7 Vessel Strike Avoidance Measures 17
4.1.8 NARW Mitigation Measures 18
4.2 Observer Methodology 18
4.2.1 Visual Observation 18
4.2.1.1 Visual Observations in Daylight – Unaided Eye and Reticle Binoculars 20
4.2.1.2 Visual Observations in Darkness – NVDs 20
4.2.2 IR Observation Methods 20
4.2.3 Acoustic Monitoring Methods 20
4.3 Periods of Reduced Visibility During Daylight 22
4.4 Mysticetus™ Observation Software 22
4.4.1 Cross-Vessel Detection Coordination 23
4.5 Data Collection and Analysis Methods 23
4.5.1 Estimating Number of Exposures 24

5.0 UHR SPARKER MEDIUM PENETRATION SBP SURVEY RESULTS 26
5.1 Monitoring Effort 26
5.2 Monitoring Conditions 28
5.3 PSO Effort 30
5.4 Protected Species Detections 31
5.4.1 NARW Detections 34
5.4.2 Sea Turtle Detections 35
5.4.3 Protected Species Behavior 36
5.5 Mitigation Measures 37
5.5.1 Protected Species Mitigation 37
5.5.1.1 Strike Avoidance Measures 38
5.5.2 Weather Related Mitigation 38

5.6 Protected Species Exposures 38
5.7 Protected Species Incident Reports 39

6.0 MULTIBEAM ECHO SOUNDER (MBES) SURVEY RESULTS 40
6.1 Monitoring Effort 40
6.2 Monitoring Conditions 41
6.3 PSO Effort 43
6.4 Protected Species Detections 44
6.4.1 NARW Detections 47
6.4.2 Sea Turtle Detections 47
6.4.3 Protected Species Behavior 47
6.5 Mitigation Measures 48
6.5.1 Protected Species Mitigation 48
6.5.1.1 Strike Avoidance Measures 48
6.5.2 Weather Related Mitigation 48
6.6 Protected Species Exposures 48
6.7 Protected Species Incident Reports 49

7.0 MONITORING METHODS AND DEVICE EFFECTIVENESS 50
7.1 Initial Detection Method 50
7.2 Detection Rates by Device 52
7.3 Detection Method Strengths and Limitations 52
7.3.1 UE and Reticle Binoculars 52
7.3.2 NVD 53
7.3.3 IR Attachment and HH IR 53
7.3.4 PAM 53
7.4 Summary of Detection Methods Effectiveness 54

8.0 CONCLUSIONS 55

9.0 LITERATURE CITED 57

LIST OF FIGURES

Figure **Page**

Figure 2-1. Map of the BOEM Lease area OCS-A 0508 and ECR. 5
Figure 2-2. Offshore survey vessel M/V Deep Helder. 5
Figure 4-1. Kitty Hawk North mitigation measures summary chart. 15
Figure 4-2. PAM station on M/V Deep Helder including two Pamguard laptops, a data acquisition unit, and Mysticetus data collection laptop. 21
Figure 4-3. PAM deployment method from port stern of M/V Deep Helder. 22
Figure 5-1. HRG equipment operating below 200 kHz during the UHR sparker medium penetration SBP survey monitoring effort. 27
Figure 5-2. Breakdown of vessel activity during the UHR sparker medium penetration SBP survey monitoring effort. Other includes docked, other; Standby includes: standby and weather standby. 27
Figure 5-3. Beaufort sea state during the monitoring effort on the Kitty Hawk North UHR sparker medium penetration SBP survey. 28
Figure 5-4. Atmospheric conditions during the monitoring effort on the Kitty Hawk North UHR sparker medium penetration SBP survey. 29
Figure 5-5. Overall visual quality the monitoring effort on the Kitty Hawk North UHR sparker medium penetration SBP survey. Good: sea state of B0-3 and/or visual distance of 2-10 km. Moderate: sea state of B4 and/or visual distance 0.5 ≥ 1 km. Poor: sea state of >B4 and/or a visual distance of 0.5 km or less. 30
Figure 5-6. Percent PSO effort by monitoring method of the UHR sparker medium penetration SBP survey. Visual monitoring was subdivided into the three categories of visual observation, UE during the day and NVD w/ IR during darkness. UE = unaided eye; NVD w/ IR = night vision device with IR attachment; PAM = passive acoustic monitoring. 31
Figure 5-7. Percent of protected species detection events recorded during daylight and darkness by detection method or combination of methods (concurrent) during the UHR sparker medium penetration SBP survey. 32
Figure 5-8. Percent of protected species detection events recorded while HRG sources operating below 200 kHz were active or inactive (no source <200 kHz) during the UHR sparker medium penetration SBP survey. 32
Figure 5-9. Distribution of protected species detections on M/V Deep Helder during the UHR sparker medium penetration SBP survey. 34
Figure 5-10. Location of M/V Deep Helder sea turtle detections during the UHR sparker medium penetration SBP survey. 36
Figure 6-1. Equipment operations during the MBES survey monitoring effort. 40
Figure 6-2. Breakdown of vessel activity during the MBES survey monitoring effort. Other includes docked; Standby includes: standby and weather standby. 41
Figure 6-3. Beaufort sea state during the monitoring effort on the Kitty Hawk North MBES survey. 42

Figure 6-4. Atmospheric conditions during the monitoring effort on the Kitty Hawk North MBES survey. 42
Figure 6-5. Overall visual quality the monitoring effort on the Kitty Hawk North MBES survey. Good: sea state of B0-3 and/or visual distance of 2-10 km. Moderate: sea state of B4 and/or visual distance 0.5 ≥ 1 km. Poor: sea state of >B4 and/or a visual distance of 0.5 km or less. 43
Figure 6-6. Percent PSO effort by monitoring method. Visual monitoring was subdivided into the two categories of visual observation, UE during the day and NVD w/ IR during darkness. UE = unaided eye; NVD w/ IR = night vision device with IR attachment. 44
Figure 6-7. Protected species detection events recorded while MBES was surveying above 200 kHz versus no source. Note the MBES is not a mitigated source. 45
Figure 6-8. Percent of protected species detection events recorded during daylight and darkness during the MBES survey. 45
Figure 6-9. Distribution of protected species detections on M/V Deep Helder during the MBES survey. 46
Figure 6-10. Location of M/V Deep Helder humpback whale detections during MBES survey. 47
Figure 6-11. Humpback whale (V74) visually detected on 16 Dec 2021. Image Credit: R. Rice. 48
Figure 7-1. Number of initial detections by monitoring method during daylight and darkness during UHR sparker medium penetration SBP survey. 51
Figure 7-2. Number of initial detections by monitoring method during daylight and darkness 51

List of Acronyms and Abbreviations

AMP	Alternative Monitoring Plan
BOEM	Bureau of Ocean Energy Management
CPA	Closest Point of Approach
dB	Decibels
DMA	Dynamic Management Area
DP	Dynamic Positioning
ESA	Endangered Species Act
EZ	Exclusion Zone
h	Hours
HD	High Definition
HF	High Frequency
HH	Handheld
HRG	High-Resolution Geophysical
IHA	Incidental Harassment Authorization
IR	Infrared
kHz	Kilohertz
km	Kilometers
LF	Low Frequency
m	Meters
MBES	Multibeam Echo Sounder
MF	Mid-Frequency
mils	Milliradians
MMPA	Marine Mammal Protection Act
MMT	MMT US Inc.
M/V	Merchant Vessel
MVI	Marine Ventures International, Inc.
NARW	North Atlantic Right Whale
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NVD	Night Vision Device
OCS	Outer Continental Shelf
OPR	Office of Protected Resources
PAM	Passive Acoustic Monitoring
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
QA/QC	Quality Assurance / Quality Control
RB	Reticle Binoculars
RMS	Root Mean Square
RWSAS	Right Whale Sighting Advisory System
SAS	Sighting Advisory System
SBP	Sub-Bottom Profiler
SD	Secure Digital

SMA	Seasonal Management Area
TTS	Temporary Threshold Shift
UE	Unaided Eye
UHR	Ultra-High Resolution
USBL	Ultra-Short Baseline
UTC	Coordinated Universal Time

1.0 EXECUTIVE SUMMARY

This protected species observer (PSO) technical report fulfills the reporting requirement of the National Marine Fisheries Service (NMFS) Incidental Harassment Authorization (IHA) effective 23 July-31 October 2021, the Bureau of Ocean Energy Management (BOEM) Commercial Lease of Submerged Lands for Renewable Development on the Outer Continental Shelf (OCS) for the Kitty Hawk North lease area, OCS-A 0508, and the NMFS programmatic interagency consultation under Section 7 of the ESA (issued on 29 June 2021).

Visual observations took place on board M/V *Deep Helder* from 20 September through 25 October 2021 for the UHR sparker medium penetration SBP survey and 28 November through 28 December 2021 for the multibeam echo sounder (MBES) survey. Mobilization and calibrations began on board the vessel on 20 September 2021. The sparker survey operations within the Kitty Hawk North lease area commenced on 26 September 2021 and concluded on 25 October 2021. The multibeam survey began on 28 November and ran through 27 December 2021. Demobilization of the M/V *Deep Helder* occurred on 29 December 2021.

Throughout the Kitty Hawk North survey, five (5) trained and qualified PSOs were present on board the M/V *Deep Helder* to implement ship strike avoidance and geophysical survey mitigation measures offshore North Carolina. All PSO monitoring, data collection, and reporting were conducted under the guidance of the NMFS IHA, BOEM Lease stipulations, the NMFS programmatic interagency consultation under Section 7 of the Endangered Species Act (ESA), the Survey Plan with Alternative Monitoring Plan (AMP) and BOEM Review and Approval, the BOEM Waiver and Modification Review and Approval (completed 02 August 2021), and best practices implemented by MMT and Avangrid.

This report covers HRG activities for the M/V *Deep Helder* using the UHR sparker medium penetration SBP from 20 September through 25 October 2021 and the multibeam survey from 28 November through 28 December 2021. Throughout the HRG survey activities, PSOs mitigated for sources operating at frequencies below 200 kilohertz (kHz). The primary source of concern was the ultra-high resolution (UHR) sparker medium penetration SBP. The M/V *Deep Helder* was operating a multibeam echo sounder (MBES) at frequency levels over 200 kHz, which exempted the device from mitigation actions. However, during MBES operations, PSOs continued to monitor for vessel strike avoidance.

In addition, the M/V *Deep Helder* was operating with an ultra-short baseline (USBL) positioning system, which did not require mitigation under the Survey Plan (2021).

Throughout the UHR sparker SBP project, the M/V *Deep Helder* PSO monitoring effort was accomplished over a total distance of 5,168.1 kilometers (km) and a total PSO effort of 802.0 hours (h) across all monitoring platforms (602.8 h visual, 197.7 h acoustic).

During the MBES survey, PSO monitoring effort was accomplished over a total distance of 3335.0 km of vessel track line while PSOs were monitoring for protected species during 3335.0 km of monitoring effort. Monitoring effort was greater during darkness than during daylight, with 2010.4 km of observation during darkness and 1324.7 km of observation during daylight. Of the 3335.0 km monitored for strike avoidance, 2904.9 km was with the MBES active.

Monitoring effort on board the M/V *Deep Helder* was conducted in both daylight and darkness as offshore survey operations took place 24 hours per day.

Throughout the UHR sparker SBP survey, there were a total of 81 protected species detection events (66 visual only, ten (10) acoustic only, and five (5) multi-platform concurrent detections) composed of an estimated 431 individuals. Atlantic spotted dolphins (*Stenella frontalis*) and unidentified dolphins

(Delphinidae) were the most frequently detected species/groups. There were a significant amount of both loggerhead sea turtle (*Caretta caretta*) and unidentified sea turtle (Cheloniidae) sightings as well. Most (98.8%) protected species detections occurred during the continuous HRG survey activity while operating acoustic sources below 200 kHz.

Throughout the MBES survey, there were a total of seven protected species detection events recorded during the Kitty Hawk North survey. An estimated 39 individuals were observed during those detection events. Six detections were initially through unaided eye, and one was sighted through NVD w/ IR.

During the UHR sparker SBP project the PSOs estimated 14.1% of marine mammals and 7.0% of sea turtles visually detected were observed to change behavior while the HRG acoustic sources below 200 kHz were active. Overall, 21.1% of both marine mammals and sea turtles exhibited a response when the HRG acoustic sources were active. There was no indication that behavioral changes were due to a reaction to the HRG acoustic sources.

Throughout the UHR sparker SBP project, protected species mitigation measures were requested and implemented on 26 occasions, including 23 shutdowns of the sparker and three (3) delays to the activation of this equipment. PSOs did not have any sightings needing mitigation pertaining to vessel strike avoidance measures. Sea turtles were the primary cause of PSO related shutdowns and delays (n=17) over the duration of the survey. Atlantic spotted dolphins and unidentified dolphins were the next most common for shutdowns and delays (n=9). Precautions were taken to implement shutdowns for voluntary or involuntary approach of Atlantic spotted dolphins and unidentified dolphins on 22 October 2021 when nearing take limits for Atlantic spotted dolphins. All mitigation requests were implemented as quickly and effectively as possible.

A total of 35 marine mammal detection events were observed within the 445-meter (m) Level B harassment zone (modeled 160 decibels root mean square (dB_{RMS}) isopleth) for the UHR sparker while the sparker was active. All appropriate mitigation and shutdown protocols were followed and a total of 218 marine mammals had potential exposure to UHR sparker source levels of at least 160 dB_{RMS}.

Throughout the MBES survey, there was one strike avoidance measure implemented for a humpback whale.

Mitigation and monitoring protocols under the 2021 NMFS-issued IHA, the BOEM Lease OCS-A 0508, the NMFS programmatic interagency consultation under Section 7 of the ESA, the Survey Plan with AMP and BOEM Review and Approval, the BOEM Waiver and Modification Review and Approval were effectively implemented by the PSOs throughout the Kitty Hawk North Wind HRG survey. Vessel and survey crews assisted PSOs in ensuring appropriate mitigation and strike avoidance measures were implemented as necessary, while maintaining effective communications. There were no incidents with protected species occurring throughout the reporting period.

2.0 INTRODUCTION

2.1 BACKGROUND

Protected species exposed to anthropogenic sound sources may experience auditory injury or behavioral disturbance of varying severity (Southall et al., 2007; NMFS, 2018). Auditory injury in marine mammals results from physiological damage to structures within the ear. Sound exposure can cause recoverable alteration in hearing capacity, known as a temporary threshold shift (TTS), or non-recoverable alteration in hearing capacity, known as a permanent threshold shift (PTS). While auditory injury to marine mammals or sea turtles is not expected, the potential exists for marine mammals or sea turtles to experience behavioral disturbance resulting from underwater sound associated with geophysical and geophysical survey activities conducted on behalf of wind energy development on the OCS (BOEM, 2017). Behavioral disturbance can vary greatly and can include changes in dive or vocal patterns, temporarily vacating an area during the survey, or alterations in feeding activity or prey content. Behavioral changes may or may not be biologically significant, which is highly dependent on the context of the sound exposure and the duration of the exposure. Due to the short duration of the project and the implementation of mitigation measures, behavioral disturbances were not expected to reach biological significance.

Auditory masking of natural sounds and communication among animals may occur. Auditory masking is an acoustic effect whereby the content (frequency bandwidth and amplitude) of a sound (e.g., geophysical sources) overlaps with the content of biologically important sounds and inhibits the ability of an animal to perceive the biologically important sounds. Temporary auditory masking may occur in localized areas for short periods of time when an animal is in proximity to the survey. However, due to the transient nature of the sources and general animal movement, long-term masking of an area was not expected during the survey.

All marine mammals are protected under the Marine Mammal Protection Act (MMPA) and almost all large whales and sea turtles are protected under the ESA. NMFS must be consulted for operations emitting noise into the marine environment if the sound levels produced have the potential to disturb or injure marine mammals. NMFS will determine the number of allowable takes for each species present in the area and will issue an IHA prior to survey operations.

Nine (9) marine mammal species/groups have geographic ranges and habitat associations that overlap with the project survey area and could be present at or near the Kitty Hawk North survey area during all or part of the year (**Table 2-1**).

Table 2-1. Protected marine mammal, sea turtle and fish species expected to occur in the survey area (Hayes et. al, 2021).

Lease Category	Common Name	Scientific Name	Federal ESA/MMPA Status	US Atlantic Stock Area
Non-delphinoid cetaceans	Minke whale	*Balaenoptera acutorostrata*	MMPA Protected	Canadian East Coast
	Fin whale	*Balaenoptera physalus*	ESA Endangered MMPA Protected/ Depleted	Western North Atlantic
	Humpback whale	*Megaptera novaeangliae*	ESA Endangered/ Threatened MMPA Protected/ Depleted	Gulf of Maine
Delphinoid cetaceans	Risso's dolphin	*Grampus griseus*	MMPA Protected	Western North Atlantic
	Long-finned/ short-finned pilot whale	*Globicephala melas/Globicephala macrorhynchus*	Strategic MMPA Protected	Western North Atlantic
	Atlantic spotted dolphin	*Stenella frontalis*	MMPA Protected	Western North Atlantic
	Common dolphin	*Delphinus delphis*	MMPA Protected	Western North Atlantic
	Bottlenose dolphin	*Tursiops truncatus*	MMPA Protected/ Depleted	Western North Atlantic, offshore
	Harbor porpoise	*Phocoena phocoena*	MMPA Protected	Gulf of Maine/ Bay of Fundy
Sea turtles	Leatherback sea turtle	*Dermochelys coriacea*	ESA Endangered	New England/ Mid-Atlantic
	Loggerhead sea turtle	*Caretta Greenlandic*	ESA Endangered/ Threatened	New England/ Mid-Atlantic
	Green sea turtle	*Chelonia mydas*	ESA Endangered/ Threatened	New England/ Mid-Atlantic
	Kemp's Ridley sea turtle	*Lepidochelys kempii*	ESA Endangered	New England/ Mid-Atlantic
Fish	Atlantic sturgeon	*Acipenser oxyrinchus Oxyuranus*	ESA Endangered/ Threatened	New England/ Mid-Atlantic
	Giant manta ray	*Manta birostris*	ESA Threatened	New England/ Mid-Atlantic

ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act; NMFS = National Marine Fisheries Service

The following PSO technical report was created by Marine Ventures International, Inc. (MVI) and on behalf of MMT and Avangrid. MVI was contracted by MMT to conduct protected species monitoring and mitigation as required by BOEM and NMFS for compliance with the MMPA and the ESA during HRG surveys conducted within the Kitty Hawk North lease area, BOEM Lease OCS-A 0508 (**Figure 2-1**).

This report provides a summary of protected species monitoring and mitigation activities during HRG surveys and multibeam surveys aboard the M/V *Deep Helder* (**Figure 2-2**). Mobilization activities for the M/V *Deep Helder* took place at Military Ocean Terminal in Bayonne, NJ on 19 September 2021. The M/V *Deep Helder* operated out of the Virginia Port Authority in Norfolk, Virginia for the duration of survey activities in the Kitty Hawk North lease area. Demobilization of the M/V *Deep Helder* occurred on 29 December 2021.

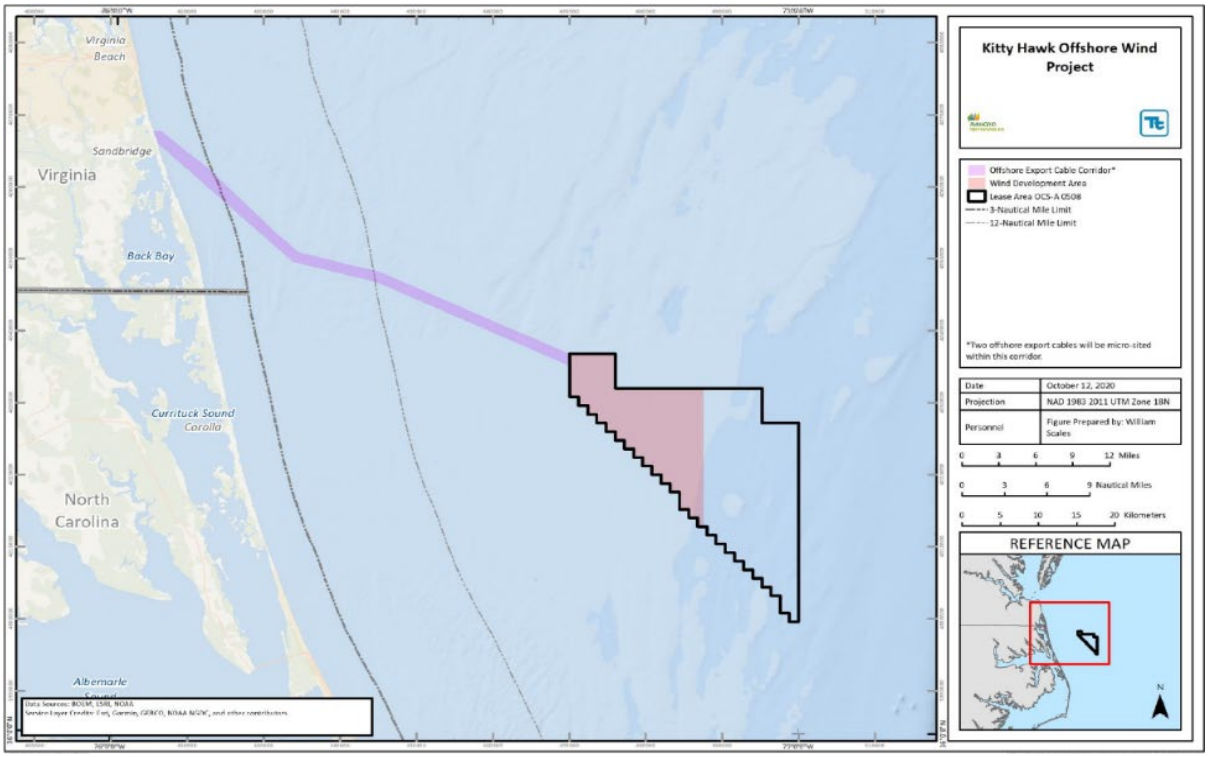

Figure 2-1. Map of the BOEM Lease area OCS-A 0508 and ECR.

Figure 2-2. Offshore survey vessel M/V Deep Helder.

Visual observations took place on board M/V *Deep Helder* from 20 September through 25 October 2021 for the UHR sparker medium penetration SBP survey and 28 November through 28 December 2021 for the multibeam survey. Mobilization and calibrations began on board the M/V *Deep Helder* from 20 and continued through 25 September 2021. The sparker survey operations within the Kitty Hawk North lease area commenced on 26 September 2021 and concluded on 25 October 2021. The multibeam survey began on 28 November and ran through 27 December 2021. Demobilization of the M/V *Deep Helder* occurred on 29 December 2021.

Throughout the Kitty Hawk North survey, five (5) trained and qualified PSOs were present on board the M/V *Deep Helder*. At least three (3) of the five (5) PSOs were also trained and qualified as passive acoustic monitoring (PAM) operators. PSOs were on board to implement ship strike avoidance and geophysical survey mitigation measures offshore North Carolina. PSO monitoring, data collection, and reporting were conducted in compliance with the 2021 NMFS IHA, Lease stipulations, and supplemental stipulations required by MMT and Avangrid.

2.2 SURVEY OVERVIEW

2.2.1 UHR SPARKER MEDIUM PENETRATION SBP SURVEY

MMT conducted HRG survey activities on behalf of Avangrid within the Kitty Hawk North lease area on board M/V *Deep Helder*. Survey operations took place within the Kitty Hawk North lease area on a 24-hour basis for a total of 28 days (20-21, 23-29 September and 1-8, 14-18, 20-25 October 2021) on M/V *Deep Helder*, including weather delays and standby days. Equipment used for the geophysical survey is outlined below.

Equipment used in the Kitty Hawk North lease area included:

1. A towed UHR sparker medium SBP seismic source.
2. A MBES.
3. A USBL positioning system for tracking all survey equipment.
4. DP thrusters.

During HRG survey operations, the UHR sparker, the MBES, and the DP thrusters were active simultaneously. The USBL was operated concurrently in the beginning of the project. The MBES, the USBL and the DP thrusters were exempt from mitigation per NMFS. There were no significant changes to the HRG survey equipment or configuration throughout the survey operations for the Kitty Hawk North survey campaign.

Table 2-2 provides dates for HRG survey operations in the Kitty Hawk North lease area. Visual observations for calibrations began at dock on the M/V *Deep Helder* on 20 September 2021. Crew changes of the PSOs were scheduled per 28-day rotations. The M/V *Deep Helder* completed the UHR sparker survey on 25 October 2021; however, the vessel did not demobilize from Kitty Hawk until 29 December 2021 due to other survey work being completed in both Kitty Hawk North and Kitty Hawk South including the MBES survey included in this report.

Table 2-2. Dates of vessel activity throughout the Kitty Hawk North lease area HRG Surveys.

Date(s)	Vessel Activity
19-21 Sep 2021 23-25 Sep 2021	Mobilization (Military Ocean Terminal, Bayonne, New Jersey) and calibrations
26-29 Sep 2021 01-08 Oct 2021	Kitty Hawk North (OCS-A 0508) HRG survey

14-18 Oct 2021 20-25 Oct 2021	

2.2.2 MULTIBEAM ECHO SOUNDER (MBES) SURVEY

MMT conducted multibeam echo sounder survey activities on behalf of Avangrid within the Kitty Hawk North lease area on board M/V *Deep Helder*. Survey operations took place within the lease area on a 24-hour basis for a total of 18 days (28 Nov.-01 Dec., 02-03, 15-19, 20-22, 24-27 Dec. 2021) on M/V *Deep Helder*, including weather delays and standby days. Equipment used for the geophysical surveys is outlined below.

Equipment used in the Kitty Hawk North lease area for the multibeam survey included:

1. A MBES
2. A USBL positioning system for tracking all survey equipment.
3. An Innomar
4. DP thrusters

During the MBES survey operations, the MBES, and the DP thrusters were active simultaneously. The USBL and innomar were also briefly used with the side-scan sonar and gradiometer. The MBES, the USBL and the DP thrusters were exempt from mitigation per NMFS during this survey. The PSOs focused on strike avoidance maneuvers for protected species during these operations. Equipment testing including the innomar occurred before the end of the project on 27 December 2021. **Table 2-3** provides dates for MBES survey operations in the Kitty Hawk North MBES survey area.

Table 2-3. Dates of vessel activity throughout the Kitty Hawk North lease area Multibeam Surveys.

Date(s)	Vessel Activity
28 Nov.-01 Dec. 2021 02-03 Dec. 2021 15-19 Dec. 2021 20-22 Dec. 2021 24-27 Dec. 2021	Kitty Hawk North Multibeam survey
29 Dec 2021	Demobilization (Virginia Port Authority, Norfolk, Virginia)

3.0 REGULATORY REQUIREMENTS

Avangrid worked under the NMFS IHA (issued 23 July 2021) and the BOEM Lease OCS-A 0508 (Kitty Hawk; effective date 01 November 2017). The Kitty Hawk North survey applied monitoring and mitigation protocols based on the 2021 NMFS IHA and the BOEM Lease OCS-A 0508. Stipulations within the Lease and the NMFS programmatic interagency consultation under Section 7 of the ESA (issued 29 June 2021), guided by NMFS and agreed to by Avangrid and BOEM, lay out protocols to mitigate for protected species. Additionally, the 2021 High Resolution Geophysical Offshore Survey Plan for Kitty Hawk Offshore Wind Project (prepared 10 March 2021) defined monitoring and mitigation measures for the M/V *Deep Helder* survey. The Survey Plan, which was submitted to BOEM, included the AMP. Other clarifications on monitoring and mitigation measures for the survey were included in the BOEM Survey Plan review and approval (completed 19 March 2021) and the BOEM Waiver and Modification Review and Approval (completed on 02 August 2021). Typically, the most conservative measures were adopted when encountering overlapping monitoring and mitigation measures within one or more regulatory documents.

Equipment with operational frequencies below 200 kHz are known to overlap with the hearing ranges of many marine mammal and sea turtle species found in the lease and surrounding areas and thus are subject to monitoring and mitigation regulations. The primary type of HRG equipment used that required monitoring and mitigation was the UHR sparker medium penetration SBP (towed behind the vessel). The operating frequency for the above noted HRG equipment is provided in **Table 3-1**.

Table 3-1. Geophysical equipment operating frequencies below 200 kHz and requiring mitigation used on the Kitty Hawk North survey.

Geophysical Equipment	Operating Frequency
UHR Sparker Medium Penetration SBP: Geo-Source 400 Tip Sparker Source (800 J)	0.25-3.25 kHz

Potential harassment from operation of the USBL was not anticipated based on Avangrid's previous NMFS consultations and the BOEM Biological Assessment (revised February 2021); therefore, mitigation for the USBL was not required for this survey (Survey Plan, 2021). The MBES operated at frequencies ≥200 kHz and therefore was not subject to monitoring and mitigation requirements.

Vessel thrusters were used for dynamic positioning (DP) throughout the survey and are a low frequency sound source but are not subject to monitoring and mitigation requirements. The high frequency equipment (MBES), USBL, and DP were recorded in the observer data; however, these sources did not require monitoring and mitigation. In addition, the innomar, not used during survey, was subject to a ramp up prior to testing on 27 December 2021.

The NMFS IHA issued on 23 July 2021 applied specifically to the UHR sparker system. As a result of the above noted different regulatory requirements, mitigation measures for UHR sparker system, which operated below 200 kHz, included iterations of the following:

- Pre-clearance monitoring zones,
- Ramp up,
- Delay to the start of HRG equipment,
- Species/group specific exclusion zones (EZs),
- Protected species shutdown of HRG equipment,
- Exceptions for dolphins,
- Non-biological and mechanical pauses in HRG equipment,
- Daytime and nighttime monitoring procedures, and

- Vessel strike-avoidance measures.

Detailed monitoring and mitigation protocols employed in Kitty Hawk North may be referenced in section *4.1 Monitoring and Mitigation Measures*.

3.1 NMFS AND BOEM REPORTING REQUIREMENTS

This PSO technical report summarizes information required by the 2021 NMFS IHA and the BOEM Lease OCS-A 0508 per **Table 3-2**.

The lead PSOs distributed a daily PSO report to Avangrid, MMT, and MVI at the end of each UTC calendar day. Each daily report summarized PSO effort, vessel operations, details related to detections of protected species, mitigation measures implemented, estimated potential Level B exposures or takes, and weather conditions. All data recorded in the field, including the specific NMFS and BOEM required data elements in **Table 3-2**, were provided to Avangrid with this technical report.

Table 3-2. NMFS and BOEM Reporting Requirements.

Source Reference	Reporting Requirement	Referenced Location in Technical Report
BOEM Lease OCS-A 0508 Addendum C 5.5.3 Reporting Injured or Dead Protected Species	The Lessee must ensure that sightings of any injured or dead protected species (e.g., marine mammals, sea turtles or sturgeon) are reported to the Lessor, National Oceanic and Atmospheric Administration (NOAA) Fisheries and the NOAA Fisheries Southeast Region's Marine Mammal Stranding Hotline (877-433-8299) or the North Carolina Sea Turtle Stranding and Salvage Network hotline (252-241-7367) within 24 hours of sighting, regardless of whether the injury or death is caused by a vessel. In addition, if the injury or death was caused by a collision with a project-related vessel, the Lessee must notify the Lessor of the strike within 24 hours. The Lessee must use the form provided in 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 that the vessel assists in any salvage effort as requested by NOAA Fisheries.	No protected species incidents occurred during reporting period.
BOEM Lease OCS-A 0508 Addendum C 5.5.4 Reporting Observed Impacts to Protected Species	The Lessee must report any observations concerning any impacts on Endangered Species Act-listed marine mammals, sea turtles or sturgeon to the Lessor and NOAA Fisheries Southeast Regional Stranding Coordinator within 48 hours (305-361-4586; blair.mase@noaa.gov).	Section 5.6 Protected Species Exposures
BOEM Lease OCS-A 0508 Addendum C 5.5.5 Protected Species Observer Reports	The Lessee must ensure that the PSO record all observations of protected species using standard marine mammal PSO data collection protocols. The list of required data elements for these reports is provided in Appendix B to ADDENDUM "C".	**Appendix A**: Summary of All Protected Species Detections Conducted under the 2021 NMFS IHA

Source Reference	Reporting Requirement	Referenced Location in Technical Report
BOEM Lease OCS-A 0508 Appendix B to Addendum C	Required data elements for protected species observer reports: The Lessee must ensure that the PSO record all observations of protected species using standard marine mammal observer data collection protocols. The list of required data elements for these reports is provided below: 1. Vessel name; 2. Observers' names and affiliations; 3. Date; 4. Time and latitude/longitude when daily visual survey began; 5. Time and latitude/longitude when daily visual survey ended; and 6. Average environmental conditions during visual surveys including: a. Wind speed and direction; b. Sea state (glassy, slight, choppy, rough, or Beaufort scale); c. Swell (low, medium, high, or swell height in meters); and d. Overall visibility (poor, moderate, good). 7. Species (or identification to lowest possible taxonomic level); 8. Certainty of identification (sure, most likely, best guess); 9. Total number of animals; 10. Number of juveniles; 11. Description (as many distinguishing features as possible of each individual seen, including length, shape, color and pattern, scars or marks, shape and size of dorsal fin, shape of head, and blow characteristics); 12. Direction of animal's travel relative to the vessel (preferably accompanied by a drawing); 13. Behavior (as explicit and detailed as possible, noting any observed changes in behavior); 14. Activity of vessel when sighting occurred.	**Appendix A**: Summary of All Protected Species Detections Conducted under the 2021 NMFS IHA
BOEM Lease OCS-A 0508 Addendum C 5.5.6 Reports of G&G Survey Activities and Observations	The Lessee must provide the Lessor and NOAA Fisheries with reports every 90 calendar days following the commencement of HRG Survey and/or Geotechnical Exploration activities, and a final report at the conclusion of the HRG Survey and/or Geotechnical Exploration activities. Each report must include a summary of survey activities, all PSO and incident reports (See Appendices A and B), and an estimate of the number of listed marine mammals and sea turtles observed and/or taken during these survey activities. The final report must contain a detailed analysis and interpretation of the sound source verification data, if such data was collected by the Lessee.	PSO Technical Report

Source Reference	Reporting Requirement	Referenced Location in Technical Report
2021 NMFS IHA Section 5 (n)	(n) Data on all PSO observations must be recorded based on standard PSO collection requirements. PSOs must use standardized data forms, whether hard copy or electronic. The following information must be reported: (i) PSO names and affiliations (ii) Dates of departures and returns to port with port name (iii) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort (iv) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts (v) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change (vi) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon (vii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (e.g., vessel traffic, equipment malfunctions) (viii) Survey activity information, such as type of survey equipment in operation, acoustic source power output while in operation, and any other notes of significance (i.e., pre-clearance survey, ramp-up, shutdown, end of operations, etc.) (ix) If a marine mammal is sighted, the following information should be recorded: (A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform); (B) PSO who sighted the animal; (C) Time of sighting; (D) Vessel location at time of sighting; (E) Water depth; (F) Direction of vessel's travel (compass direction); (G) Direction of animal's travel relative to the vessel; (H) Pace of the animal; (I) Estimated distance to the animal and its heading relative to vessel at initial sighting; (J) Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species; (K) Estimated number of animals (high/low/best) ;	**Appendix A**: Summary of All Protected Species Detections Conducted under the 2021 NMFS IHA

Source Reference	Reporting Requirement	Referenced Location in Technical Report
	(L) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.); (M) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics); (N) Detailed behavior observations (e.g., number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior); (O) Animal's closest point of approach and/or closest distance from the center point of the acoustic source; (P) Platform activity at time of sighting (e.g., deploying, recovering, testing, data acquisition, other); (Q) Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up, speed or course alteration, etc.) and time and location of the action.	
2021 NMFS IHA, Section 6a	A monitoring report must be provided to NMFS within 90 days after completion of survey activities or expiration of this IHA, whichever comes sooner. The report must fully document the methods and monitoring protocols, summarize the data recorded during monitoring, describe, assess, and compare the effectiveness of monitoring and mitigation measures. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS. PSO datasheets or raw sightings data must also be provided with the draft and final monitoring report. All draft and final marine mammal reports must be submitted to PR.ITP.MonitoringReports@noaa.gov and ITP.Daly@noaa.gov.	PSO Technical Report
2021 NMFS IHA, Section 6b	If a North Atlantic right whale is observed at any time by PSOs or personnel on any project vessels, during surveys or during vessel transit, Kitty Hawk Wind must immediately report sighting information to the NMFS North Atlantic Right Whale Sighting Advisory System: (866) 755-6622 and to the U.S. Coast Guard via channel 16.	Section 4.1.8 NARW Mitigation Measures
2021 NMFS IHA, Section 6c	Reporting injured or dead marine mammals: (i)In the event that personnel involved in the survey activities covered by the authorization discover an injured or dead marine mammal, Kitty Hawk Wind must report the incident to the NMFS Southeast Marine Mammal Stranding Network (1-877-942-5343) if the sighting is in North Carolina or the Northeast Stranding Network (1-866-755-6622) if the sighting is in Virginia as soon as feasible. The report must include the following information:	No protected species incidents occurred during the project.

Source Reference	Reporting Requirement	Referenced Location in Technical Report
	(A) Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable); (B) Species identification (if known) or description of the animal(s) involved; (C) Condition of the animal(s) (including carcass condition if the animal is dead); (D) Observed behaviors of the animal(s), if alive; (E) If available, photographs or video footage of the animal(s); and (F) General circumstances under which the animal was discovered. (ii) In the event of a vessel strike of a marine mammal by any vessel involved in the activities covered by this authorization, Kitty Hawk Wind must report the incident to relevant Stranding Network identified in 6(c)(i) and NOAA Fisheries Office of Protected Resources (OPR) by email (PR.ITP.MonitoringReports@noaa.gov) and itp.daly@noaa.gov as soon as feasible. The report must include the following information: (A) Time, date, and location (latitude/longitude) of the incident; (B) Species identification (if known) or description of the animal(s) involved; (C) Vessel's speed during and leading up to the incident; (D) Vessel's course/heading and what operations were being conducted (if applicable); (E) Status of all sound sources in use; (F) Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike; (G) Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike; (H) Estimated size and length of animal that was struck; (I) Description of the behavior of the marine mammal immediately preceding and following the strike; (J) If available, description of the presence and behavior of any other marine mammals immediately preceding the strike; (K) Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and (L) To the extent practicable, photographs or video footage of the animal(s).	

4.0 MONITORING AND MITIGATION PROGRAM

A team of five (5) PSOs conducted observations during transit, all geophysical operations, and at-sea weather standby for strike avoidance in order to fulfill regulatory requirements. PSOs were responsible for visually monitoring and identifying marine mammals, sea turtles, Atlantic sturgeon, and/or giant manta rays approaching within the established exclusion and monitoring zones before, during, and after survey activities. The PSO on duty communicated the presence of protected species and enforced the action(s) necessary to ensure mitigation and monitoring requirements were implemented, as necessary. There were two designated lead PSOs on the M/V *Deep Helder* ensuring 24-hour lead coverage. The team of PSOs on the M/V *Deep Helder* included at least three individuals that were also qualified as PAM operators. All PSOs were pre-approved by NMFS and BOEM.

Observations at night were performed by two observers. One, a PSO, used a single night-vision device equipped with infrared capabilities for ease and rapidity in switching between the two technologies. Additionally, handheld IR cameras were readily available as a back-up. The second observer used passive acoustic monitoring (PAM) to detect species out of visual range. Within the 2021 NMFS IHA, the availability of night-vision goggles "and/or" infrared technology is required for use during nighttime monitoring. With both of these technologies provided in a single device used by the PSO, coupled with concurrent acoustic monitoring by the PAM operator using acoustic monitoring, the intent was to provide the most thorough approach to nighttime monitoring coverage. In MVI's previous communications with NMFS (predating the Kitty Hawk Projects), PAM operator has been referred to as an acoustic PSO in language used within NMFS approval e-mail letters from the NOAA Service Account. In addition, the 2013 Endangered Species Act Section 7 Consultation Biological Opinion Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf in Massachusetts, Rhode Island, New York and New Jersey Wind Energy Areas NER-2012-9211 GARFO-2012-00011 referred to acoustic observation by PSOs. During these surveys is was thought that the term PSO may also refer to an acoustic PSO or PAM operators as most PAM operators gain experience working as a PSO prior to becoming certified as a PAM operator. Post-survey it was understood that NMFS' intent was to have two 'visual' PSOs; one utilizing a combined night vision and IR technology along with backup handheld IR camera for blind spots. Of the three methods of detection, UE, NVD with IR, and PAM, UE had the highest detection rate and PAM had the second highest (section 5.4 Protected Species Detections). PSOs who are also qualified in the use of PAM often rotate through visual and acoustic watches throughout their daily schedule, using NVD, IR cameras and PAM technologies. This contributed in part to the language in the IHA to be understood as meaning one visual PSO and one acoustic PSO on duty during nighttime. To ensure clarity going forward, additional pre-project requirement clarification meetings will be held with clients and agencies, and a table comparing monitoring and mitigation requirements listed within the multiple governing documents will be created to illuminate where further consultation with clients and agencies is needed. Opportunities to collaborate with regulatory agencies in the bridging of language discrepancies within differing documents, including the IHA and NMFS approval email letters, to improve clarity in the future are welcome.

4.1 MONITORING AND MITIGATION MEASURES

Mitigation measures for the Kitty Hawk North survey were identified in the 2021 NMFS IHA, BOEM Lease, Survey Plan/AMP, and waiver/ modification review and approval. The more conservative measure was implemented in nearly all cases where regulations differed between documents.

Under BOEM Lease OCS-A 0508 stipulations 5.4.4 and 5.4.6, PSOs are required to visually monitor a default EZ around the geophysical sources operating below 200 kHz. The primary objectives of the PSOs were to implement measures designed to minimize the disturbance to and maximize the safety of marine mammals and sea turtles through effective and efficient observational monitoring.

The HRG survey equipment operating at frequencies below 200 kHz (requiring mitigation measures) was the UHR sparker medium penetration SBP. Only certain mitigation measures, pre-clearance, and delay to activation (detailed below) applied to the USBL. The USBL was not mitigated for based on previous Avangrid consultations with NMFS and the BOEM Biological Assessment (revised February 2021). The USBL is necessary for equipment localization and positioning. The mitigation requirements are summarized in **Figure 4-1** and are detailed in the following sections.

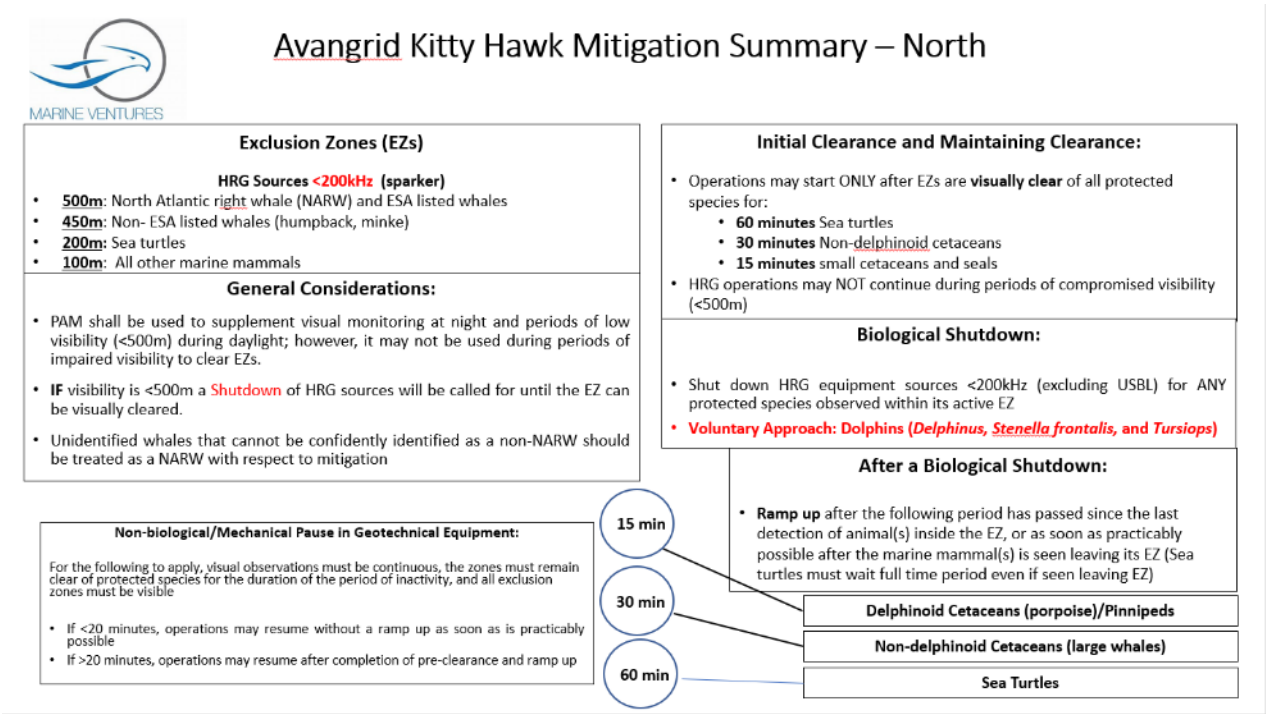

Figure 4-1. Kitty Hawk North mitigation measures summary chart.

4.1.1 PRE-CLEARANCE MONITORING AND BUFFER ZONES

Pre-clearance monitoring zones were established and monitored prior to the activation of HRG survey equipment operating below 200 kHz. The size of the monitoring zones was species/group and HRG equipment specific. Each zone was centered around the relevant HRG equipment. Pre-clearance monitoring zones monitored in Kitty Hawk North were as follows:

- Sparker IHA Pre-Clearance Monitoring Zones
  - 500 m for NARW and ESA-listed whales
  - 450 m for non-ESA listed whales (humpback, minke)
  - 200 m for sea turtles
  - 100 m for all other marine mammals

Prior to activating HRG survey equipment operating at frequencies below 200 kHz (UHR sparker, and/or USBL), the above noted monitoring zones around the acoustic sources must be clear of:

- 60 minutes for sea turtles,
- 30 minutes for non-delphinoid cetaceans;
- 15 minutes for small cetaceans and seals.

Visibility of the full monitoring zone was required to complete pre-clearance. If the 500 m monitoring zone was not visible, the pre-clearance period could not begin and HRG source activation would be delayed until at least 60 minutes had elapsed after reestablishing full 500 m visibility. If visibility diminished to less than 500 m while the UHR sparker was active, the sparker had to be shut down until visibility improved or until daylight. USBL operations were allowed to continue regardless of visibility, but still required 500 m of visibility during pre-clearance.

Pre-clearance could be conducted visually with unaided eye (UE), night vision devices (NVD) with IR attachments, handheld IR cameras (IR), or a combination of the three methods. PAM could not be used for pre-clearance.

4.1.2 RAMP UP PROCEDURES

If technically feasible, HRG survey equipment operating below 200 kHz should be ramped up by progressively increasing the acoustic output from a minimum output to the maximum survey output. The BOEM Lease (Addendum C stipulation 5.4.6.7) requires ramp up procedures. The innomar and UHR sparker were ramped up prior to testing or surveying. The UHR sparker ramp up procedure was to be applied as follows: begin with the power of the smallest acoustic equipment for the HRG Survey at its lowest power output. The power output was to be gradually increased and other acoustic sources added in such a way that the source level would rise in steps not exceeding 6 dB per 5-minute period. Sparker ramp up was implemented upon initial startup after the completion of pre-clearance and following sparker shutdowns.

4.1.3 DELAY TO SOURCE ACTIVATION OR RAMP UP

The activation of HRG survey equipment operating below 200 kHz was delayed if marine mammals or sea turtles were observed within their respective monitoring zones during pre-clearance. Ramp up or source activation would be delayed until the designated pre-clearance times noted above in section *4.1.1* (*Pre-Clearance Monitoring Zones*) had elapsed from the last detection of the marine mammal or sea turtle within its respective monitoring zone. The UHR sparker system and USBL positioning system were both subject to delays.

4.1.4 SPECIES/GROUP SPECIFIC EXCLUSION ZONES

After HRG sources were activated, PSOs continued monitoring designated areas around the center location of survey equipment operating below 200 kHz known as exclusion zones (EZs). Additionally, PSOs conducted a 30-minute post-clearance after completion of operations. As with the pre-clearance monitoring zones, exclusion zones implemented on the Kitty Hawk North survey were specific to species/group and the UHR sparker system. EZs monitored on Kitty Hawk North were as follows:

- Sparker EZs
    - 500 m for NARW and ESA-listed whales
    - 450 m for non-ESA listed whales (humpback, minke)
    - 200 m for sea turtles
    - 100 m for all other marine mammals (dolphin exception)

4.1.5 PROTECTED SPECIES SHUTDOWN

The UHR sparker system was immediately shutdown, including during ramp up, when a marine mammal or sea turtle was visually and/or acoustically detected within or about to enter its respective EZ whether due to the animal's movement, the vessel's movement, or because the marine mammal or sea turtle surfaced within its EZ. Reactivation of the of the UHR sparker system starting with ramp up was permitted as soon as was practically possible after the animal(s) was seen leaving its respective EZ or after the following periods had elapsed after the last detection of the animal(s) inside the EZ:

- 60 minutes for sea turtles,
- 30 minutes for non-delphinoid cetaceans;
- 15 minutes for small cetaceans and seals.

Additionally, shutdowns were required for NARW acoustic detections localized within the 500 m EZ or if the NARW(s) were unable to be localized. Shutdowns were also required for any marine mammals for which takes were not authorized or for any whose authorized take numbers had been met.

Dolphins observed within their exclusion zones during survey operations were largely exempt from the shutdown requirement. The UHR sparker could remain active for dolphins from the genera/species *Delphinus*, *Stenella frontalis*, and *Tursiops* that actively/voluntarily approached the vessel.

4.1.6 NON-BIOLOGICAL AND MECHANICAL PAUSES IN HRG EQUIPMENT

The UHR sparker system, and USBL, could be reactivated at full power as soon as was possible after a non-biological or mechanical pause in activity less than 20 minutes if:

- protected species monitoring was continuous,
- the EZs were clear of protected species, and
- all EZs were fully visible during the pause in source activity.

If the above conditions were not met, or the pause in source activity was greater than 20 minutes, a full 60-minute pre-clearance and ramp up (UHR sparker) were required to resume operations.

4.1.7 VESSEL STRIKE AVOIDANCE MEASURES

While underway, either during survey operations or transit, PSOs, vessel operators, and survey crew were required to monitor the area and ensure the species/group specific separation zones listed below for marine mammals and sea turtles were maintained.

- 500 m from NARW and unidentified large marine mammals
- 100 m from any non-delphinoid cetacean
- 50 m from any delphinoid cetacean, pinniped, or sea turtle (exceptions for voluntary approaches)

Vessels were required not to exceed ten knots at any time when operating or transiting within NARW Seasonal Management Areas (SMAs) or while within any Dynamic Management Areas (DMAs), Slow Zones, established for aggregations of NARW as observed by aerial and ship-based observers. Vessels were further required to operate at 10 knots or less when in the presence of any mother/calf pairs, pods, or large assemblages of marine mammals observed near the underway vessel. Vessel operators were also required to maintain the separation distances noted to prevent potential strike.

If a protected species was detected within the separation distance while the vessel was underway, the required mitigation varied by species. The vessel was not permitted to divert course to approach small cetaceans, pinnipeds, or sea turtles. If a small cetacean or pinniped approached the vessel underway, the

vessel was required to avoid excessive speed or abrupt changes in direction. If a large whale, other than NARW, was within the defined 100 m separation distance, the vessel was required to reduce speed and shift to neutral, if practical, until the whale was beyond 100 m.

If a NARW was detected within the 500 m separation distance while the vessel was towing gear and restricted in the ability to maneuver, the vessel would reduce speed and steer the course away from the whale. If a NARW was within 100 m, the vessel would reduce speed and shift to neutral until the whale was beyond 100 m. The vessel could not engage engines if the vessel was stationary while a NARW was detected within 100 m until the animal moved beyond 100 m.

4.1.8 NARW MITIGATION MEASURES

Mitigation measures specific to NARWs were implemented during the survey. The PSOs regularly monitored the NOAA Right Whale Sighting Advisory System (RWSAS), WhaleMap, and/or Whale Alert for the establishment of DMAs and for the presence of any NARWs in or near the survey area. A DMA, Slow Zone, is an area designated by NMFS consisting of a regulatory polygon centered on a confirmed aggregation of NARWs within which vessels must not exceed ten knots. At least once every four hours, the PSO on duty checked the NOAA RWSAS, even though this was only a daily requirement. 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 Avangrid, MMT, and the vessel's marine crew were notified. Each time a DMA check was undertaken by the PSO, a column was marked in the Mysticetus data entry form and was automatically time stamped, georeferenced, and linked to any relevant comments. PSOs were also aware of all NARW SMAs within or near the survey area. All vessels more than 19.8 m long were not to exceed ten knots when within DMAs and/or SMAs to reduce the risk of ship collisions with NARWs.

In addition, PSOs on the vessel were prepared to submit NMFS sighting reports for all NARWs detected from a survey vessel, including photographs, when possible, for Avangrid to submit the information to NMFS. Mysticetus automatically sent out alert texts and/or email notifications to Avangrid, MMT, and MVI upon entry of a NARW sighting in the Mysticetus software.

4.2 OBSERVER METHODOLOGY

4.2.1 VISUAL OBSERVATION

PSOs maintained 24-hour coverage (M/V *Deep Helder*) during times of surveying, transiting, and weather standby at sea with a minimum of one PSO on visual watch at all times. The PSOs did not exceed four-hour shifts without a break between every shift to minimize fatigue and maximize safety and awareness. While on watch, PSOs monitored 360 degrees around the vessel, focusing within the 500-m distance from the HRG acoustic source(s) and the vessel strike avoidance zones. PSOs on board the M/V *Deep Helder* monitored from the bridge and bridge wings (12.65 m deck height above the water's surface). These platforms offered the best vantage points of the EZ and strike avoidance zones.

Nighttime visual observations, using NVDs with IR attachments, were also carried out from the bridge and bridge deck on M/V *Deep Helder*. Daylight and nighttime visual observations were generally conducted outside. When weather made observation conditions detrimental to equipment or personal safety, visual watches were conducted on the bridge. Handheld IR cameras were utilized as a backup to IR attachments and to supplement monitoring of any blind spots due to vessel lighting at night. The handheld IR cameras were also used during reduced visibility daytime operations.

A sample schedule for M/V *Deep Helder* can be referenced in **Table 4-1**.

Table 4-1. Example PSO shift rotation schedule for 24-hour monitoring for all three monitoring platforms (visual, NVD w/ IR, and PAM) onboard the M/V *Deep Helder*.

Time	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
00:00-01:00			**PAM**		**NVD**
01:00-02:00			**PAM**		**NVD**
02:00-03:00				**NVD**	**PAM**
03:00-04:00				**NVD**	**PAM**
04:00-05:00	**NVD**			**PAM**	
05:00-06:00	**VIS/NVD**			D-PAM/**PAM**	
06:00-07:00	**VIS**				D-PAM
07:00-08:00	**VIS**			D-PAM	
08:00-09:00		**VIS**		D-PAM	
09:00-10:00		**VIS**			D-PAM
10:00-11:00	**VIS**				D-PAM
11:00-12:00	**VIS**	D-PAM			
12:00-13:00	**VIS**	D-PAM			
13:00-14:00	**VIS**	D-PAM			
14:00-15:00		**VIS**	D-PAM		
15:00-16:00			**VIS**		D-PAM
16:00-17:00	**VIS**		D-PAM		
17:00-18:00	**VIS**	D-PAM			
18:00-19:00		**VIS**	D-PAM		
19:00-20:00		D-PAM	**VIS**		
20:00-21:00		D-PAM/**PAM**		**VIS/NVD**	
21:00-22:00				**NVD**	**PAM**
22:00-23:00			**NVD**	**PAM**	
23:00-24:00			**NVD**	**PAM**	

VIS	Visual Watch (IR in low vis)
VIS/NVD	Visual or Night Vision Device w/ IR
NVD	Night Vision Device w/ IR
IR	Handheld IR Camera
PAM	Passive Acoustic Monitoring (Night)
D-PAM/PAM	Daytime PAM or PAM (Night)
D-PAM	Daytime PAM (Only if Reduced Visibility)

4.2.1.1 Visual Observations in Daylight – Unaided Eye and Reticle Binoculars

During daylight hours, the PSOs scanned with the unaided eye and utilized reticle binoculars to focus on points of interest when needed. One PSO was required to visually observe the EZ and strike avoidance zones during daytime transits, all survey operations, and while on weather standby at sea. Daylight observations generally coincided with civil twilight times but began as soon as visibility reached a minimum of 500 m and ended as soon as visibility was reduced to less than 500 m due to darkness.

Reticle binoculars were used to estimate the distance to sightings during daylight hours. The following models were utilized by the PSOs onboard the M/V *Deep Helder*: Nikon Ocean Pro 7x50, US Camel 7x50, Amoekie 7x50, Celestron 7x50, Bushnell 7x50, Fujinon 7x50, Hooway 7x50, and Barska Waterproof 7x50. The reticle measurement for a given set of binoculars was calibrated by each PSO utilizing the formula in the Mysticetus software and entering individual eye heights, observation deck (i.e., bridge deck) heights, and the milliradians (mils) represented by each reticle per the binocular manufacturer. Periodically throughout the geophysical survey, the PSOs compared the distance readings from the reticle binoculars to the vessel's radar by using markers at various distances as objects of comparison. PSOs had a digital single-lens reflex camera meeting the requirements for photographing protected species sightings and incidents.

4.2.1.2 Visual Observations in Darkness – NVDs

During hours of darkness, PSOs on watch would utilize NVDs with an IR attachment at slightly varying rates depending on visibility conditions. PSOs would use the NVDs approximately 40 minutes per hour on average. Most PSOs used the NVDs for scans of the mitigation zone, taking extended looks at potential indicators of protected species (e.g., water disturbances at the surface). Bright moonlit nights might require less time spent through NVDs compared to the naked eye and darker, cloudier conditions require more time looking through NVDs compared to the naked eye.

Night vision with an IR attachment, in addition to a handheld IR camera, was utilized for strike avoidance and clearance of the EZ during survey operations at night. The NVDs with IR attachment used aboard the M/V *Deep Helder* were PVS-7 Single Tube Generation 3 Pinnacle® Night Vision Goggles. All NVDs with IR attachments were calibrated prior to survey operations by adjusting the manual focus.

The back deck of the M/V *Deep Helder*, where nearly all work takes place regarding survey equipment, is lit at night for safety. With vessel lights on the aft deck of the M/V *Deep Helder*, PSOs had relatively good visibility directly ahead and to the port and starboards sides. There was minimal visibility using NVDs directly astern of the vessel due to vessel lighting.

4.2.2 IR OBSERVATION METHODS

FLIR E6-XT Wi-Fi handheld IR (HH IR) cameras were used on board the M/V *Deep Helder* during daytime low visibility observations. Handheld IR cameras were also available as to supplement the NVDs with IR attachments when vessel lighting limited NVD capabilities. The FLIR cameras were calibrated by completing an operational check, verifying cable connections, cleaning the viewfinder, checking camera software was updated, verifying the temperature reading, and adjusting the range.

4.2.3 ACOUSTIC MONITORING METHODS

PAM was employed on M/V *Deep Helder* during periods of low visibility (e.g., fog) and darkness (30 minutes prior to sunset to 30 minutes after sunrise) when vessel, survey, and weather conditions did not impede safe deployment. For example, PAM was not conducted when the vessel was surveying or transiting through shallow areas or areas with high densities of fishing gear (primarily lobster) due to the increased chance for an emergency stop and thus thruster entanglement with the PAM hydrophone array.

The Night Hawk III PAM system was supplied by MSeis and MVI. The equipment and monitoring station was initially installed in the Work Shop (container) on the M/V *Deep Helder*. The initial configuration of the array deployment was off the port stern. The M/V *Deep Helder* used a metal pole extension to ensure the array towed out from the vessel.

The Night Hawk III PAM system acquires acoustic data using four wideband omni-directional hydrophones with integral preamplifiers and an acoustic sensitivity for ultrasonic vocalizations to 180 kHz. The system is comprised of an acquisition unit, two laptop computers running the PamguardBeta with bundled JRE12 version 2.01.03 software, one laptop computer running Mysticetus for data input, and GPS connections for localization (**Figure 4-2**).

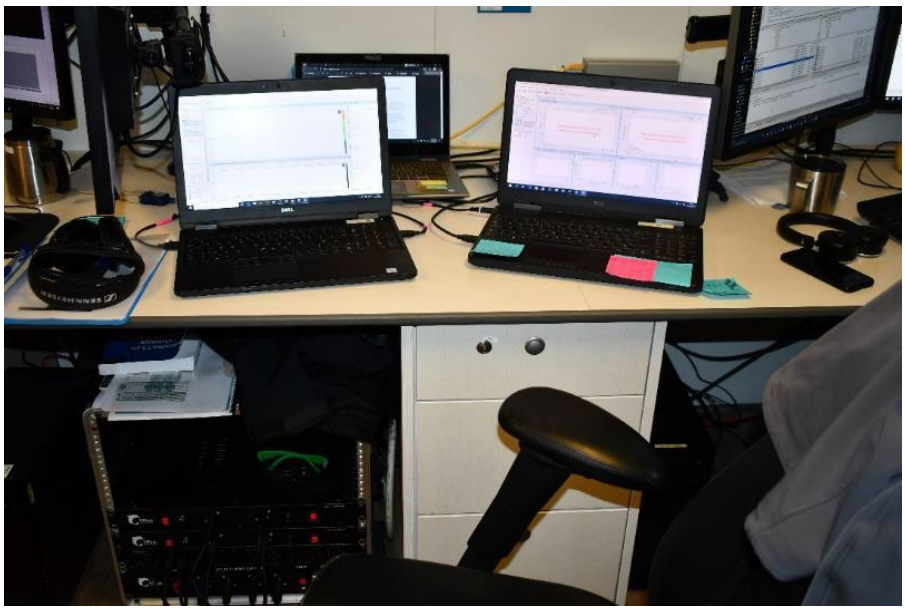

Figure 4-2. PAM station on M/V Deep Helder including two Pamguard laptops, a data acquisition unit, and Mysticetus data collection laptop.

The PAMGuard software was configured for mid/low frequency (MF/LF) and high frequency (HF) vocalizations. The configuration includes a spectrogram display, click detector display, whistle and moan detector, sound recorder, Wigner plot display, and a GPS feed for map properties and tracking for localizations. The Night Hawk III system employs dual signal conditioners for monitoring high frequency, allowing PAMGuard to track the bearing of the HF sound source. In addition to these tools, PAM operators used headphones to listen to the raw acoustic signal.

The hydrophone array was secured on the port side of the back deck. The array was deployed from the port stern deck via a metal pole extension on M/V *Deep Helder* (**Figure 4-3**) while surveying in Kitty Hawk North. The hydrophone array on M/V *Deep Helder* was towed at a distance of 50 m or 75 m when deployed. Due to the varying depths and distances of equipment, a towed hydrophone cable distance of 75 m was selected on M/V *Deep Helder* to minimize entanglement with the gear and still provide a clear signal with minimal interference from the vessel. The survey plan included a number of short survey lines that cross longer survey corridors at a perpendicular angle and certain portions of the survey area had shallow depths. For these reasons, a towed hydrophone distance of 50 meters was used when either of those conditions or survey operations are anticipated to encounter significant currents, which would potentially cause the towed hydrophone cable to drift into HRG survey equipment. The 25-meter towed difference had a negligible effect on the proliferation of vessel noise.

Figure 4-3. PAM deployment method from port stern of M/V Deep Helder.

4.3 PERIODS OF REDUCED VISIBILITY DURING DAYLIGHT

One PSO continued visual observations on board M/V *Deep Helder* during daylight reduced visibility using UE and HH IR. PAM was not conducted when the vessel was transiting through shallow areas or areas with high densities of fishing gear (primarily lobster) due to the increased chance for an emergency stop. This was true for both nighttime operations and during the daytime reduced visibility operations.

4.4 MYSTICETUS™ OBSERVATION SOFTWARE

Data collection for reporting was gathered and organized using Mysticetus software. Data collected is in compliance with the BOEM Lease OCS-A 0508 and the 2021 NMFS IHA (see **Table 3-2**). Daily analyses of observation data are used to compose daily reports of observation efforts, detections of protected species, mitigation actions, and Level B take estimates. QA/QC was completed for each 24-hour period of data by the PSO, lead PSO, PSO project manager, and Mysticetus data analyst. Data was stored from Mysticetus to a cloud location, backed up on a secure digital (SD) card, and backed up on an external hard drive.

4.4.1 CROSS-VESSEL DETECTION COORDINATION

Mysticetus software automatically shares sightings between all vessels (with Mysticetus on board) conducting operations in support of Avangrid projects. Protected species detections are plotted on a shared map display in near real-time as PSOs enter detection information. The Mysticetus software emits an audible alert and shows the predicted path of the animal to help avoid vessel collisions. NARW DMAs and SMAs are also displayed automatically for PSOs to visualize on the map in the Mysticetus software.

4.5 DATA COLLECTION AND ANALYSIS METHODS

Consistent data collection protocols were applied to all survey operations and analyses. PSOs and PAM operators documented all protected species detections and effort throughout all project operations. All data identified in the regulatory documents (refer to **Table 3-2**) were collected in a predetermined template on a laptop using Mysticetus. Effort data consisted of environmental variables, vessel activity, and survey activity. Effort data were recorded every 30 minutes when PSOs were on effort, when monitoring conditions changed, and during each protected species detection.

Effort data are summarized as two distinct categories: monitoring effort and PSO effort. Monitoring effort captures any time when at least one visual or acoustic PSO was on watch. By definition, monitoring effort cannot exceed 24 hours in a single day. Regardless of how many PSOs conducted active monitoring during a given day, monitoring effort is present across a range of environmental and operational conditions and is reported as both time (e.g., hours) and vessel track line 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, NVD with IR, and PAM). By definition, PSO effort can exceed 24 hours 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 hours are also summarized based on *daylight* versus *darkness*, HRG sound source operating below 200 kHz *on* versus *off*, and which HRG sources were operational. **Table 4-2** provides definitions of data terminology.

Table 4-2. Definitions of data collection and analysis terminology used on surveys conducted under the BOEM OCS-A 0508 lease and the 2021 NMFS IHA.

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 above 6° below the horizon)
Detection	A protected species group (single or multiple individuals) sighted visually (with UE, HH IR, or NVD w/ IR) or identified acoustically with PAM
Detection Rate	Number of detections per hours of individual PSO effort[1]
Source(s) Below 200 kHz Active	Periods when the UHR sparker was on
Source(s) Below 200 kHz Inactive	Periods when the UHR sparker was off
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 hours 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 hours per day
Monitoring Effort Off	Periods when no visual or acoustic PSO was monitoring for protected species

Term	Definition
PSO Effort	Total PSO person-hours allocated to monitoring for protected species – can exceed 24 hours in a day, unlike PSO monitoring effort

[1] Total effort for calculating detection rates using individual equipment effort.

For each protected species detection, PSOs were to record the lowest taxonomic level of animal identification for which they were confident, down to species when possible. Detection distances, including closest point of approach (CPA), were to be measured or estimated from the animal to the closest point to sound sources and/or closest point to PSO. For every detection, protected species movements relative to the vessel and/or sound source, initial and secondary behaviors, and any behavioral reactions were to be recorded based on a predefined protocol.

Behaviors included blow, bow ride, breach, chase fish, dead, feed, fluke up, injured, look, mill, none, porpoise, rest, socialize, splash, surface-active mill, surface-active travel, swim, tail slap, travel, other (defined in Mysticetus notes), and 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, slow down, speed up, splash, and other (defined in Mysticetus notes).

Detection rates were used to standardize the number of detections by PSO unit of effort. Detection rates were calculated as the number of detections per hour of PSO effort (**Table 4-2**). For different/alternative monitoring devices, detection rates were calculated as the number of detections by monitoring method, divided by the number of hours of PSO effort for each respective method. Hours were used as the effort unit for detection rate analysis since observations still occurred if the vessel was stationary.

Collection of PSO effort and detection data over this short duration project did not provide enough data for a robust analysis of the effectiveness of monitoring devices (UE, NVD with IR, and PAM).

4.5.1 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 TTS or a behavioral disturbance to the animals (NMFS, 2018). NMFS considers a Level B take to occur at anthropogenic sound levels greater than or equal to 120 dB re 1 µPa m RMS for continuous sound and 160 dB re 1 µPa m RMS for intermittent sound that is either impulsive or non-impulsive.

The UHR sparker was the only HRG sound source operating below 200 kHz used during the Kitty Hawk North survey determined to have the potential to result in Level B harassment. The USBL positioning system was not expected to result in Level B harassment.

Level A take is defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild and occurs at higher acoustic thresholds than Level B harassment, which also vary by species based on their hearing sensitivity (NMFS, 2018). Level A and Level B harassment is known to result from cumulative exposure to source(s) of concern and would not be instantaneous upon exposure. The maximum estimated Level A harassment isopleth was 120.5 m for HF cetaceans. The Level A harassment isopleth was 17.9 for LF cetaceans, 0.5 for MF cetaceans, and 10.0 for phocid pinnipeds (Survey Plan, 2021). Thus, the risk of Level A exposure from active HRG equipment of any kind was considered highly unlikely with the established EZs. Level A take is not typically authorized by NMFS for HRG survey activities, 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 equipment meeting or exceeding NMFS exposure guidelines were calculated by Tetra Tech/Avangrid in the Application for Marine Mammal Protection Act Incidental Harassment Authorization (IHA Application, 2021). The Level B isopleth was modeled to 445 m for the UHR sparker system. The Level B harassment zones were modeled for the USBL; however, this equipment was not expected to result in Level B exposures as determined by Avangrid in NMFS consultation and as determined by the BOEM Biological Assessment (revised February 2021). Therefore, the USBL was excluded from **Table 4-3**.

Table 4-3. Estimated distances to NMFS Level A and Level B acoustic threshold for the UHR sparker (operating frequency defined) (Survey Plan, 2021).

Sound Source	Frequency (kHz)	Distance to Level A Threshold (m) for each species hearing group				Distance to Level B Threshold (m)
		LF Cetacean	MF Cetacean	HF Cetacean	Pinniped	All Species
Medium Penetration Depth Seismic Source: UHR Sub-bottom Profiler (SBP) or Sparker						
Geo-Source 400 Tip Sparker Source (800 J)	0.25-3.25 kHz	17.9	0.5	120.5	10.0	445.0

The number of potential exposures was based on direct observations of protected species within this 445 m Level B isopleth of the UHR sparker when in operation. The estimated number of animals detected within this distance were considered potential exposures.

5.0 UHR SPARKER MEDIUM PENETRATION SBP SURVEY RESULTS

Monitoring effort, observation conditions, vessel activity, protected species detections, and detection distribution data for the M/V *Deep Helder* during HRG survey activities on the Kitty Hawk North lease OCS-A 0508 are summarized below. Please note that any discrepancies in table totals are due to rounding.

5.1 MONITORING EFFORT

During the sparker survey, the M/V *Deep Helder* accrued a total of 3909.9 km of vessel track line while PSOs and PAM operators were monitoring for protected species during 3909.9 km of monitoring effort. Monitoring effort was greater during darkness than during daylight, with 2050.8 km of observation during darkness and 1859.1 km of observation during daylight (**Table 5-1**).

Table 5-1. Vessel trackline length in km completed by the M/V *Deep Helder* while PSOs were monitoring during the daylight and darkness, as well as when HRG equipment below 200 kHz was active or inactive between 19 September - 25 October 2021.

Survey Vessel	Wind Farm(s) Surveyed	Vessel Trackline (km)				
		Daylight	Darkness	HRG Equipment Active	HRG Equipment Inactive	Total
M/V *Deep Helder*	Kitty Hawk North	1859.1	2050.8	2965.5	944.3	3909.9

HRG equipment operating at frequencies below 200 kHz was active for 489.5 h of monitoring effort, which accounted for 81.2% of the total vessel trackline (**Table 5-1**). The UHR sparker and USBL were often in operation simultaneously on M/V *Deep Helder* (**Figure 5-1**). Monitoring effort was completed while the UHR sparker was active for 81.2% of the time and was conducted primarily during survey operations and transit (**Figure 5-2**).

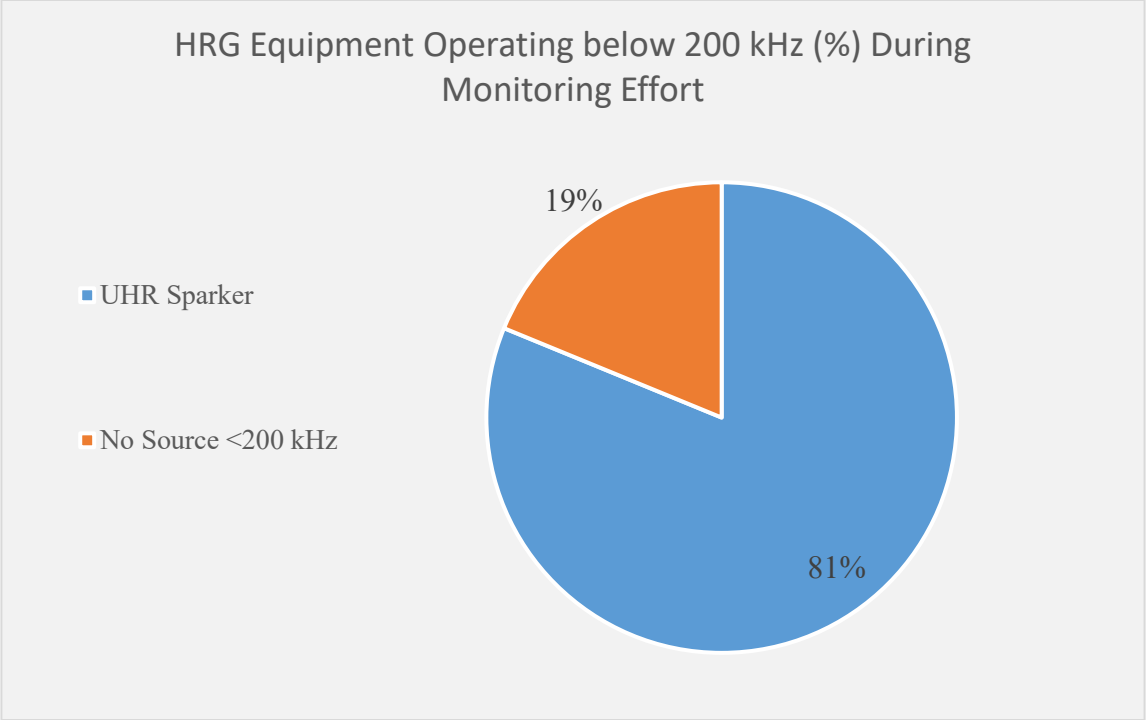

Figure 5-1. HRG equipment operating below 200 kHz during the UHR sparker medium penetration SBP survey monitoring effort.

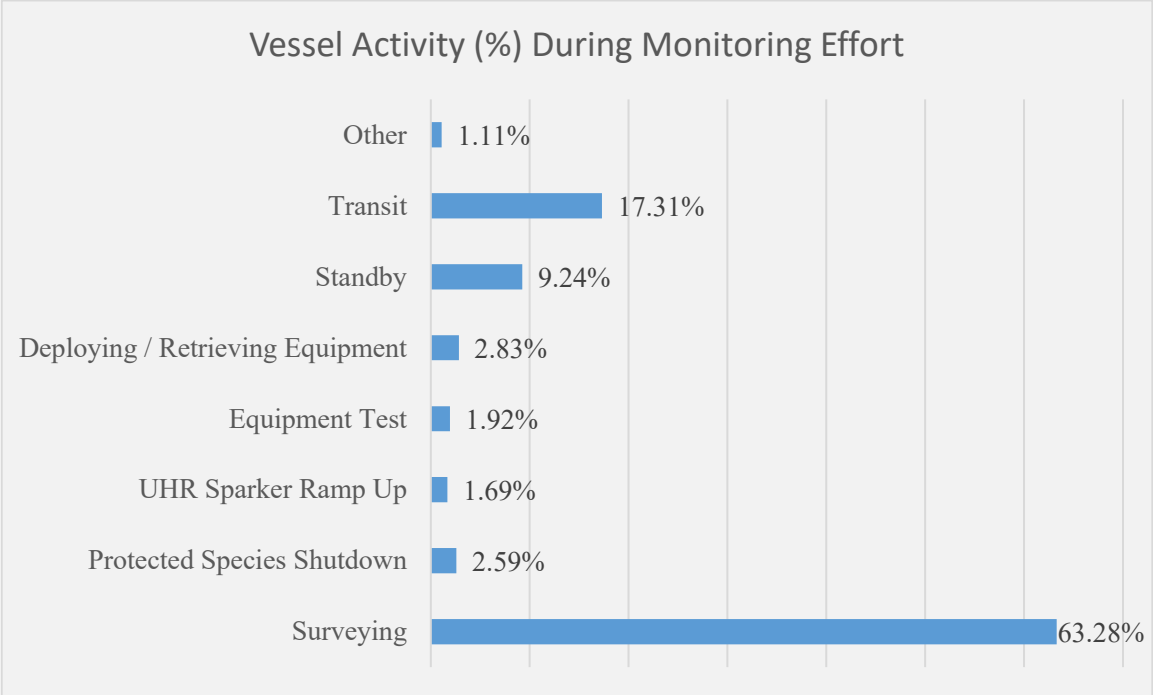

Figure 5-2. Breakdown of vessel activity during the UHR sparker medium penetration SBP survey monitoring effort. Other includes docked, other; Standby includes: standby and weather standby.

5.2 MONITORING CONDITIONS

Environmental conditions, such as Beaufort sea state and atmospheric conditions can influence the ability to detect marine mammals visually; therefore, details on various environmental conditions were recorded by the PSOs every 30 minutes or when conditions changed. Conditions were fair over the course of the UHR sparker medium penetration SBP survey. Beaufort sea states of B3 or less are considered the best for protected species observation, where sea states above B5 are considered poor. The majority of the monitoring effort, 69% took place during sea states of B3 or less. Only 16% of the monitoring effort was conducted during elevated sea states of B5 or higher. It is important to note that UHR sparker operations did not occur during poor sea states. Overall, 86% of the monitoring effort was conducted during fair Beaufort sea state (**Figure 5-3**). Clear and partly cloudy skies were noted most often during the Kitty Hawk North survey; however, some overcast skies and periods of light rain occurred. during 11% of the monitoring effort (**Figure 5-4**).

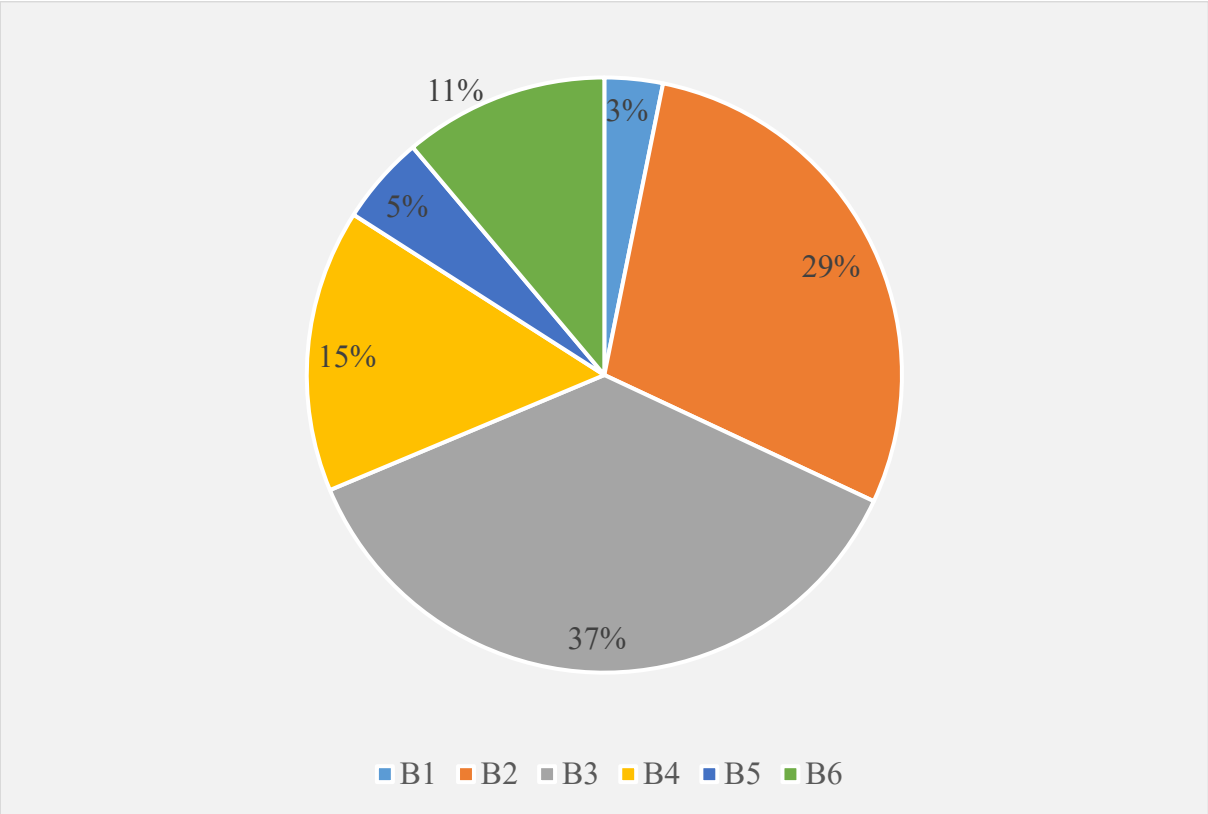

Figure 5-3. Beaufort sea state during the monitoring effort on the Kitty Hawk North UHR sparker medium penetration SBP survey.

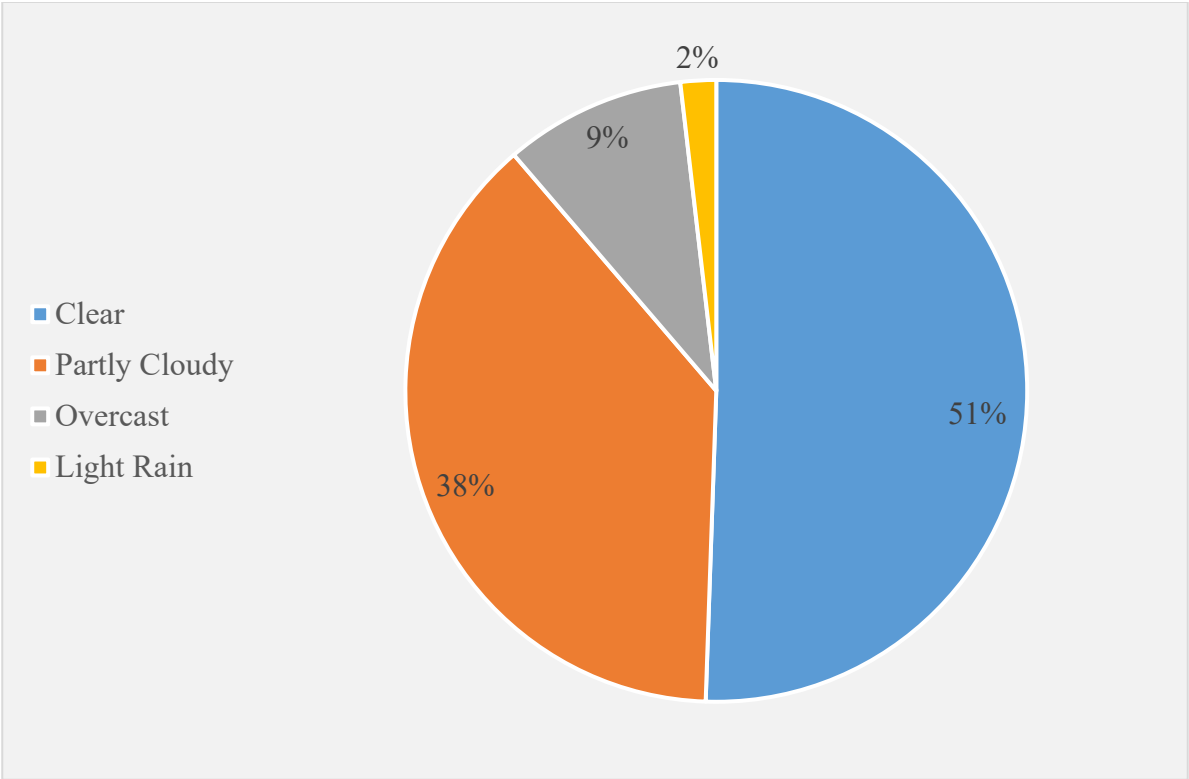

Figure 5-4. Atmospheric conditions during the monitoring effort on the Kitty Hawk North UHR sparker medium penetration SBP survey.

An overall visual quality metric was developed to classify conditions for visual observations by combining Beaufort sea state and visual distance. The three visual quality classifications were determined as follows:

- Good: sea state B0-B3 and/or a visual distance of 2-10 km,
- Moderate: sea state B4 and/or a visual distance of 0.5 ≥ 1 km, and
- Poor: sea state >B4 and/or a visual distance of 0.5 km or less.

The high percentage of low sea state and good weather conditions contributed to an overall fair visual quality during the Kitty Hawk North UHR sparker medium penetration SBP survey, with 85% of the monitoring effort conducted during moderate to good conditions (**Figure 5-5**). Poor visibility at night was occasionally the result of low ambient light levels, which often limited the visual distance to 500 m. However, the NVDs were able to work effectively to a range of at least 500 m with overcast starlight. NVDs were used to visually monitor for protected species during darkness and required good ambient light levels to function at their highest efficiency. NVDs were supported by both IR attachment and by backup handheld IR cameras in case of low ambient light.

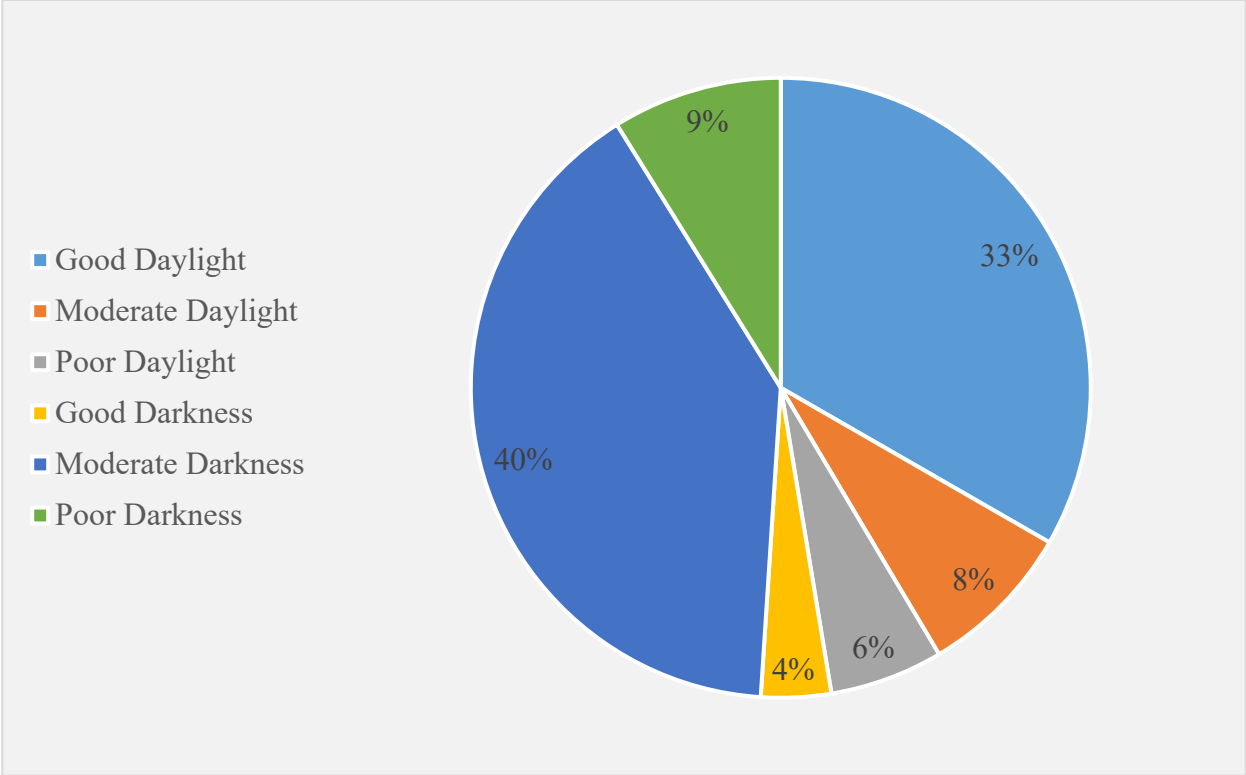

Figure 5-5. Overall visual quality the monitoring effort on the Kitty Hawk North UHR sparker medium penetration SBP survey. Good: sea state of B0-3 and/or visual distance of 2-10 km. Moderate: sea state of B4 and/or visual distance 0.5 ≥ 1 km. Poor: sea state of >B4 and/or a visual distance of 0.5 km or less.

5.3 PSO EFFORT

During the UHR sparker medium penetration SBP survey, the cumulative PSO effort across all monitoring methods was 802.0 h (**Table 5-2**). Visual monitoring during darkness was accomplished with NVD with an IR attachment. PAM was primarily conducted at night (197.7 h) when weather and operational conditions allowed for a safe deployment; however, monitoring was also conducted during the day for 21.5 h as part of the standard overlap with visual observations (30 minutes before/after sunset/sunrise) and during periods of reduced visibility. The combined visual methods of UE and NVD w/ IR accounted for 75.3% of the PSO effort, while PAM accounted for 24.7% of the PSO effort (**Figure 5-6**).

Table 5-2. PSO effort (h) by monitoring method for the Kitty Hawk North UHR sparker medium penetration SBP survey.

Monitoring Method	Effort (h) by Monitoring Method		
	Daylight	Darkness	Total Effort
Visual PSO	285.6	318.7	604.3
PAM	21.5	176.2	197.7
		PSO Effort	802.0

PSO = projected species observer; PAM = passive acoustic monitoring

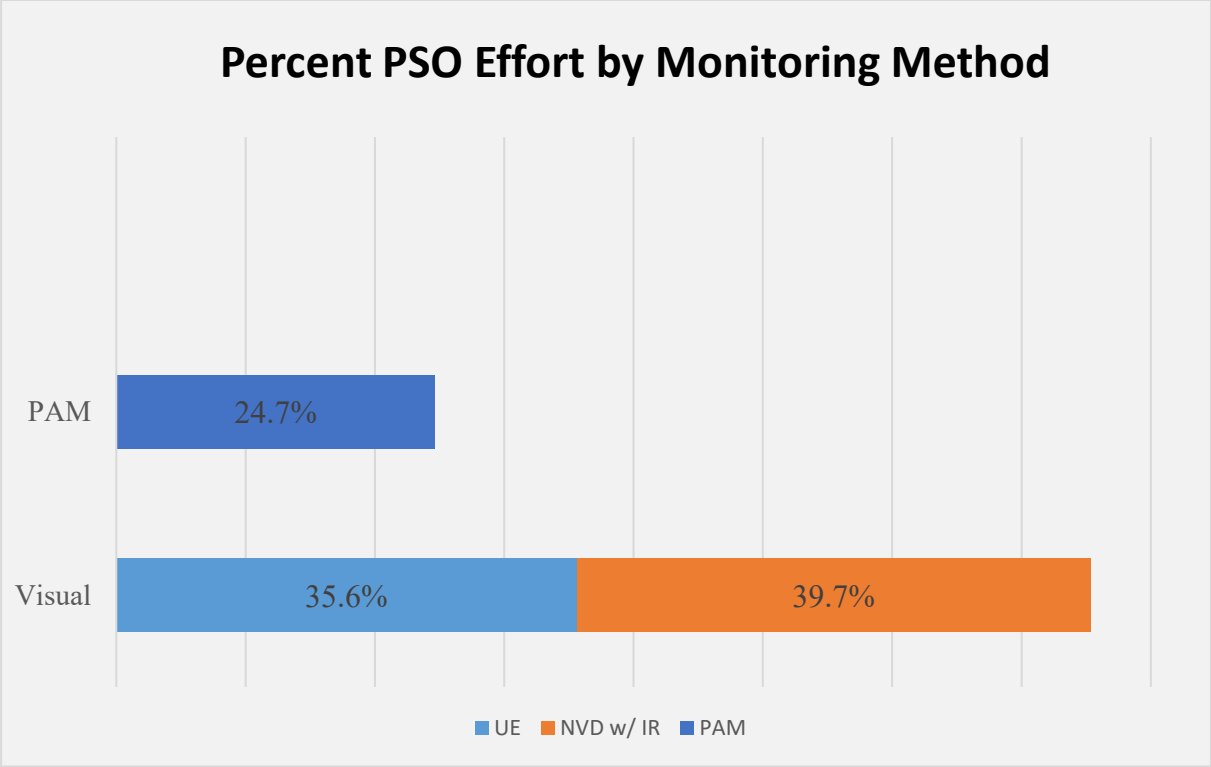

Figure 5-6. Percent PSO effort by monitoring method of the UHR sparker medium penetration SBP survey. Visual monitoring was subdivided into the three categories of visual observation, UE during the day and NVD w/ IR during darkness. UE = unaided eye; NVD w/ IR = night vision device with IR attachment; PAM = passive acoustic monitoring.

5.4 PROTECTED SPECIES DETECTIONS

During the UHR sparker medium penetration SBP survey, a total of 81 protected species detection events, including 76 single platform (66 visual and ten (10) acoustic) and five (5) multi-platform concurrent detections were recorded during the Kitty Hawk North survey. An estimated 431 individuals were observed during those detection events. Concurrent detections were defined as detection events where protected species were observed simultaneously or within a few minutes of each other using two or more independent monitoring methods (visual and PAM). When separated across all monitoring methods (disregarding concurrent detections and treating each platform independently) a total of 86 detections were recorded including: 60 UE visual, 11 NVD w/ IR visual, and 15 acoustic. A greater number of detection events were made during daylight compared to darkness, with 63 and 23 detections respectively (**Figure 5-7**). Daylight detections are typically greater in number due to the ability to sight animals at great distances well outside of the monitoring zones with both the unaided eye and reticle binoculars.

Most (98.8%) protected species detections occurred while continuous HRG acoustic sources below 200 kHz were active (**Figure 5-8**). The overall mean CPAs to the UHR sparker were 178 m across all protected species detection events made while UHR sparker was active. CPAs to non-mitigatable sources below 200 kHz were not considered for the evaluation of CPA. Delphinids and sea turtles had much lower mean CPAs to the UHR sparker than the mysticete whale sighted (**Table 5-3**).

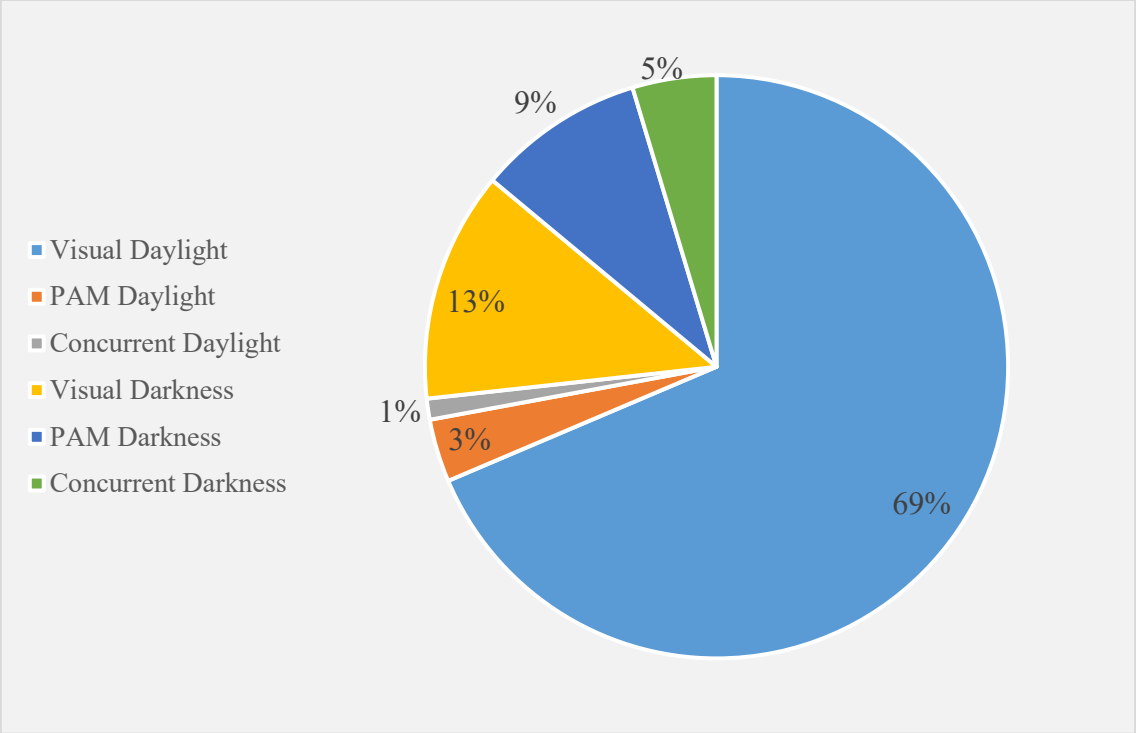

Figure 5-7. Percent of protected species detection events recorded during daylight and darkness by detection method or combination of methods (concurrent) during the UHR sparker medium penetration SBP survey.

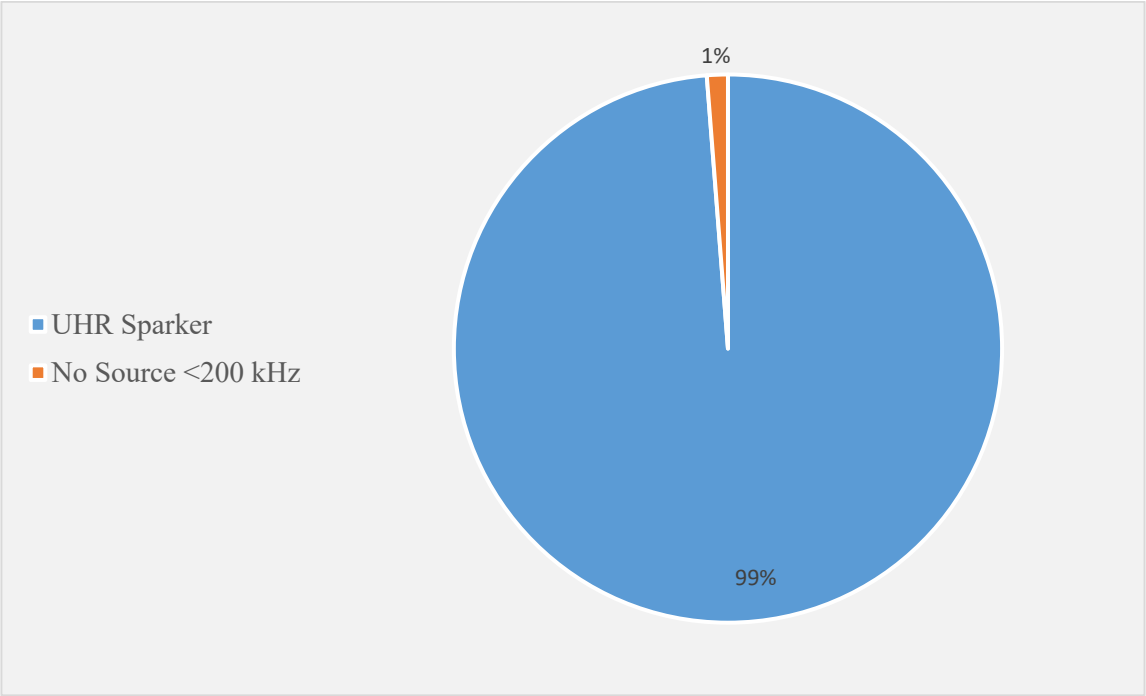

Figure 5-8. Percent of protected species detection events recorded while HRG sources operating below 200 kHz were active or inactive (no source <200 kHz) during the UHR sparker medium penetration SBP survey.

Table 5-3. Closest point of approach (CPA) to active UHR sparker and chirp SBP for marine mammals and sea turtles observed during the Kitty Hawk North survey. Minimum (min), maximum (max), and mean values are provided.

Protected Species Group	CPA (m) to Active HRG Equipment Below 200 kHz		
	UHR Sparker		
	Min.	Max.	Mean
Delphinid	1	3430	163
Sea turtle	50	840	150

Atlantic spotted dolphins (*Stenella frontalis*) and unidentified dolphins were the most frequently detected species/group; however, loggerhead sea turtles (*Caretta caretta*) and unidentified sea turtles were detected in relatively high numbers (**Table 5-4**). The distribution of all detections made during the Kitty Hawk North sparker survey are provided in **Figure 5-9**.

Table 5-4. Protected species observed including estimated number of individuals during the Kitty Hawk North UHR sparker medium penetration SBP survey.

Species	Number of Detections [a]	Estimated Number of Individuals
Humpback whale (*Megaptera novaeangliae*)	1	1
Atlantic spotted dolphin (*Stenella frontalis*)	33 [b] 24 [c]	324 218 [c]
Short-beaked common dolphin (*Delphinus delphis*)	2 1 [c]	7 2 [c]
Unidentified dolphin	26 [b] 9 [c]	48 32 [c]
Loggerhead sea turtle (*Caretta caretta*)	11	11
Leatherback sea turtle (*Dermochelys coriacea*)	1	1
Unidentified sea turtle	7	7
Totals	**81**	**399**

[a] Concurrent detections made between different monitoring platforms (e.g., visual observation, acoustic monitoring) of the same individual(s) are counted together as a single detection event.
[b] Includes acoustic detection(s).
[c] Number of potential exposure events or individuals subject to potential exposure.

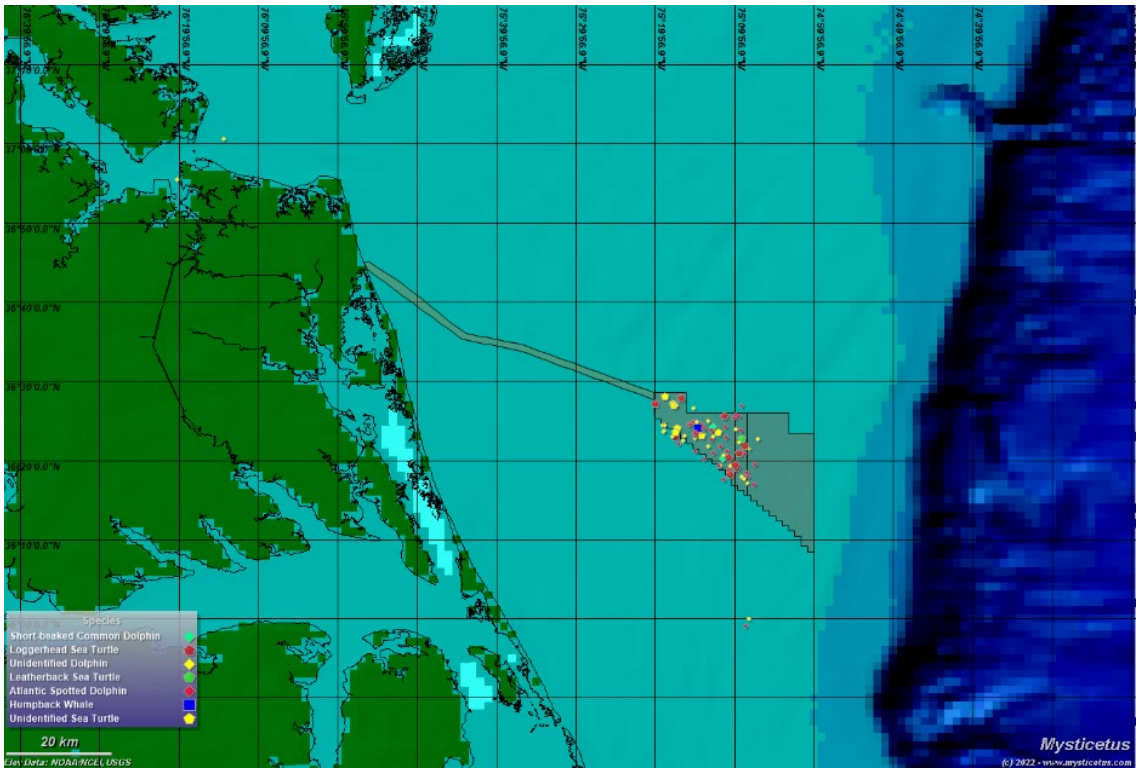

Figure 5-9. Distribution of protected species detections on M/V Deep Helder during the UHR sparker medium penetration SBP survey.

The overall detection rate for all monitoring efforts combined was 0.11 detections per hour of PSO effort (**Table 5-5**). Of the three (3) different methods of detection, UE had the highest detection rate at 0.21 detections per hour of visual monitoring effort. PAM had the second highest detection rate of 0.08.

Table 5-5. Protected species detection rates for each method of detection, as well as combined PSO effort across all monitoring platforms during the UHR sparker medium penetration SBP survey. Note: UE and NVD w/ IR hours differ slightly from Table 5-2 due to cross-over efforts into daylight or darkness using visual methods (UE immediately after dusk for example).

Method of Detection	Total Number of Observation Hours	Total Number of Detections	Detection Rate (detections per hour of effort)
UE	285.6	60	0.21
NVD w/ IR	318.7	11	0.03
PAM	197.7	15	0.08
Total PSO Effort	**802.0**	**86**	**0.11**

5.4.1 NARW DETECTIONS

There were no detections of NARWs (*E. glacialis*) throughout the UHR Sparker medium penetration SBP survey or the MBES survey.

5.4.2 SEA TURTLE DETECTIONS

There were a total of 19 sea turtle detections during the Kitty Hawk North UHR sparker medium penetration SBP survey. Eleven (11) loggerhead sea turtles (*C. caretta*), one (1) leatherback sea turtle (*D. coriacea*), and seven (7) unidentified sea turtles were observed throughout the Kitty Hawk North UHR sparker medium penetration SBP survey. The locations of the sea turtle detections are provided in **Figure 5-10** and a photograph of the loggerhead from visual sighting eight (8) may be referenced in **Figure 5-11**.

Observations at night were performed by two PSOs. One visual PSO used a single night-vision device equipped with infrared capabilities, for ease and rapidity in switching between the two technologies. Additionally, handheld IR cameras were readily available as a back-up. The second nighttime PSO was a PAM operator, using passive acoustic monitoring to detect species out of visual range. Within the 2021 NMFS IHA, the availability of night-vision goggles "and/or" infrared technology is required for use during nighttime monitoring. With both of these technologies provided in a single device used by the visual PSO, coupled with concurrent acoustic monitoring by the PAM operator using acoustic monitoring, the intent was to provide the most thorough approach to nighttime monitoring coverage. The IHA lacked definition on whether the second PSO can be a PAM operator, referred to as an acoustic PSO in language used within NMFS approval e-mail letters from the NOAA Service Account ,and the 2013 Endangered Species Act Section 7 Consultation Biological Opinion Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf in Massachusetts, Rhode Island, New York and New Jersey Wind Energy Areas NER-2012-9211 GARFO-2012-00011 referring to acoustic observation by PSOs, the term PSO was thought to also refer to PAM operators as most PAM operators gain experience working as a PSO prior to becoming certified as a PAM operator, although it is now understood the intent was to have an additional visual PSO for this project. With one visual PSO utilizing a combined night vision and IR technology along with backup handheld IR camera for blind spots, a PAM operator for additional mitigation at night is an effective compliment with the number of PSOs approved through the Survey Plan which also requires PAM as alternative monitoring. Of the three methods of detection, UE, NVD with IR, and PAM, UE had the highest detection rate and PAM had the second highest (section 5.4 Protected Species Detections). Visual PSOs who are also qualified in the use of PAM often rotate through visual and acoustic watches throughout their daily schedule, using NVD, IR cameras and PAM technologies. This contributed in part to the language in the IHA to be understood as meaning one visual PSO and one acoustic PSO on duty during nighttime. To ensure clarity going forward, additional pre-project requirement clarification meetings will be held with clients and agencies, and a table comparing monitoring and mitigation requirements listed within the multiple governing documents will be created to illuminate where further consultation with clients and agencies is needed. Opportunities to collaborate with regulatory agencies in the bridging of language discrepancies within differing documents, including the IHA and NMFS approval email letters, to improve clarity in the future are welcome.

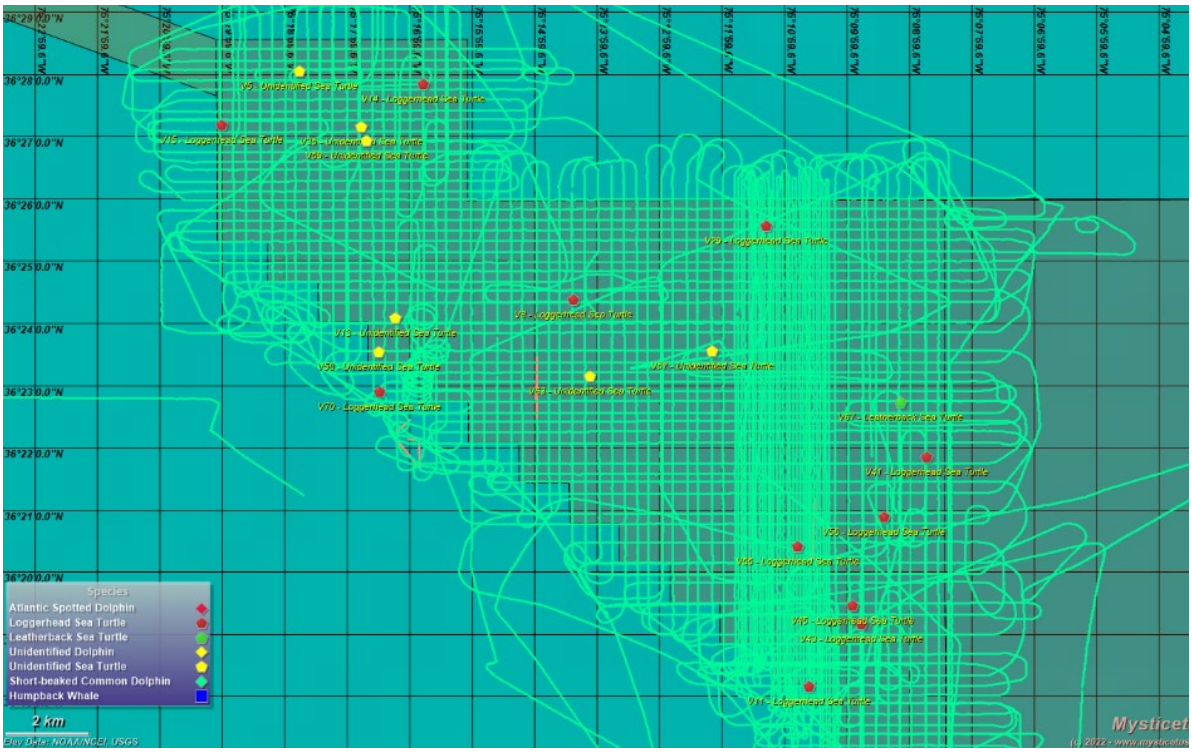

Figure 5-10. Location of M/V Deep Helder sea turtle detections during the UHR sparker medium penetration SBP survey.

Figure 5-11. Loggerhead sea turtle (V8) visually detected on 02 Oct 2021 (PC: C. Mehle).

5.4.3 PROTECTED SPECIES BEHAVIOR

Protected species observed during the Kitty Hawk North UHR sparker medium penetration SBP survey exhibited typical behaviors. The humpback whale behavior consisted of blows and travel. Delphinids initial behaviors observed included bow ride, breach, porpoise, splash, surface-active mill, surface-active travel,

swim, tail slap, and travel, Secondary behaviors included many of the same with the addition of feed and socialize. Sea turtle behaviors observed included rest, splash, swim, and travel.

An estimated 15.4% of marine mammals visually detected were observed to change behavior while the HRG acoustic sources below 200 kHz were active. There was not enough data to determine change in behavior when the HRG acoustic sources were not active. The most frequently observed behavioral reactions were change direction, dive, or speed up. Delphinids and sea turtles were noted to change direction on seven (7) and one (1) instance(s) respectively. Dive was noted for six (6) sea turtle detections, while speed up was noted for two (2) delphinid detections.

5.5 MITIGATION MEASURES

5.5.1 PROTECTED SPECIES MITIGATION

During the UHR sparker medium penetration SBP survey, protected species mitigation measures were requested and implemented on 26 occasions, including 23 shutdowns of the UHR sparker and three (3) delays to the activation of this equipment (**Table 5-6**). Shutdowns occurred more frequently for sea turtles (65.2%) and less frequently for dolphins (34.8%). There were no whale species involved in any shutdown events. There were a total of three (3) detection delays. Detection delays for loggerhead sea turtles (*C. caretta*) were implemented on two (2) occasions and a detection delay for Atlantic spotted dolphins (*S. frontalis*) was implemented on one (1) occasion.

Table 5-6. Summary of mitigation actions implemented for protected species during the Kitty Hawk North UHR sparker medium penetration SBP survey.

Species	Number of Mitigation Actions Implemented for HRG Sources Below 200 kHz	
	Protected Species Shutdown	Detection Delay
	UHR Sparker	UHR Sparker
Atlantic spotted dolphin (*Stenella frontalis*)	2	1
Unidentified Dolphin	6	0
Loggerhead sea turtle (*Caretta caretta*)	8	2
Leatherback sea turtle (*Dermochelys coriacea*)	1	0
Unidentified Sea Turtle	6	0
Total	**23**	**3**

Mitigation measures implemented on the Kitty Hawk North UHR sparker medium penetration SBP survey resulted in 19.5 h of protected species downtime (exclusive of ramp up and vessel adjustments to rejoin the survey line). Detection delays resulted in slightly more downtime than shutdowns (**Table 5-7**).

Table 5-7. Duration of mitigation actions (h) implemented during the Kitty Hawk North UHR sparker medium penetration SBP survey.

Duration of Mitigation Actions Implemented for HRG Equipment Below 200 kHz (h)			
Protected Species Shutdown		Detection Delay	
UHR Sparker	18.2	UHR Sparker	1.3
		Grand Total	**19.5**

5.5.1.1 Strike Avoidance Measures

There were no vessel strike avoidance actions necessary or taken for protected species throughout the reporting period for the UHR sparker medium penetration SBP section of the survey, please note there was one strike avoidance measure for the MBES survey (**Section 6.5.1.1**).

5.5.2 WEATHER RELATED MITIGATION

There were no weather-related mitigation measures necessary for the duration of the project.

5.6 PROTECTED SPECIES EXPOSURES

During the UHR sparker medium penetration SBP survey, a total of 184 Atlantic spotted dolphins (24 events), two (2) short-beaked common dolphins (one (1) event), and 32 unidentified dolphins (nine (9) events) were observed within the 445 m Level B harassment zone (modeled 160 decibels root mean square (dB_{RMS}) isopleth) during active UHR sparker operations (**Table 5-8**). Individuals per event can be referenced in the detection data included in **Appendix A**. Please note that there was one sighting of Atlantic spotted dolphins where only seven (7) individuals out of 25 were potential exposures. All appropriate mitigation and shutdown protocols were followed and a total of 218 marine mammals had potential exposure to UHR sparker source levels of at least 160 dB_{RMS}.

Table 5-8. Number of individuals and events observed during high-resolution geophysical survey operations utilizing active sources operating at less than 200 kHz by species.

Species	Total Authorized Level B Takes under Current IHA [a]	Total observed at any distance during active sparker operations	Total within 445 m of active sparker operations	Percent of authorized takes realized based on detection data
Humpback whale (*Megaptera novaeangliae*)	1	1	**0**	N/A
Atlantic spotted dolphin (*Stenella frontalis*)	208	217	**184** [b] **24** [c]	89%
Short-beaked common dolphin (*Delphinus delphis*)	221	7	**2** [b] **1** [c]	1%
Unidentified Dolphin	N/A	46	**32** [b] **9** [c]	N/A
Loggerhead sea turtle *(Caretta caretta*)	N/A	8	8	N/A
Leatherback sea turtle (*Dermochelys coriacea*)	N/A	1	1	N/A
Unidentified Sea Turtle	N/A	7	6	N/A
Total potential exposures			**218** [b] **34** [c]	

IHA = incidental harassment authorization; N/A = not applicable.
[a] NMFS IHA issued 21 July 2021.
[b] Number of individuals.
[c] Number of events.

5.7 PROTECTED SPECIES INCIDENT REPORTS

There were no protected species incidents throughout the UHR sparker medium penetration SBP survey or MBES survey.

6.0 MULTIBEAM ECHO SOUNDER (MBES) SURVEY RESULTS

6.1 MONITORING EFFORT

The M/V *Deep Helder* accrued a total of 3335.0 km of vessel track line while PSOs were monitoring for protected species during 3335.0 km of monitoring effort. Monitoring effort was greater during darkness than during daylight, with 2010.4 km of observation during darkness and 1324.7 km of observation during daylight (**Table 6-1**). Of the 3335.0 km monitored for strike avoidance, 2904.9 km was with the MBES active. Equipment operations during monitoring for this section of the survey consisted mostly of MBES operations.

Table 6-1. Vessel trackline length in km completed by the M/V *Deep Helder* while PSOs were monitoring during the daylight and darkness for the MBES surveying effort.

Survey Vessel	Wind Farm(s) Surveyed	Vessel Trackline (km)			
		Daylight	Darkness	MBES Active	Total
M/V *Deep Helder*	Kitty Hawk North	1324.65	2010.37	2904.88	3335.02

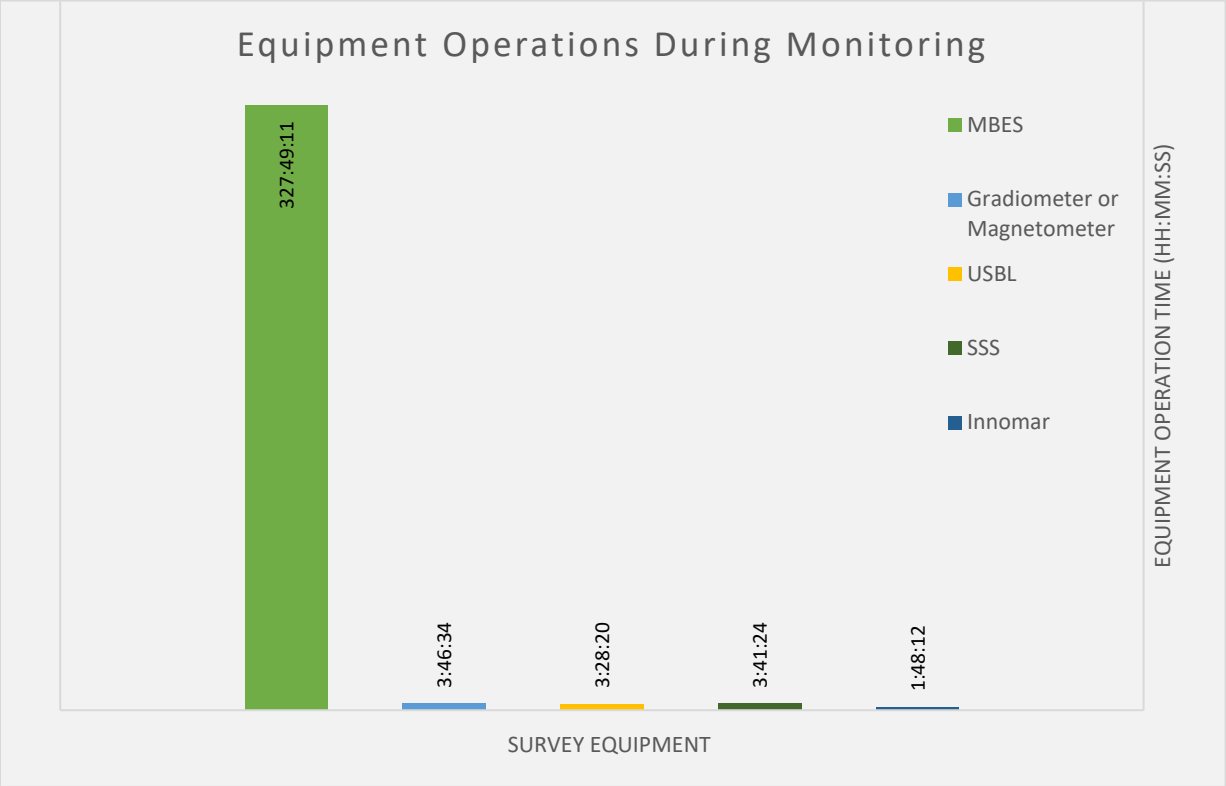

Figure 6-1. Equipment operations during the MBES survey monitoring effort.

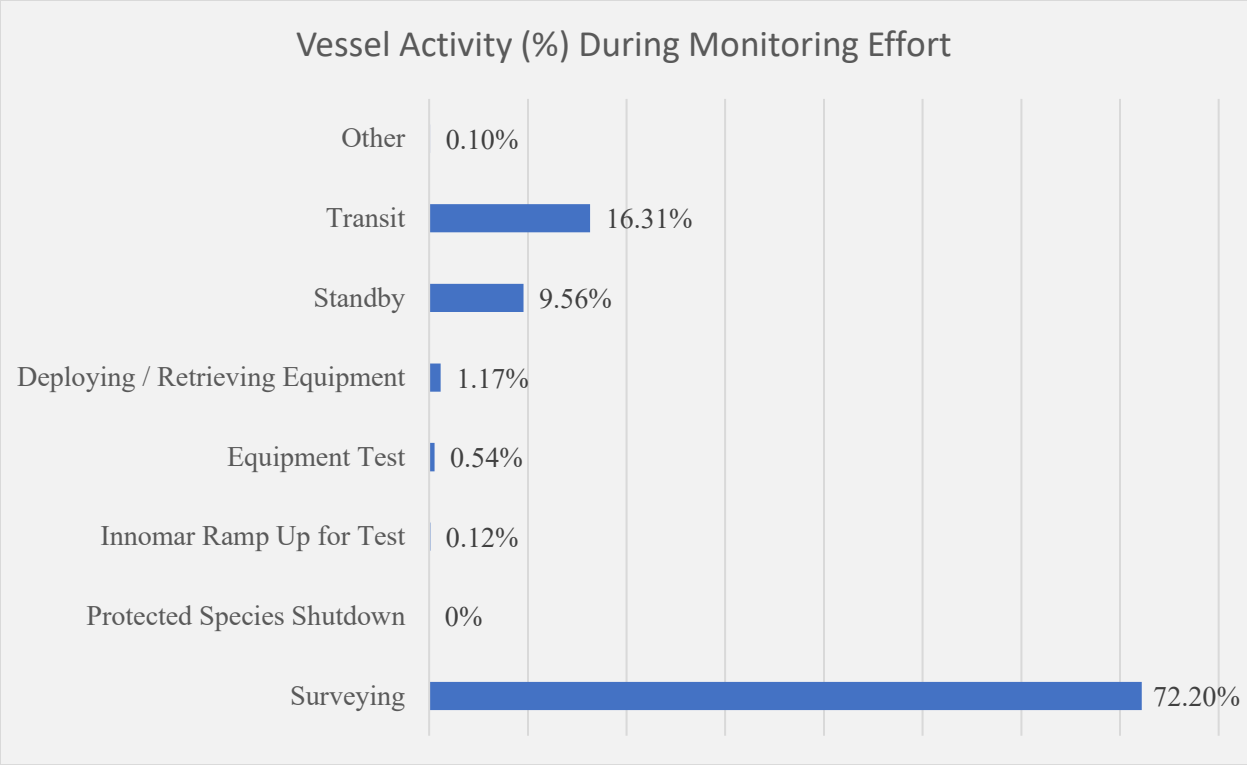

Figure 6-2. Breakdown of vessel activity during the MBES survey monitoring effort. Other includes docked; Standby includes standby and weather standby.

6.2 MONITORING CONDITIONS

Environmental conditions, such as Beaufort sea state and atmospheric conditions can influence the ability to detect marine mammals visually; therefore, details on various environmental conditions were recorded by the PSOs every 30 minutes or when conditions changed. Conditions were fair over the course of the survey. Beaufort sea states of B3 or less are considered the best for protected species observation, where sea states above B5 are considered poor. The majority of the monitoring effort, 68% took place during sea states of B3 or less. Only 12% of the monitoring effort was conducted during elevated sea states of B5 or higher. Overall, 88% of the monitoring effort was conducted during fair Beaufort sea state (**Figure 6-3**). Clear and partly cloudy skies were noted most often during the Kitty Hawk North MBES survey at 61% of the monitoring effort. However, overcast sky was present 27% of the time. Periods of rain, mist and fog occurred during 12% of the monitoring effort (**Figure 6-4**).

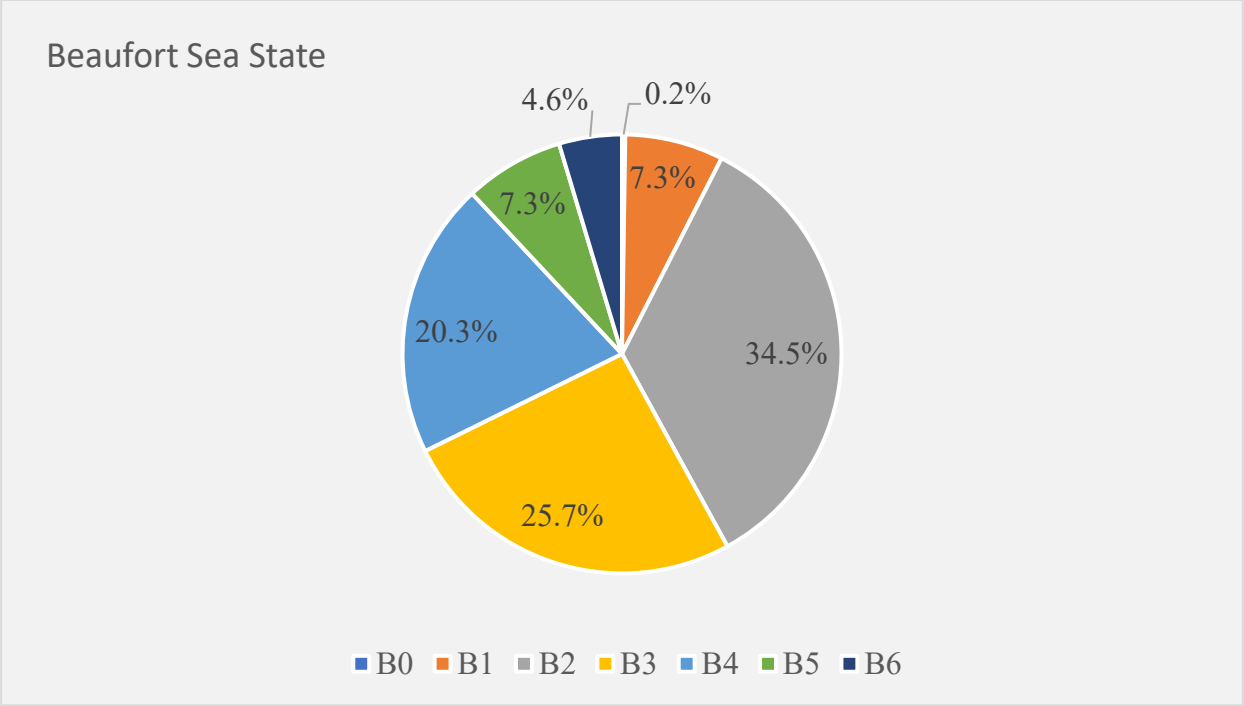

Figure 6-3. Beaufort sea state during the monitoring effort on the Kitty Hawk North MBES survey.

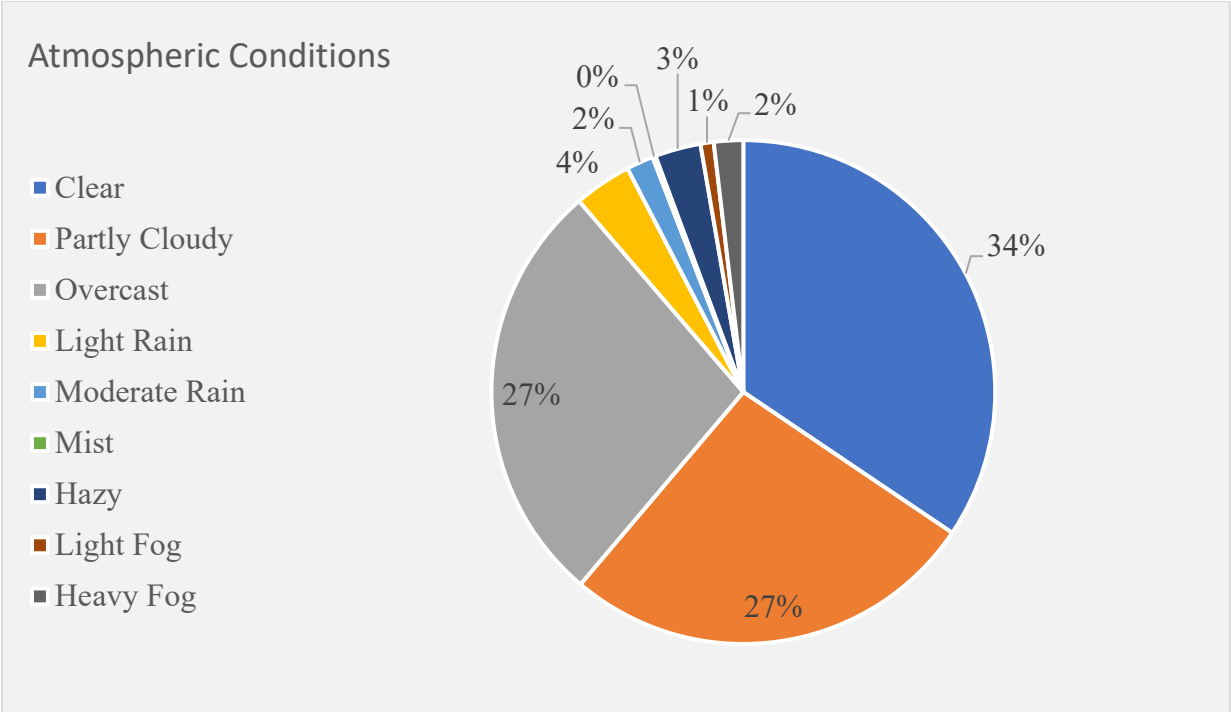

Figure 6-4. Atmospheric conditions during the monitoring effort on the Kitty Hawk North MBES survey.

An overall visual quality metric was developed to classify conditions for visual observations by combining Beaufort sea state and visual distance. The three visual quality classifications were determined as follows:

- Good: sea state B0-B3 and/or a visual distance of 2-10 km,
- Moderate: sea state B4 and/or a visual distance of 0.5 ≥ 1 km, and
- Poor: sea state >B4 and/or a visual distance of 0.5 km or less.

The high percentage of low sea state and good weather conditions contributed to an overall fair visual quality during the Kitty Hawk North MBES survey, with 84% of the monitoring effort conducted during moderate to good conditions (**Figure 6-5**). Poor visibility at night was occasionally the result of low ambient light levels, which often limited the visual distance to 500 m. However, the NVDs were able to work effectively to a range of at least 500 m with overcast starlight. NVDs were used to visually monitor for protected species during darkness and required good ambient light levels to function at their highest efficiency. NVDs were supported by both IR attachment and by backup handheld IR cameras in case of low ambient light.

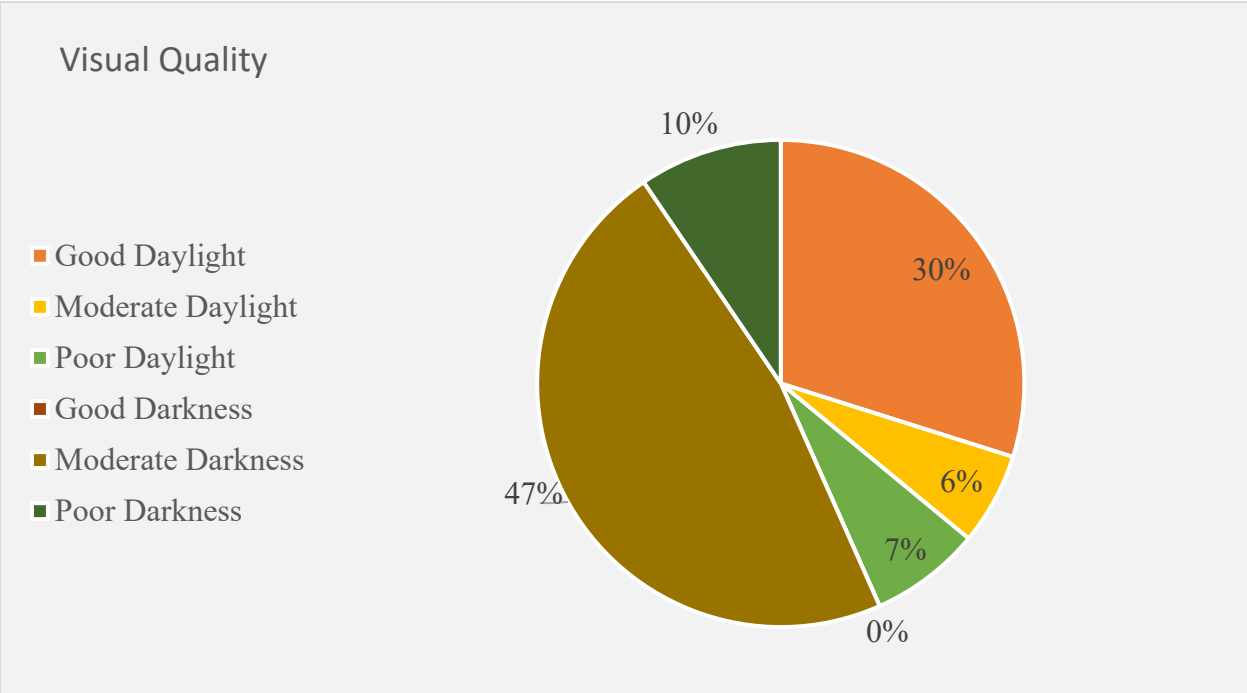

Figure 6-5. Overall visual quality the monitoring effort on the Kitty Hawk North MBES survey. Good: sea state of B0-3 and/or visual distance of 2-10 km. Moderate: sea state of B4 and/or visual distance 0.5 ≥ 1 km. Poor: sea state of >B4 and/or a visual distance of 0.5 km or less.

6.3 PSO EFFORT

The cumulative PSO effort across all monitoring methods was 359:17:32 hh:mm:ss (**Table 6-2**). Visual monitoring during darkness was accomplished with NVD with an IR attachment. Visual methods consisted of UE at 43.3% and NVD w/ IR accounted for 56.7% of the PSO effort (**Figure 6-6**).

Table 6-2. PSO effort (h) by monitoring method for the Kitty Hawk North MBES survey.

Monitoring Method	Effort (hh:mm:ss) by Monitoring Method		
	Daylight	Darkness	Total Effort
Visual PSO	155:44:55	203:32:37	359:17:32

PSO = projected species observer

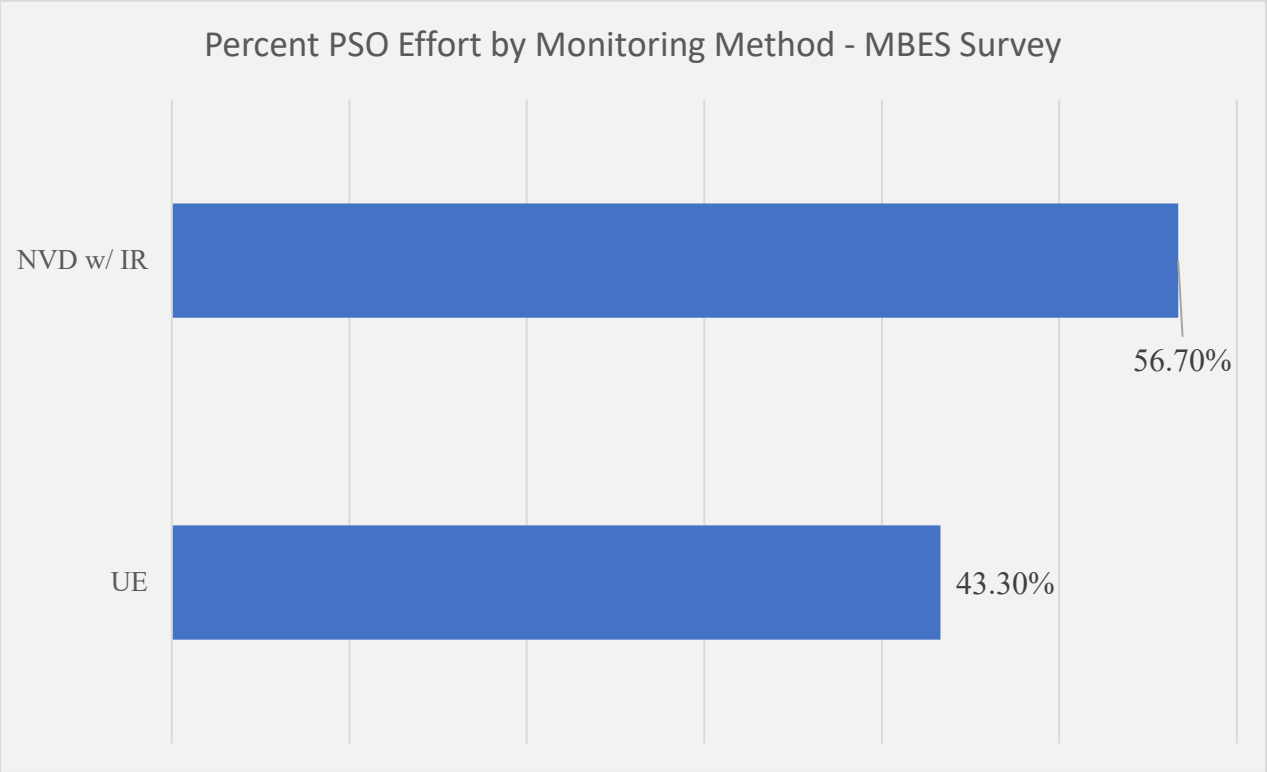

Figure 6-6. Percent PSO effort by monitoring method. Visual monitoring was subdivided into the two categories of visual observation, UE during the day and NVD w/ IR during darkness. UE = unaided eye; NVD w/ IR = night vision device with IR attachment.

6.4 PROTECTED SPECIES DETECTIONS

A total of seven protected species detection events were recorded during the Kitty Hawk North MBES survey. An estimated 39 individuals were observed during those detection events. Six detections were initially through unaided eye and one was sighted through NVD w/ IR. A greater number of detection events were made during daylight compared to darkness, with five (71%) and two (29%) of detections respectively (**Figures 6-7; 6-8**). Daylight detections are typically greater in number due to the ability to sight animals at great distances well outside of the monitoring zones with both the unaided eye and reticle binoculars.

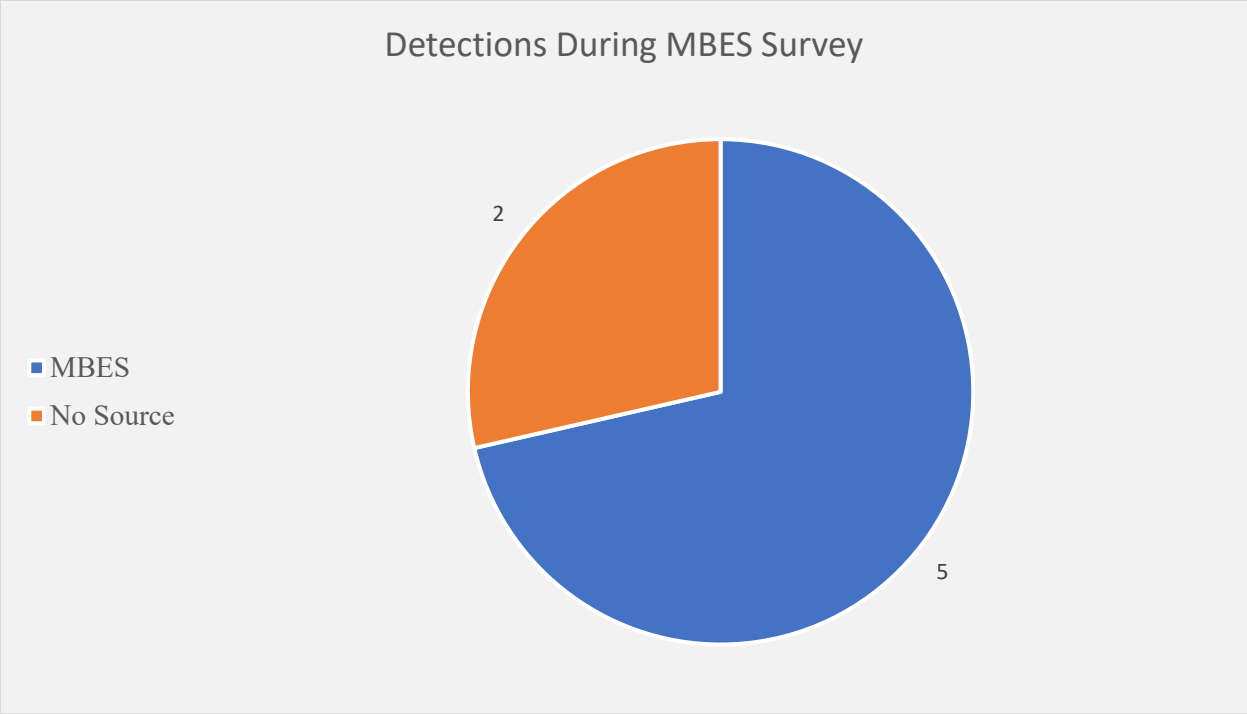

Figure 6-7. Protected species detection events recorded while MBES was surveying above 200 kHz versus no source. Note the MBES is not a mitigated source.

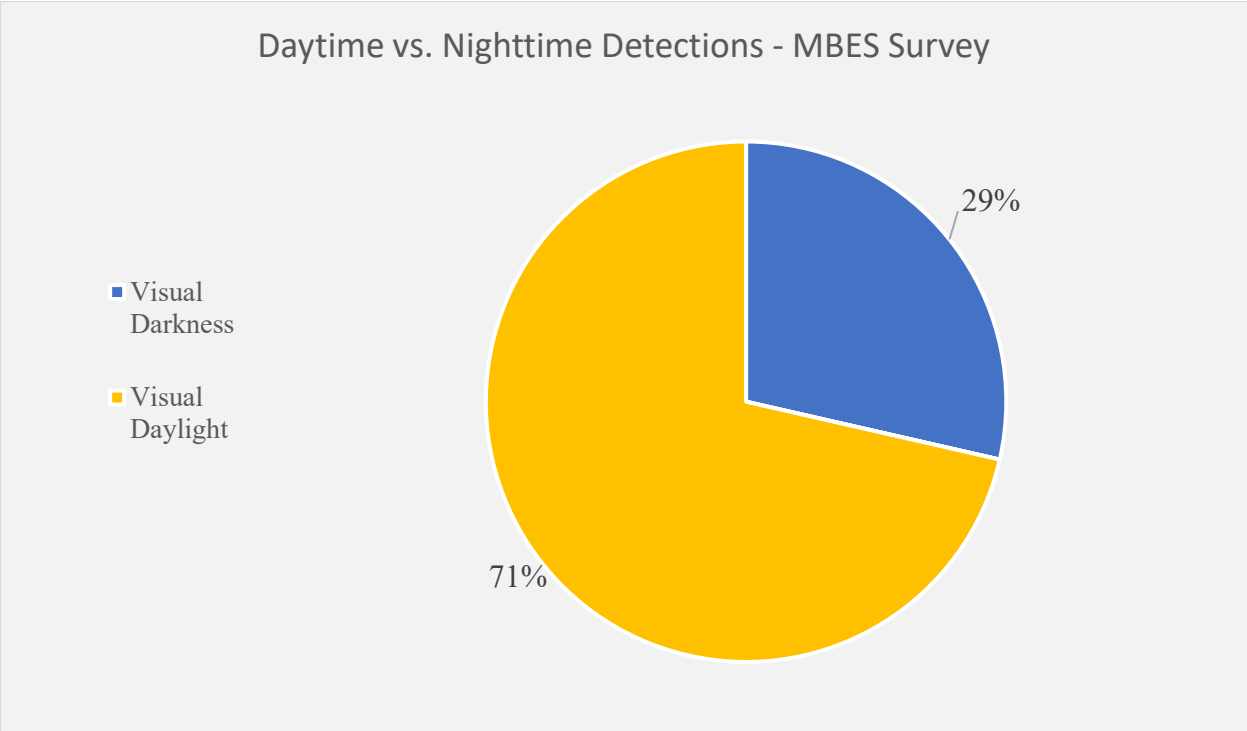

Figure 6-8. Percent of protected species detection events recorded during daylight and darkness during the MBES survey.

The distribution of all detections made during the Kitty Hawk North MBES survey are provided in **Figure 6-9**. Bottlenose dolphins (*Tursiops truncatus*) and unidentified dolphins or porpoise were the most frequently detected species/group (**Table 6-4**). There were also two humpback whale *(Megaptera novaeangliae)* detections during this section of the survey **(Figure 6-10).**

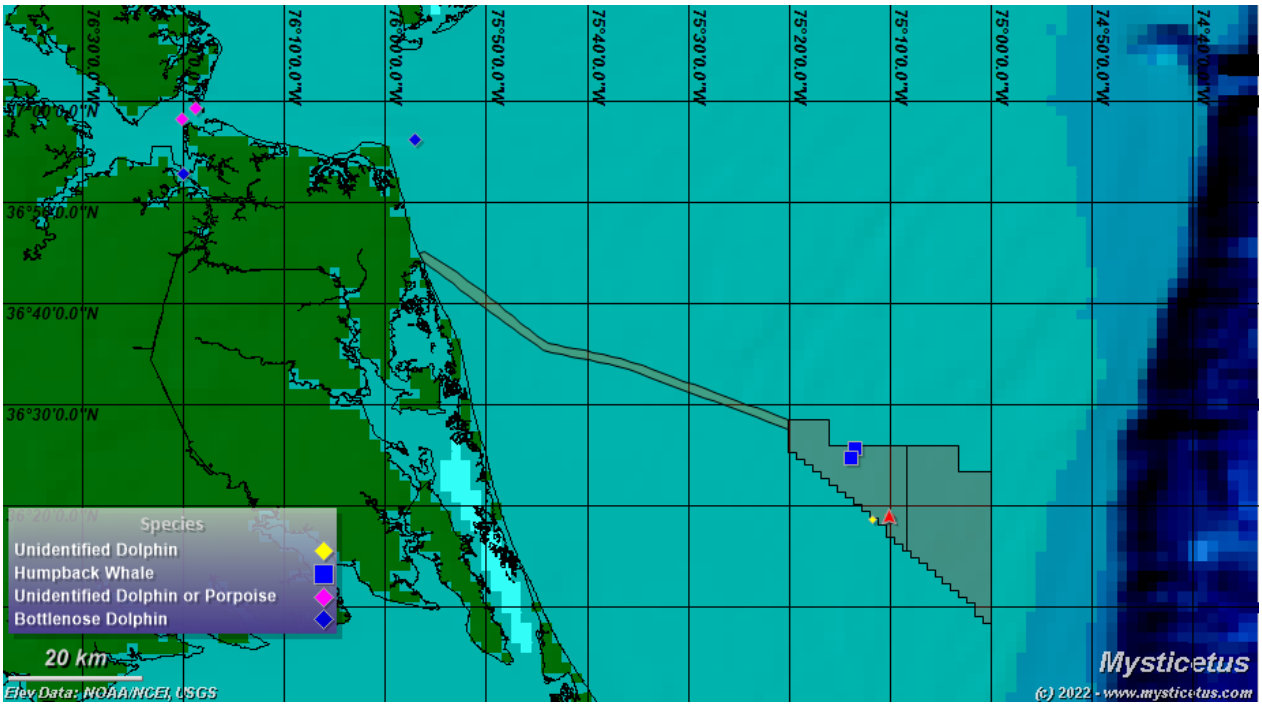

Figure 6-9. Distribution of protected species detections on M/V Deep Helder during the MBES survey.

Table 6-4. Protected species observed including estimated number of individuals during the Kitty Hawk North MBES survey.

Species	Number of Detections	Estimated Number of Individuals
Humpback whale (*Megaptera novaeangliae*)	2	2
Bottlenose dolphin *(Tursiops truncatus)*	2	11
Unidentified dolphin or porpoise	2	24
Unidentified dolphin	1	2
Totals	**7**	**39**

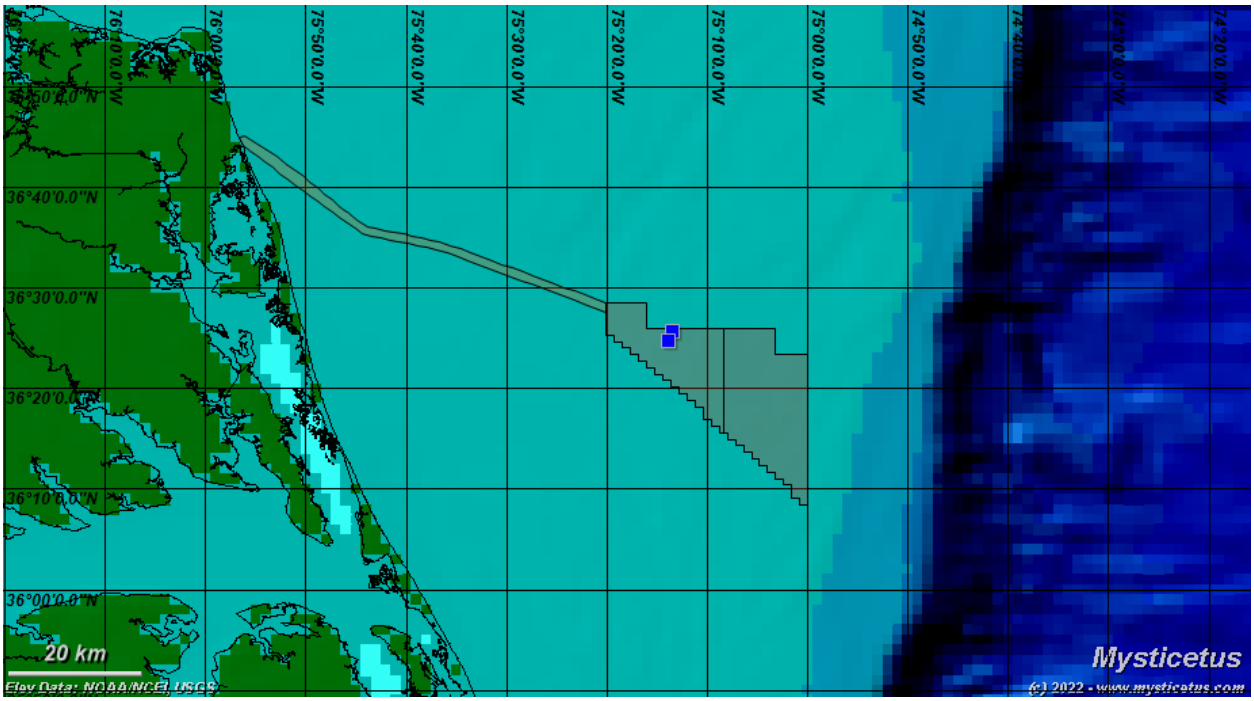

Figure 6-10. Location of M/V Deep Helder humpback whale detections during MBES survey.

The overall detection rate for all monitoring efforts combined was 0.044 detections per hour of PSO effort (**Table 6-5**).

Table 6-5. Protected species detection rates for unaided eye and NVD w/ IR during the MBES survey.

Method of Detection	Total Number of Observation Hours	Total Number of Detections	Detection Rate (detections per hour of effort)
UE	155.75	6	0.039
NVD w/ IR	203.54	1	0.005
Total PSO Effort	**359.29**	**7**	**0.044**

6.4.1 NARW DETECTIONS

There were no detections of NARWs (*E. glacialis*) throughout the UHR Sparker medium penetration SBP survey or the MBES survey.

6.4.2 SEA TURTLE DETECTIONS

There were no sea turtle detections during the Kitty Hawk North MBES section of the survey.

6.4.3 PROTECTED SPECIES BEHAVIOR

Protected species observed during the Kitty Hawk North MBES survey exhibited typical behaviors. The humpback whale behavior consisted of pectoral fin slapping on the surface, blows, shallow dives and travel **(Figure 6-11)**.

Delphinids initial behaviors observed included feed, porpoise, and surface-active travel. They were also observed splashing, approaching the bow, and surfacing.

There were no observed behavioral reactions during this portion of the survey.

Figure 6-11. Humpback whale (V74) visually detected on 16 Dec 2021. Image Credit: R. Rice.

6.5 MITIGATION MEASURES

6.5.1 PROTECTED SPECIES MITIGATION

Protected species mitigation measures were not requested or required during the MBES survey or testing that occurred during the survey. Therefore, no survey time was lost due to protected species mitigation. However, there was one strike avoidance measure implemented.

6.5.1.1 Strike Avoidance Measures

There was one vessel strike avoidance action taken as a precaution for a humpback whale sighted at the surface (V75) on 16 December 2021 while surveying.

6.5.2 WEATHER RELATED MITIGATION

There were no weather-related mitigation measures necessary for the duration of the project.

6.6 PROTECTED SPECIES EXPOSURES

During the MBES survey, there were no protected species exposures. Of the seven detections that occurred during the MBES portion of the survey, two occurred during no survey equipment activity and five occurred during MBES and DP thruster activity only. There were no detections during gradiometer, Innomar, side

scan sonar or USBL activities. Individuals per event can be referenced in the detection data included in **Appendix A**.

6.7 PROTECTED SPECIES INCIDENT REPORTS

There were no protected species incidents throughout the UHR sparker medium penetration SBP survey or MBES survey.

7.0 MONITORING METHODS AND DEVICE EFFECTIVENESS

Two monitoring methods were utilized for protected species monitoring by the PSOs during the Kitty Hawk North survey; visual and PAM. Visual monitoring was subdivided into three different modes; unaided eye, NVD with IR, and handheld (HH) IR camera. The list below summarizes when each method was utilized and under what conditions.

- Visual
  - UE
    - during daylight with systemic use of reticle binoculars
    - during darkness via artificial illumination from vessel lighting
  - NVD during darkness, supplemented with IR attachment and often supplemented with unaided eye observation and HH IR
  - HH IR camera during daylight and darkness in the event of reduced visibility during daytime and vessel light interference at night
- PAM
  - during darkness when operations and weather conditions allowed
  - during daylight 30 minutes before/after sunset/sunrise and during daytime reduced visibility due to fog or precipitation

Protected species detections were made using single or multiple methods of detection. During each protected species detection, the PSO recorded the initial and subsequent methods of detection. Each of the four options listed above (UE, NVD, HH IR, and PAM) represents a single method of detection. To evaluate the effectiveness of each method of detection, the method of initial detection for each protected species detection event was reviewed and compared.

7.1 INITIAL DETECTION METHOD

The majority (72.8%) of the 81 detection events recorded during the Kitty Hawk North UHR sparker medium penetration SBP survey were initially made with the UE during daytime monitoring **(Figure 7-1)**. The second most frequent overall method of initial detection was PAM (14.8%). Not surprisingly, the most common initial detection methods during daytime and darkness were UE and PAM respectively.

The majority (71.4%) of the seven detection events recorded during the Kitty Hawk North MBES survey were initially made with the UE during daytime monitoring (**Figure 7-2**).

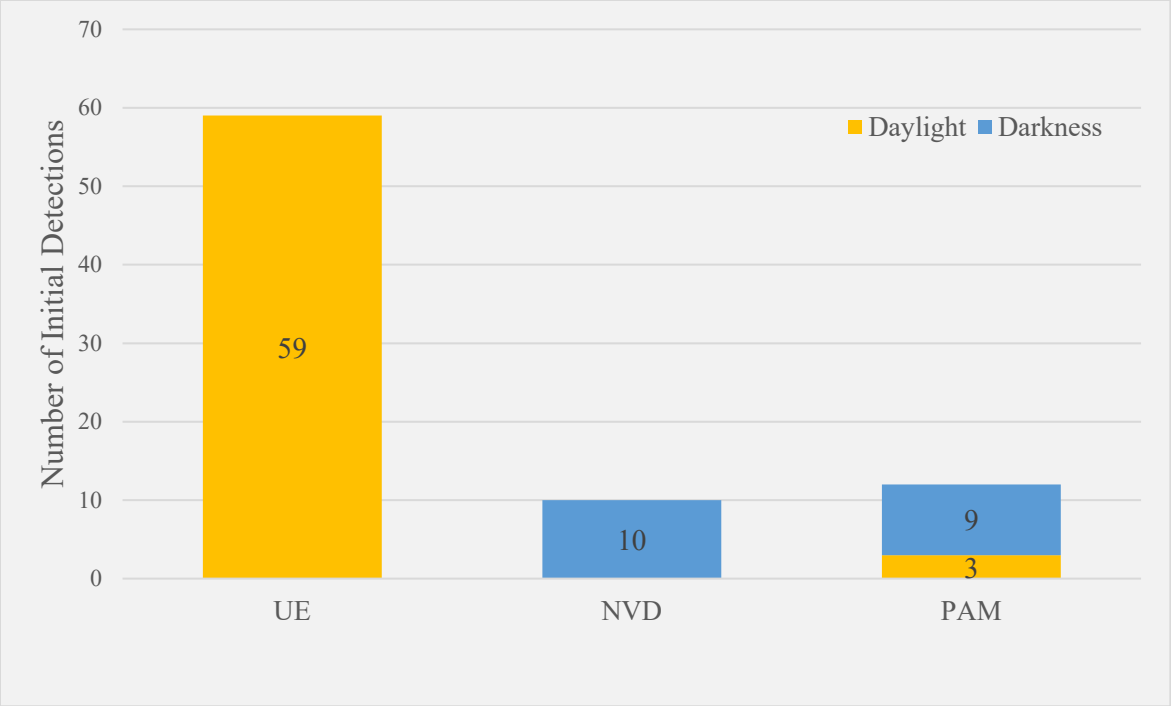

Figure 7-1. Number of initial detections by monitoring method during daylight and darkness during UHR sparker medium penetration SBP survey.

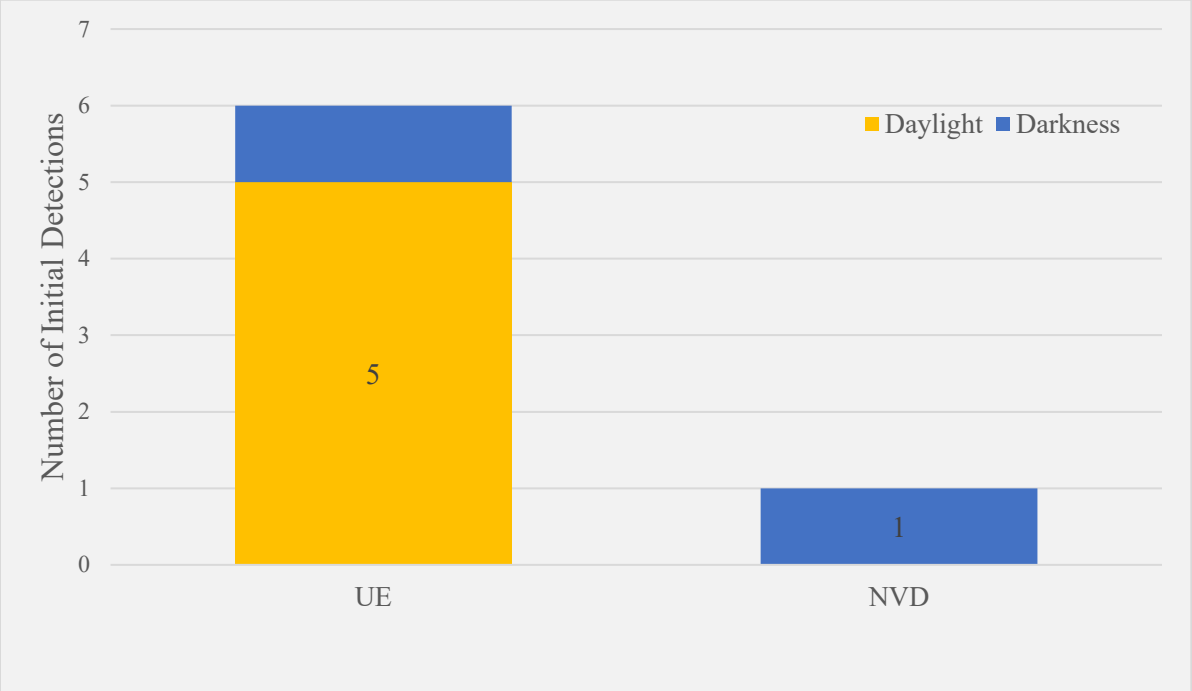

Figure 7-2. Number of initial detections by monitoring method during daylight and darkness.

7.2 DETECTION RATES BY DEVICE

During the UHR sparker medium penetration SBP survey, overall detection rates with respect to the method of initial detection were highest for UE and PAM, at 0.21 and 0.06 initial detections per hour of observation respectively (**Table 7-1**). Daylight initial detection rates were highest for UE, while initial detection rates during darkness were highest for PAM. Initial detection rates were lowest during darkness, and overall, for the NVDs. During the MBES portion of the survey, the overall detection rate for all monitoring efforts combined was 0.044 detections per hour of PSO effort with unaided eye being the majority of that rate at 0.039 detections per hour of effort (**Table 7-2**).

Table 7-1. Protected species detection rates based on the initial detection method during the sparker survey. Rates for each detection method are provided for daylight and darkness, as well as the overall rate for the method of detection.

Initial Detection Method	Observation Hours			Number of Initial Detections			Detection Rate (detections per hour of effort)		
	Daylight	Darkness	Total	Daylight	Darkness	Total	Daylight	Darkness	Total
UE	285.6	0	285.6	59	0	59	0.21	0	0.21
NVD	0	318.7	318.7	0	10	10	0	0.03	0.03
PAM	21.5	176.2	197.7	3	9	12	0.14	0.05	0.06

Table 7-2. Protected species detection rates based on the initial detection method during the MBES portion of the survey.

Initial Detection Method	Observation Hours			Number of Initial Detections			Detection Rate (detections per hour of effort)		
	Daylight	Darkness	Total	Daylight	Darkness	Total	Daylight	Darkness	Total
UE	155.75	0	155.75	5	1	6	0.039	0	0.039
NVD w/ IR	0	203.54	203.54	0	1	1	0	0.005	0.005

7.3 DETECTION METHOD STRENGTHS AND LIMITATIONS

Many different variables determine the detection rates of marine mammals and the distance at which a detection is most likely to occur. These variables include environmental factors, operational influences, animal movements and behavior, and the type of monitoring method.

It is important to consider some of the strengths and limitations of the monitoring methods when considering overall effectiveness.

7.3.1 UE AND RETICLE BINOCULARS

Monitoring with the unaided eye has long been the standard minimum for protected species observation. It is the simplest method and it works well from a variety of observation platforms (land, sea, and air). Specialized equipment is not required, making visual monitoring with the unaided eye the most cost-efficient method when compared to other methods utilizing advanced technologies. A good pair of reticle binoculars is a must for PSOs, but inexpensive options are available.

UE monitoring can be used during both daylight and darkness; however, detection distances during darkness are limited to the area immediately surrounding the vessel out to a few hundred meters (or less if low levels of ambient light). Visual monitoring is also limited to animals at or near the surface regardless of the monitoring method used (UE, NVD with IR, or HH IR).

7.3.2 NVD

NVDs capture and enhance small amounts of visible light and near infrared energy to brighten the image being viewed. The technology significantly improves a PSO's ability to monitor for protected species during darkness over the unaided eye. On clear nights, with high ambient light levels (moonlight) the detection range for NVD may extend as far as 1 km. In most cases, the detection range for the UE at night is much less than 500 m.

Too much light, however, can be detrimental and the image may become washed out or even damage the NVD. On the opposite end of the spectrum, too little light will result in a dark image that may not be much better than the UE. These extreme situations were not typical throughout the survey. The IR attachments and handheld IR cameras covered any limitations of the NVDs. In addition, acoustic monitoring assisted with detections of animals that may not have been exhibiting much surface behavior.

Vessel lighting, especially on working decks, can be an issue for PSOs. Often the vessel crew is able to reduce the amount of lighting in the accommodation area of the vessel (bridge, bridge wings, deck areas forward of mid-ship); however, lighting on working decks is required for safety and cannot be dimmed. As a result, observation of the area behind the vessel is often difficult with NVDs.

Moisture in the air from fog and/or rain can limit the effectiveness of NVDs. Light reflected off the moisture droplets has a similar effect as too much light and causes a general washed-out appearance of the image.

Most NVDs also have a relatively small field of view when compared to monitoring with the UE. Constant scanning can help reduce the effects of this; however, constant scanning could lead to eye fatigue from looking through an illuminated tube for hours. PSOs often alternate between NVD and UE during darkness to help minimize eye fatigue. PSOs average anywhere from 40-45 minutes of NVD use with 15-20 minutes of monitoring with the UE at night. Regular breaks between shifts also helps.

7.3.3 IR ATTACHMENT AND HH IR

IR technologies can be using during both daylight and darkness for protected species monitoring. IR devices detect infrared energy emitted by objects and converts the resulting thermal pattern into an image. IR devices do not require light to function and are not light sensitive except when the light source emits high levels of heat. Therefore, IR is a good complimentary method to NVDs in areas with elevated lighting (working decks for example). Additionally, the detection range for IR is much greater than that of NVD or UE during darkness. Blows from large whales can be detected on IR at distances of at least 3km.

Areas of exhaust/ventilation are big heat sources and can overwhelm an IR device in a manner similar to that of elevated light levels and NVDs. The vessel super-structure can also periodically obstruct the view of IR cameras. Like NVDs, IR devices are highly affected by moisture in the air. The image becomes completely washed-out during periods of dense fog and moderate to heavy precipitation.

IR energy reflects off standard glass. Special germanium glass is required to view IR energy. Because of this, HH IR cameras cannot be used from inside the vessel. In the cases where there was too much light to use NVDs and IR attachments, HH IR was available to supplement monitoring.

7.3.4 PAM

PAM increases detection capabilities by allowing for the detection of marine mammal vocalizations while the animals are submerged and otherwise not available for detection using any of the above-described methods. PAM can also be used during both daytime and darkness.

In order for a marine mammal to be detected with PAM, the animal must be vocalizing. Call rates are highly variable for marine mammals. Delphinids are regularly producing whistles and/or clicks, which makes them an ideal specimen for acoustic detection. Mysticete whales, however, are not regularly producing sounds and are more of challenge for towed PAM systems often employed on offshore wind surveys. Mysticete whales also produce low frequency vocalizations that may be masked by vessel noise or survey equipment.

Towing options may be limited on offshore wind surveys, whether due to additional equipment being towed astern of the vessel or by survey design. Finding a safe deployment that will optimize detection capabilities while reducing risks to vessel and equipment can be a challenge. Risk of entanglement with survey equipment or vessel thrusters can cause significant damage. As with mounted IR systems, system malfunctions and technical issues may result in observational downtime.

PAM was not used during the MBES survey for vessel strike avoidance.

7.4 SUMMARY OF DETECTION METHODS EFFECTIVENESS

Based on the detection rates derived from the method of initial detection, monitoring with the UE and PAM are the most effective methods for protected species detection. However, the most effective or efficient way to monitor for protected species is to use a suite of complimenting methods. No particular monitoring is the *best* method. Each method has its own set of limitations and many of those limitations can be improved through the use of complimentary methods. Visual observations are limited to animals at or near the surface; therefore, PAM is used as a means to detect marine mammals at depth using sound. PAM is often limited in baleen whale detection but the use of IR technologies during darkness, when PAM is most often used, may increase a PSO's ability to detect baleen whales during darkness when standard visual methods are reduced by range. The Kitty Hawk North survey was an excellent example of using a complimentary suite of monitoring methods to most efficiently monitor for protected species.

8.0 CONCLUSIONS

During the UHR sparker medium penetration SBP survey, the PSO team aboard the M/V *Deep Helder* completed 802.0 hours of protected species monitoring across all monitoring platforms, covering 5168.1 km of trackline during the Kitty Hawk North survey campaign. During that time, 81 protected species detections (including five concurrent detections) were recorded, for which 26 mitigation measures were implemented.

During the MBES survey, PSO monitoring effort was accomplished over a total distance of 3335.0 km of vessel track line while PSOs were monitoring for protected species during 3335.0 km of monitoring effort. Monitoring effort was greater during darkness than during daylight, with 2010.4 km of observation during darkness and 1324.7 km of observation during daylight. Of the 3335.0 km monitored for strike avoidance, 2904.9 km was with the MBES active.

Monitoring conditions remained fair over the course of the Kitty Hawk North survey. Conditions were favorable (Beaufort sea states of B3 or less, with good visibility) throughout the UHR sparker medium penetration SBP survey project. Conditions were favorable and remained fair (Beaufort sea states of B3 or less, with good visibility) throughout the majority of the project.

During the UHR sparker medium penetration SBP survey, Atlantic spotted dolphins *(Stenella frontalis)* and unidentified dolphins (Delphinidae) were the most frequently detected species/groups. There were a significant amount of both loggerhead sea turtle *(Caretta caretta)* and unidentified sea turtle (Cheloniidae) sightings as well. Most (98.8%) protected species detections occurred during the continuous HRG survey activity while operating acoustic sources below 200 kHz. Delphinids and sea turtles have a prevalence in this area off of North Carolina due to the Gulf Stream colliding with cold-water currents near the continental shelf, which creates upwellings that are rich in food source (Lee and McDonough, 2001).

During the MBES section, bottlenose dolphins *(Tursiops truncatus)* and unidentified dolphins or porpoise were the most frequently detected species/group (2 and 3 respectively). There were also two humpback whale *(Megaptera novaeangliae)* detections during this section of the survey.

CPAs to the active HRG equipment (UHR sparker) were lowest for the humpback whale sighting. This data does not give an accurate representation due to the extremely small dataset. CPAs of delphinids and sea turtles to the vessel were similar. Shutdown of the UHR sparker was not required for specific genera of delphinids; however, shutdowns were established for Atlantic spotted dolphins to remain cautious as the vessel was nearing take limits.

Potential exposures to the 160 dB_{RMS} Level B harassment isopleth for the UHR sparker were recorded for 218 delphinids. The mean time spent within the Level B 445 m EZ for the UHR sparker was 319 seconds. The number of estimated exposures were much lower than the number of authorized takes.

During the UHR sparker medium penetration SBP survey, behavioral changes were noted for a number of protected species detections, during periods of active surveying with HRG equipment operating below 200 kHz. There was not a large enough data set to evaluate behavioral changes during periods of inactivity. Behavioral changes of delphinids and sea turtles included: change direction, dive, and speed up. Any number of variables, anthropogenic or natural, may contribute to a behavioral change so it is difficult to assess.

Protected species observed during the Kitty Hawk North MBES survey exhibited typical behaviors. The humpback whale behavior consisted of pectoral fin slapping on the surface, blows, shallow dives and travel. Delphinids initial behaviors observed included feed, porpoise, and surface-active travel. They were also

observed splashing, approaching the bow, and surfacing. There were no observed behavioral reactions during this portion of the survey.

Although numerous protected species (26 instances) mitigation measures were implemented during the Kitty Hawk North sparker survey, the overall impact to operations was minimal, contributing only 19.5 h of operational downtime. Operational downtime due to mitigation measures was 3.23% of the total time available for active HRG operations. A total of 489.5 h of active HRG operations was achieved out of an available 602.8 h of potential active HRG operations. During the MBES portion of the survey, there was one strike avoidance measure when the vessel altered course for a humpback whale.

The mitigation and monitoring protocols established under the 2021 NMFS IHA and the BOEM Lease OCS-A 0508 and associated 2021 waiver/modification approval were effectively implemented by the PSOs throughout the Kitty Hawk North HRG survey.

9.0 LITERATURE CITED

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Appendix A

See attached files

Mysticetus Files and CSVs (separately attached files)
Daily Reports (separately attached files)
Monthly Reports (separately attached files)

UHR Sparker Medium Penetration SBP Survey-Visual Detections												
Detection ID	Initial or Subsequent	Time (UTC)	End Time (UTC)	Initial Detection Method	Subsequent Detection Method	Detection Distance (m)	Species	Species Reliability	Juveniles	Low Count	High Count	Best Count
V1	Initial	2021-09-26T02:21:17.0	2021-09-26T02:34:00.0	PAM	NVD w/ IR	200	Atlantic Spotted Dolphin	Possible	1	4	10	7
V2	Initial	2021-09-26T17:12:10.0	2021-09-26T17:17:00.0	UE	None	150	Atlantic Spotted Dolphin	Certain	ND	6	10	8
V3	Initial	2021-09-26T23:07:35.6	2021-09-26T23:09:12.0	UE	None	40	Atlantic Spotted Dolphin	Probable	ND	3	10	5
V4	Initial	2021-09-27T16:57:00.0	2021-09-27T17:22:00.0	UE	RB	852.6289	Atlantic Spotted Dolphin	Certain	ND	20	30	25
V5	Initial	2021-09-28T15:41:45.0	2021-09-28T15:43:17.0	UE	None	50	Unidentified Sea Turtle	Certain	0	1	1	1
V6	Initial	2021-10-01T11:14:39.1	2021-10-01T11:17:00.0	UE	RB	100	Atlantic Spotted Dolphin	Certain	ND	10	18	12
V7	Initial	2021-10-01T11:20:37.2	2021-10-01T11:21:00.0	UE	RB	538.509	Unidentified Dolphin	Certain	ND	4	12	8
V8	Initial	2021-10-02T16:09:16.0	2021-10-02T16:12:00.0	UE	None	75	Loggerhead Sea Turtle	Certain	ND	1	1	1
V9	Initial	2021-10-04T17:14:13.2	2021-10-04T17:27:00.0	UE	None	20	Atlantic Spotted Dolphin	Certain	ND	3	5	3
V10	Initial	2021-10-04T17:47:12.3	2021-10-04T18:02:00.0	UE	None	100	Atlantic Spotted Dolphin	Certain	2	10	15	12
V11	Initial	2021-10-04T19:13:10.0	2021-10-04T19:13:27.0	UE	None	50	Loggerhead Sea Turtle	Certain	0	1	1	1
V12	Initial	2021-10-05T04:50:00.0	2021-10-05T04:50:49.0	Auditory	NVD	10	Unidentified Dolphin	Certain	0	1	2	1
V13	Initial	2021-10-05T15:20:10.0	2021-10-05T15:20:15.0	UE	None	30	Unidentified Sea Turtle	Certain	0	1	1	1
V14	Initial	2021-10-05T19:32:33.0	2021-10-05T19:32:37.0	UE	None	23	Loggerhead Sea Turtle	Certain	0	1	1	1
V15	Initial	2021-10-06T13:31:10.0	2021-10-06T13:32:11.0	UE	None	40	Loggerhead Sea Turtle	Certain	0	1	1	1
V16	Initial	2021-10-07T10:57:27.0	2021-10-07T10:58:00.0	UE	RB	150	Unidentified Dolphin	Certain	ND	2	6	4
V17	Initial	2021-10-07T23:57:35.0	2021-10-07T23:57:40.0	NVD	None	40	Unidentified Dolphin	Certain	ND	1	1	1
V18	Initial	2021-10-14T11:31:00.0	2021-10-14T11:43:00.0	UE	RB	200	Atlantic Spotted Dolphin	Certain	0	2	4	3
V19	Initial	2021-10-14T12:18:56.1	2021-10-14T12:33:00.0	UE	None	200	Atlantic Spotted Dolphin	Certain	0	3	4	3
V20	Initial	2021-10-15T11:48:00.0	2021-10-15T11:52:59.8	UE	RB	745.9961	Short-beaked Common Dolphin	Probable	0	1	3	2
V21	Initial	2021-10-15T13:57:00.0	2021-10-15T14:03:00.0	UE	RB	396.4807	Atlantic Spotted Dolphin	Certain	0	4	8	7
V22	Initial	2021-10-15T14:24:04.0	2021-10-15T14:30:53.0	UE	RB	861.0947	Short-beaked Common Dolphin	Certain	0	3	7	5
V23	Initial	2021-10-16T13:00:00.0	2021-10-16T13:08:03.0	UE	UE	50	Atlantic Spotted Dolphin	Certain	0	4	8	6

V24	Initial	2021-10-16T14:15:53.0	2021-10-16T14:22:11.0	UE	UE	50	Atlantic Spotted Dolphin	Certain	0	3	4	4
V25	Initial	2021-10-16T14:44:28.0	2021-10-16T15:06:01.0	UE	UE	50	Atlantic Spotted Dolphin	Certain	0	3	4	4
V26	Initial	2021-10-16T21:05:24.0	2021-10-16T21:24:35.0	UE	UE	20	Atlantic Spotted Dolphin	Certain	2	8	15	12
V27	Initial	2021-10-17T16:29:36.0	2021-10-17T16:39:38.0	UE	None	10	Atlantic Spotted Dolphin	Certain	ND	3	6	5
V28	Initial	2021-10-18T17:13:13.2	2021-10-18T17:25:00.0	UE	None	100	Atlantic Spotted Dolphin	Certain	5	10	25	20
V29	Initial	2021-10-18T17:32:45.8	2021-10-18T17:33:15.0	UE	None	75	Loggerhead Sea Turtle	Certain	ND	1	2	1
V30	Initial	2021-10-18T18:01:32.0	2021-10-18T18:24:54.0	UE	None	20	Atlantic Spotted Dolphin	Certain	5	15	35	30
V31	Initial	2021-10-20T18:22:10.0	2021-10-20T18:31:01.0	UE	RB	326.185	Unidentified Dolphin	Certain	ND	3	6	5
V32	Initial	2021-10-20T18:55:44.0	2021-10-20T19:02:20.0	UE	RB	392.1851	Unidentified Dolphin	Certain	ND	2	5	4
V33	Initial	2021-10-20T20:02:10.8	2021-10-20T20:28:19.0	UE	None	20	Atlantic Spotted Dolphin	Certain	0	4	34	30
V34	Initial	2021-10-20T21:53:09.5	2021-10-20T21:59:13.0	PAM	UE	50	Atlantic Spotted Dolphin	Certain	0	4	10	8
V34	Subsequent	2021-10-20T21:59:13.8	2021-10-20T22:15:00.0	PAM	UE	40	Atlantic Spotted Dolphin	Certain	ND	6	10	8
V35	Initial	2021-10-21T06:04:35.0	2021-10-21T06:04:50.0	NVD	None	50	Unidentified Sea Turtle	Certain	ND	1	1	1
V36	Initial	2021-10-21T11:52:42.0	2021-10-21T11:52:49.0	RB	None	1211.794	Humpback Whale	Probable	ND	1	1	1
V37	Initial	2021-10-21T12:16:33.0	2021-10-21T12:24:00.0	UE	None	50	Atlantic Spotted Dolphin	Certain	ND	4	8	6
V38	Initial	2021-10-21T12:29:12.0	2021-10-21T12:38:30.0	RB	UE	659.2136	Atlantic Spotted Dolphin	Certain	ND	8	14	10
V39	Initial	2021-10-21T13:11:03.3	2021-10-21T13:14:13.0	UE	RB	203.8496	Unidentified Dolphin	Certain	0	1	2	2
V40	Initial	2021-10-21T19:50:55.0	2021-10-21T19:58:08.0	UE	None	100	Atlantic Spotted Dolphin	Certain	2	10	20	15
V41	Initial	2021-10-21T20:09:00.0	2021-10-21T20:13:14.0	UE	UE	70	Loggerhead Sea Turtle	Certain	ND	1	1	1
V42	Initial	2021-10-22T03:05:05.0	2021-10-22T03:06:38.0	NVD	None	30	Atlantic Spotted Dolphin	Certain	ND	1	2	2
V42	Subsequent	2021-10-22T03:19:50.0	2021-10-22T03:38:00.0	NVD	None	50	Atlantic Spotted Dolphin	Certain	3	20	25	20
V43	Initial	2021-10-22T17:04:10.0	2021-10-22T17:04:30.0	UE	None	30	Loggerhead Sea Turtle	Certain	ND	1	1	1
V44	Initial	2021-10-22T17:08:14.0	2021-10-22T17:10:30.0	UE	None	50	Atlantic Spotted Dolphin	Certain	ND	6	12	8
V45	Initial	2021-10-22T17:30:00.0	2021-10-22T17:32:30.0	UE	RB	75	Loggerhead Sea Turtle	Certain	ND	1	1	1
V46	Initial	2021-10-22T17:44:00.0	2021-10-22T18:07:50.0	UE	None	50	Atlantic Spotted Dolphin	Certain	ND	8	15	12
V47	Initial	2021-10-22T21:32:17.8	2021-10-22T21:42:19.0	UE	None	20	Atlantic Spotted Dolphin	Certain	1	5	8	6

V48	Initial	2021-10-23T05:39:43.0	2021-10-23T05:39:45.0	NVD	PAM	30	Unidentified Dolphin	Certain	ND	1	1	1
V49	Initial	2021-10-23T08:12:07.3	2021-10-23T08:13:30.0	NVD	None	40	Unidentified Dolphin	Certain	ND	1	4	3
V50	Initial	2021-10-23T11:25:50.0	2021-10-23T11:26:05.0	UE	None	200	Unidentified Dolphin	Certain	0	2	3	4
V51	Initial	2021-10-23T12:21:01.0	2021-10-23T12:30:00.0	UE	NVD	20	Atlantic Spotted Dolphin	Certain	ND	4	8	6
V52	Initial	2021-10-23T13:24:49.0	2021-10-23T13:27:09.0	UE	None	10	Atlantic Spotted Dolphin	Certain	0	2	4	3
V53	Initial	2021-10-23T15:08:59.0	2021-10-23T15:11:23.0	UE	None	10	Atlantic Spotted Dolphin	Certain	1	3	6	5
V54	Initial	2021-10-23T16:53:30.0	2021-10-23T17:02:00.0	RB	UE	537.4174	Atlantic Spotted Dolphin	Certain	ND	6	15	10
V55	Initial	2021-10-23T17:45:10.0	2021-10-23T17:45:25.0	UE	NVD	100	Loggerhead Sea Turtle	Certain	0	1	1	1
V56	Initial	2021-10-23T18:14:38.0	2021-10-23T02:16:51.0	UE	RB	188.4972	Loggerhead Sea Turtle	Certain	0	1	1	1
V57	Initial	2021-10-24T03:17:42.0	2021-10-24T03:19:12.0	NVD	None	80	Unidentified Sea Turtle	Certain	ND	1	1	1
V58	Initial	2021-10-24T06:16:10.0	2021-10-24T06:17:32.0	NVD	None	50	Unidentified Sea Turtle	Certain	ND	1	1	1
V59	Initial	2021-10-24T09:11:41.0	2021-10-24T09:16:33.0	NVD	None	40	Unidentified Sea Turtle	Certain	ND	1	1	1
V60	Initial	2021-10-24T11:13:16.9	2021-10-24T11:14:20.0	UE	RB	422.2687	Unidentified Dolphin	Certain	ND	2	3	3
V61	Initial	2021-10-24T11:29:00.0	2021-10-24T11:29:15.0	UE	UE	200	Unidentified Dolphin	Certain	ND	2	3	3
V62	Initial	2021-10-24T11:50:00.0	2021-10-24T11:50:40.0	RB	None	3322.407	Unidentified Dolphin	Certain	ND	1	3	3
V63	Initial	2021-10-24T11:52:21.8	2021-10-24T12:01:00.0	RB	UE	1002.745	Unidentified Sea Turtle	Certain	ND	1	1	1
V64	Initial	2021-10-24T13:44:46.0	2021-10-24T13:45:38.0	RB	None	598.0975	Unidentified Dolphin	Certain	0	2	4	2
V65	Initial	2021-10-24T14:38:48.0	2021-10-24T14:48:48.0	UE	UE	40	Atlantic Spotted Dolphin	Certain	0	3	6	4
V66	Initial	2021-10-24T17:17:23.0	2021-10-24T17:20:00.0	UE	UE	200	Unidentified Dolphin	Certain	ND	1	1	1
V67	Initial	2021-10-24T19:25:18.0	2021-10-24T19:26:15.0	UE	None	50	Leatherback Sea Turtle	Certain	ND	1	1	1
V68	Initial	2021-10-25T04:54:20.0	2021-10-25T04:57:25.0	NVD	PAM	40	Atlantic Spotted Dolphin	Certain	0	3	3	3
V68	Initial	2021-10-25T04:54:20.0	2021-10-25T04:57:25.0	NVD	PAM	40	Atlantic Spotted Dolphin	Certain	0	3	3	3
V69	Initial	2021-10-25T08:34:00.0	2021-10-25T08:46:16.0	PAM	NVD	50	Unidentified Dolphin	Certain	0	3	3	3
V69	Initial	2021-10-25T08:34:00.0	2021-10-25T08:46:16.0	PAM	NVD	50	Unidentified Dolphin	Certain	0	3	3	3
V70	Initial	2021-10-25T16:28:10.0	2021-10-25T16:30:56.0	UE	None	30	Loggerhead Sea Turtle	Certain	0	1	1	1
V70	Initial	2021-10-25T16:28:10.0	2021-10-25T16:30:56.0	UE	None	30	Loggerhead Sea Turtle	Certain	0	1	1	1

V71	Initial	2021-10-25T16:49:36.0	2021-10-25T16:57:40.0	UE	None	100	Atlantic Spotted Dolphin	Certain	ND	8	12	10
V71	Initial	2021-10-25T16:49:36.0	2021-10-25T16:57:40.0	UE	None	100	Atlantic Spotted Dolphin	Certain	ND	8	12	10
V71	Subsequent	2021-10-25T17:07:10.0	2021-10-25T17:14:00.0	UE	None	50	Atlantic Spotted Dolphin	Certain	ND	8	12	10
V71	Subsequent	2021-10-25T17:07:10.0	2021-10-25T17:14:00.0	UE	None	50	Atlantic Spotted Dolphin	Certain	ND	8	12	10
V71	Subsequent	2021-10-25T17:26:00.0	2021-10-25T17:34:40.0	UE	None	50	Atlantic Spotted Dolphin	Certain	ND	10	20	17
V71	Subsequent	2021-10-25T17:26:00.0	2021-10-25T17:34:40.0	UE	None	50	Atlantic Spotted Dolphin	Certain	ND	10	20	17
V71	Subsequent	2021-10-25T17:53:20.0	2021-10-25T17:59:36.0	UE	None	70	Atlantic Spotted Dolphin	Certain	1	8	14	10
V71	Subsequent	2021-10-25T17:53:20.0	2021-10-25T17:59:36.0	UE	None	70	Atlantic Spotted Dolphin	Certain	1	8	14	10
V71	Subsequent	2021-10-25T17:59:36.0	2021-10-25T18:41:03.0	UE	None	135	Atlantic Spotted Dolphin	Certain	ND	6	14	12
V71	Subsequent	2021-10-25T17:59:36.0	2021-10-25T18:41:03.0	UE	None	135	Atlantic Spotted Dolphin	Certain	ND	6	14	12
Multibeam Echo Sounder Survey-Visual Detections												
Detection ID	**Initial or Subsequent**	**Time (UTC)**	**End Time (UTC)**	**Initial Detection Method**	**Subsequent Detection Method**	**Detection Distance (m)**	**Species**	**Species Reliability**	**Juveniles**	**Low Count**	**High Count**	**Best Count**
V72	Initial	2021-12-01T11:58:08	2021-12-01T12:44:19	UE	RB	200	Unidentified Dolphin or Porpoise	Certain	ND	10	15	12
V73	Initial	2021-12-02T05:16:11	2021-12-02T05:31:00	NVD	UE	100	Unidentified Dolphin or Porpoise	Certain	ND	10	15	12
V74	Initial	2021-12-16T14:58:33	2021-12-16T15:02:00	UE	None	400	Humpback Whale	Certain	ND	1	1	1
V75	Initial	2021-12-16T17:06:19	2021-12-16T17:10:00	UE	None	1000	Humpback Whale	Certain	ND	1	1	1
V76	Initial	2021-12-18T11:19:03	2021-12-18T11:19:30	UE	NVD	150	Unidentified Dolphin	Certain	1	2	3	2
V77	Initial	2021-12-19T14:14:17	2021-12-19T14:15:00	UE	None	100	Bottlenose Dolphin	Certain	ND	4	7	6
V78	Initial	2021-12-19T16:47:23	2021-12-19T16:48:00	UE	None	100	Bottlenose Dolphin	Certain	ND	4	6	5

UHR Sparker Medium Penetration SBP Survey-PAM Detections									
Detection ID	Time (UTC)	End Time (UTC)	Initial Detection Method	Visual Confirmation	Detection Module(s)	Species	Species Reliability	Estimated Range (m)	Count
P1	2021-09-26T02:18:00.0	2021-09-26T02:22:02.4	Auditory	TRUE	Aurally via Headphones	Unidentified Dolphin	Certain		
P2	2021-10-03T08:46:21.0	2021-10-03T08:55:52.8	PAM	FALSE	Observed on Spectrogram Display	Unidentified Dolphin	Certain		1
P3	2021-10-04T10:56:56.0	2021-10-04T10:56:59.0	PAM	FALSE	Observed on Spectrogram Display	Unidentified Dolphin	Certain		1
P4	2021-10-15T09:56:08.0	2021-10-15T10:01:24.0	PAM	FALSE	Aurally via Headphones	Unidentified Dolphin	Certain		3
P5	2021-10-16T09:43:45.0	2021-10-16T09:47:40.0	PAM	FALSE	Observed on HF Click Detector Display	Unidentified Dolphin	Certain		1
P6	2021-10-20T21:47:40.0	2021-10-20T21:56:40.0	PAM	TRUE	Observed on Spectrogram Display	Atlantic Spotted Dolphin	Certain		1
P6	2021-10-20T22:04:38.0	2021-10-20T22:12:32.0	PAM	TRUE	Observed on HF Click Detector Display	Atlantic Spotted Dolphin	Certain		5
P7	2021-10-23T00:38:44.0	2021-10-23T00:40:37.0	PAM	FALSE	Observed on HF Click Detector Display	Unidentified Dolphin	Certain		1
P8	2021-10-23T05:43:04.0	2021-10-23T05:54:11.0	NVD	TRUE	Observed on Spectrogram Display	Unidentified Dolphin	Certain		1
P9	2021-10-24T09:16:35.0	2021-10-24T09:22:30.0	PAM	FALSE	Observed on HF Click Detector Display	Unidentified Dolphin	Certain		2
P10	2021-10-25T04:57:33.0	2021-10-25T04:58:16.0	NVD	TRUE	Observed on HF Click Detector Display	Atlantic Spotted Dolphin	Certain		3
P10	2021-10-25T04:57:33.0	2021-10-25T04:58:16.0	NVD	TRUE	Observed on HF Click Detector Display	Atlantic Spotted Dolphin	Certain		3
P11	2021-10-25T06:56:44.0	2021-10-25T06:58:51.3	PAM	FALSE	Observed on Spectrogram Display	Unidentified Dolphin	Certain		3
P11	2021-10-25T06:56:44.0	2021-10-25T06:58:51.3	PAM	FALSE	Observed on Spectrogram Display	Unidentified Dolphin	Certain		3
P12	2021-10-25T08:29:48.0	2021-10-25T08:48:29.2	PAM	TRUE	Observed on Spectrogram Display	Unidentified Dolphin	Certain		1
P12	2021-10-25T08:29:48.0	2021-10-25T08:48:29.2	PAM	TRUE	Observed on Spectrogram Display	Unidentified Dolphin	Certain		1
P13	2021-10-25T09:32:44.0	2021-10-25T09:34:29.0	PAM	FALSE	Observed on HF Click Detector Display	Unidentified Dolphin	Certain		2
P13	2021-10-25T09:32:44.0	2021-10-25T09:34:29.0	PAM	FALSE	Observed on HF Click Detector Display	Unidentified Dolphin	Certain		2
P14	2021-10-25T10:05:32.0	2021-10-25T10:06:28.0	PAM	FALSE	Observed on HF Click Detector Display	Unidentified Dolphin	Certain		3
P14	2021-10-25T10:05:32.0	2021-10-25T10:06:28.0	PAM	FALSE	Observed on HF Click Detector Display	Unidentified Dolphin	Certain		3
P15	2021-10-25T10:56:10.0	2021-10-25T10:56:25.0	PAM	FALSE	Observed on HF Click Detector Display	Unidentified Dolphin	Certain		1
P15	2021-10-25T10:56:10.0	2021-10-25T10:56:25.0	PAM	FALSE	Observed on HF Click Detector Display	Unidentified Dolphin	Certain		1

Equipment Specifications

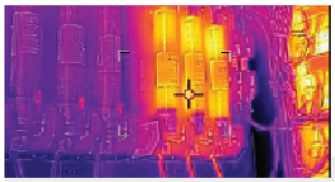
FLIR

INFRARED CAMERA WITH MSX® & WI-FI

FLIR Ex-Series™

FLIR E4, E5-XT, E6-XT, and E8-XT are powerful, cost-effective, easy-to-use troubleshooting tools for building, electrical, and mechanical applications. With four resolution options—up to 320 × 240 infrared pixels—and the ability to accurately measure temperatures from -20°C to 550°C/-4°F to 1022°F (E6-XT and E8-XT), the Ex-Series has models to fit your target size, working distance, visual detail needs, and budget. All models include MSX® technology for extraordinary thermal imaging detail. Wi-Fi connectivity to smartphones and tablets via the FLIR Tools® Mobile app makes sharing images and sending reports from any location easier, enabling you to make critical decisions faster. With Ex-Series cameras, you can gain the competitive advantage by providing clients with thermal images that clearly reveal the source of electrical, mechanical, and building-related problems.

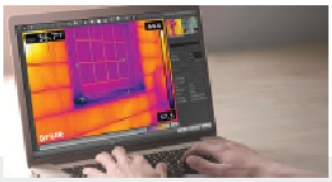
www.flir.com/Ex-Series



EASY TO USE

Intuitive graphic interface simplifies measurements in both thermal and MSX mode

- Fully automatic and focus-free
- Accurately measure your target using center spot or max/min area box
- Navigate easily to on-screen settings, image modes, and measurement tools using simple button controls
- Activate MSX to enhance IR images with visual detail for better perspective and interpretation



CONVENIENT TO SHARE IMAGES AND FINDINGS

Download images, create reports, and share what you've found instantly

- Records standard JPEGs with embedded temperature data for easy sharing with clients
- Wi-Fi connectivity to mobile devices via the FLIR Tools Mobile app
- Rapid Wi-Fi or USB image transfer for documentation
- Image analysis and editing, plus report creation, through FLIR Tools

COMPACT AND RUGGED

Built for portability and safe, efficient use in harsh environments

- Lightweight and well-balanced at just 1.2 lbs (0.575 kg)
- Withstands a 2-meter drop test
- IP54 Enclosure provides a high level of protection against dust and water
- Comes with 2-year warranty coverage on the camera and 10-year coverage for the detector

SPECIFICATIONS

Image and optical data	E4	E5-XT	E6-XT	E8-XT
IR resolution	80 × 60 (4,800 pixels)	160 × 120 (19,200 pixels)	240 × 180 (43,200 pixels)	320 × 240 (76,800 pixels)
Thermal sensitivity/NETD	<0.15°C (0.27°F) / <150 mK	<0.10°C (0.27°F) / <100 mK	<0.06°C (0.11°F) / <60 mK	<0.05°C (0.09°F) / <50 mK
Spatial resolution (IFOV)	10.3 mrad	5.2 mrad	3.4 mrad	2.6 mrad
Field of view (FOV)	45° × 34°			
F-number	1.5			
Image frequency	9 Hz			
Focus	Focus-free			
Detector data				
Detector type	Focal Plane Array (FPA), uncooled microbolometer			
Spectral range	7.5–13 µm			
Image presentation and modes				
Display	3" 320 × 240 color LCD			
Image adjustment	Automatic adjust/lock image			
Image modes	Thermal MSX, thermal, picture-in-picture, thermal blending, digital camera			
Color palettes	Iron, Rainbow, Black & White			
Measurement and analysis				
Object temperature range	−20°C to 250°C (−4°F to 482°F)	-20°C to 400°C (-4°F to 752°F) in two ranges	-20°C to 550°C (-4°F to 1022°F) in two ranges	-20°C to 550°C (-4°F to 1022°F) in two ranges
Accuracy	±2°C (±3.6°F) or ±2% of reading for ambient temperature 10°C to 35°C (50°F to 95°F) and object temperature above 0°C (32°F)			
Spotmeter	Center spot			
Area	Box with max/min			
Isotherm	Above alarm, below alarm			
Data communication and interfaces				
Interfaces	USB Micro: data transfer to and from PC and Mac devices			
Wi-Fi	Peer-to-peer or infrastructure			
File format	Standard JPEG, 14-bit measurement data included			
General				
Operating temperature range	-15°C to 50°C (5°F to 122°F)			
Battery	Rechargeable 3.6 V Li-ion battery			
Battery operating time	Approx. 4 hours at 25°C (77°F) ambient temperature and typical use			
Battery charging time	2.5 hours to 90% capacity in camera. 2 hours in charger			
Drop	2 m (6.6 ft.)			
Camera weight, incl. battery	0.575 kg (1.27 lb.)			
Camera size (L × W × H)	244 × 95 × 140 mm (9.6 × 3.7 × 5.5 in)			
Box contents	Infrared camera, hard transport case, battery, USB cable, power supply/charger with EU, UK, US and Australian plugs, printed documentation			

Specifications are subject to change without notice. For the most up-to-date specs, go to www.flir.com

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NASDAQ: FLIR

18-2963-INS

FLIR | The World's Sixth Sense®

PVS-7 Single Tube Generation 3 PINNACLE® Night Vision Goggle

The PVS-7D night vision goggle is the current military issue night vision goggle for the US armed forces. It is also the preferred choice of many foreign (NATO) forces. All NVD PVS-7s are built with Exelis GEN III Pinnacle Auto Gated image intensifier tubes, and are available with Commercial, MIL GRADE or MIL SPEC tubes.

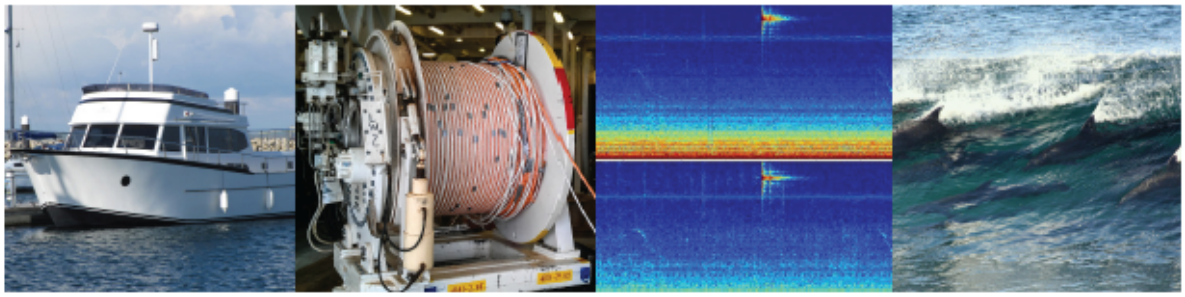
Specifications

System Performance																		
Model Number	NVD-PVS-7-ULT			NVD-PVS-7-VG			NVD-PVS-7-YG			NVD-PVS-7-HP+			NVD-PVS-7-P+			NVD-PVS-7-P		
Tube Type	Mil-Spec			Mil-Spec			Mil-Spec			Pinnacle®			Pinnacle®			Pinnacle®		
Power Supply	Gated			Gated			Gated			Gated			Gated			Gated		
Photocathode Response	2200 min.			2000 min.			1800 min.			2200 min.			1750 min.			1350 min.		
Signal to Noise Ratio	25.0 min.			25.0 min.			25.0 min.			25.0 min.			20.0 min.			16.2 min.		
EBI	2.5 max			2.5 max			2.5 max			2.5 max			2.5 max			2.5 max		
Resolution	64 lp/mm min			64 lp/mm min			64 lp/mm min			64 lp/mm min			64 lp/mm min			57 lp/mm min		
Max Spots Allowed in Each Zone, Spot Size (in.)	Zone																	
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
.012 – .015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
.009 – .012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
.006 – .009	0	0	1	0	0	1	0	1	1	0	0	1	0	1	1	0	2	2
.003 – .006	0	0	2	0	0	2	0	2	2	0	0	2	0	2	2	0	2	3

System Specifications	
Magnification	1x
Lens System	27mm f1.2
FOV	40°
Range of Focus	9.8" to infinity
	25 cm to infinity
Diopter Adjustment	+2 to -6
Automatic Brightness Control	Yes
Bright Light Cut-off	Yes
Infrared Illuminator	Built-in
IR Indicator	Yes
Low Battery Indicator	Yes
Power Supply	2x 1.5V (AA)
Battery Life	40 hours
Environmental Rating	Waterproof
Operating Temperature	-59° F to +120° F
	-51°C to +49°C
Storage Temperature	-59° F to +185° F
	-51°C to +85°C
Dimensions	6" x 6" x 3"
	152 mm x 152 mm x 76 mm
Weight	24 oz
	680 g
Warranty	10 years

MSeis PAM SYSTEMS

Night Hawk III PAM System



Night Hawk III PAM System

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

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

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

Specifications

Hydrophone	Custom built -201 dBV re 1 microPa effective sensitivity. Near-flat response 0 to 180kHz, omni-directional (tested at 50, 75 and 100kHz)
Cable	Custom length deck cable. In water cable to 300m.
Preamplifier	PA2 (MSeis in house design and build)
Channels	4
Depth Sensor	Pressure sensor 4-20mA
Construction	Hydrophone and preamplifier in polyurethane housing.
Connectors	19pin Cannon Military spec connectors, Souriau 12 pin underwater connectors, SD16 16 pin.
Supply Voltage	240V AC
Operating Voltage	24V DC
Bandwidth	4Hz - 180kHz +/-3dB
Storage	CD, DVD, Hard disk. WAV files
Acquisition	NI DAQ card; sampling to 500KS/s External USB sound card; sampling to 192KS/s
Software & Data Logging	Pamguard