Protected Species Mitigation and Monitoring Plan

South Fork Wind, LLC

South Fork Wind | Powered by Ørsted & Eversource

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List of Acronyms

AAR	autonomous acoustic recorder
ASV	autonomous surface vehicle
AUV	autonomous underwater vehicle
BBC	Big bubble curtain
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management
Cm	centimeter
COP	Construction and Operations Plan
CTV	crew transfer vessel
DASBRS	Drifting Autonomous Spar Buoy Recorders
dB	decibel
DIFAR	Directional Frequency Analysis and Recording
DMA	Dynamic Management Area
DZ	Disturbance Zone
ESA	Endangered Species Act
EZ	Exclusion Zone
ft	foot
GPS	global positioning system
HD	high definition
HRG	high-resolution geophysical
HSD	Hydro Sound Damper
Hz	hertz
IHA	Incidental Harassment Authorization
IR	infrared
ISO	International Organization for Standardization
kHz	kilohertz
km	kilometer
Lease Area	BOEM-designated Renewable Energy Lease Area
m	meter
µPa	Micropascal
mm	millimeter
MMPA	Marine Mammal Protection Act
NARW	North Atlantic right whale
NMFS	National Marine Fisheries Service
NVD	night vision device

NMS	noise mitigation system
OCS	outer continental shelf
O&M	operations and maintenance
OSS	offshore substation
PAM	passive acoustic monitoring
PECP	Permits and Environmental Compliance Plan
Project	South Fork Wind Farm Project
POC	point of contact
PSMMP, or Plan	Protected Species Mitigation and Monitoring Plan
PSO	Protected Species Observer
PTS	permanent threshold shift
QA	quality assurance
QC	quality control
rms	root mean square
ROD	Record of Decision
SAS	Sighting Advisory System
SEL_{cum}	cumulative sound exposure level
SFV	sound field verification
SFEC	South Fork export cable
SFW	South Fork Wind, LLC (applicant), South Fork Wind (project)
SFWF	South Fork Wind Farm
SMA	Seasonal Management Area
SNR	Signal to Noise Ratio
SOV	service operation vessel
SPL	sound pressure level
SPL_{pk}	peak sound pressure level
UHF	Ultra-High frequency
UHRS	Ultra-High Resolution Seismic
USCG	United States Coast Guard
VHF	very high frequency
WFA	Wind Farm Area
WTG	wind turbine generator
ZOI	Zone of Influence

Glossary

Acoustic range	Range to acoustic thresholds calculated using acoustic modeling which assumes a stationary receiver and only considers sound propagation
Autonomous acoustic recorder	Self-contained acoustic recording device designed for long-term deployment and data collection
Autonomous surface vehicle	Unmanned surface vehicle or boat operated without a crew onboard
Buffer zone	An area added to any existing zone, usually prior to specific operations, to enhance the effectiveness of mitigation such that there is a buffer in space and time during which the mitigation can be applied
Clearance zone	The area that must be visually clear of protected species prior to starting an activity that produces sound at frequencies and amplitudes that could result in Level A or Level B exposures (e.g., HRG sources with operating frequencies <200 kHz; impact and vibratory pile driving)
Construction and operations plan	Plan submitted to BOEM by developers as required by 30 CFR part 585 to describe all planned facilities proposes for construction and use for the Project, along with all proposed activities including the proposed construction activities, commercial operations, and conceptual decommissioning plans for all planned facilities, including onshore and support facilities
Dynamic Management Area	Areas established by NMFS to protect North Atlantic right whales in which a voluntary speed restriction of 10 knots or less is encouraged while transiting through these areas
Ecological monitoring	Used to assess the effectiveness of mitigation measures within the context of long term or ecosystem-based assessments outside of any mitigation requirements
Exclusion Zone	The area in which shut down or other active mitigation measures must be applied once a source is active if a protected species is sighted inside the corresponding zone
Exposure range	Ranges to acoustic thresholds calculated using acoustic modeling which considers animal movement and behavior
Hydrophone	Microphone/audio recorder designed for use underwater

Incidental harassment authorization	Authorization from NMFS per the MMPA for the "taking" of small numbers of marine mammals resulting from Project activities
Level A Zone	The area encompassed by the water from a sound source to an isopleth that meets a threshold at which onset of a permanent threshold shift (PTS) in hearing can occur
Level B Zone	The area encompassed by the water from a sound source to an isopleth that meets a threshold at which onset of a behavioral disturbance can occur
Mitigation	the set of personnel, equipment and protocols that are in place to minimize the risk of any potential impacts to marine mammals that could result from project activities
Mitigation monitoring	Typically comprised of PSOs who visually and acoustically monitor specified zones, during Project activities
Monitoring zone	The body of water around an activity that is visually and/or acoustically monitored for the presence of marine protected species
Noise Mitigation System	Any device or suite of devices that reduces pile driving sound levels that are transmitted through the water. Primary systems reduce the source levels produced by the pile and secondary systems reduce the propagated sound levels of the piling.
Offshore substation	Stations that collect and export the power generated by the WTGs, to be installed on either monopile or jacket foundations within the SFW Lease Area
Passive acoustic monitoring	Real-time monitoring using an underwater recorder during Project activities for the presence of marine mammal vocalizations
Project Area	SFW Lease Area (OCS-A 0517) and associated export cable routes
Protected species observer	NMFS-approved visual observers trained to monitor the area around vessel or platform during Project activities for the presence of protected species and implement appropriate mitigation as necessary
Record of decision	Decision issued by BOEM following review of the COP which described their decision, any alternatives considered, and plans for mitigation and monitoring, as necessary
Seasonal Management Area	Areas established by NMFS along the U.S. east coast at certain times throughout the year in which all vessels greater than 65 ft are required to travel and 10 knots or less while transiting these areas to reduce the threat of vessel strikes on North Atlantic right whales

Sound field verification	Acoustic measurements taken in the field of specific Project activities used to verify modeling results and confirm the monitoring and mitigation methods implemented for the Project are appropriate
Wind farm area	Maximum work area surrounding the South Fork Lease Area (BOEM Lease OCS-A 0517)
Wind turbine generator	A device that converts wind energy into electricity, to be installed on monopile foundations within the SFW Lease Area
Zone of influence	The area within which potential impacts to species are assessed and estimated

1 Protected Species Monitoring and Mitigation Plan

This protected species mitigation and monitoring plan (PSMMP) is in place for high-resolution geophysical (HRG) survey, construction, and operations and maintenance (O&M) activities planned for South Fork Wind LLC's (SFW) South Fork Wind Farm (SFWF) located in the Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A-O517 and the associated South Fork Export Cable(SFEC); herein referred to as the Project Area.

1.1 Purpose of PSMMP

The objective of this PSMMP is to provide protocols and guidelines for mitigation and monitoring marine mammals. The PSMMP also serves as Section 11 (Mitigation Measures to Protect Marine Mammals and their Habitat) of the Incidental Harassment Authorization (IHA) for the Project. The PSMMP provides consistency in the monitoring and mitigation methods employed across all Orsted and Orsted partnership wind projects in the Atlantic Outer Continental Shelf (OCS) and all development and operational phases. A PSMMP will be developed for each project.

1.1.1 PSMMP Format

General Project standard conditions are presented in **Sections 1** and **2** of the PSMMP; while Project-specific activities will be reflected in the **Section 3** and beyond as applicable. The Project-specific sections consider the range of activities and potential impacts; the biological and ecological information about species likely to occur within each project area; and permit conditions under which the work is being performed.

The protocols described herein are designed to:

- minimize impacts to protected species resulting from Project activities.

record the occurrence of protected species in proximity to the Project Area. The described monitoring and mitigation methods primarily target marine mammals potentially exposed to underwater sound levels that could constitute "take" under the Marine Mammal Protection Act (MMPA).

Subsequent sections of the PSMMP provide Project-specific details regarding the protocols that will be implemented during:

- HRG surveys, and
- construction

Each activity section is designed to be used as a reference to the required measures that will be implemented during the corresponding activity including:

- designating mitigation and monitoring zones,

- defining measures related to sound impacts, and
- vessel strike avoidance measures as applicable for each activity.

Users should reference the PSMMP to confirm that all agreed and regulatory measures are being implemented using the accepted methods and practices. Additionally, sections are included that address longer term and ecological monitoring initiatives that are associated with specific projects or are in development through broader Orsted and Orsted partnership activities.

The ***Standard Conditions for Mitigation and Monitoring*** (**Section 2**) that follows, outlines standard protocols and definitions that are common between all Orsted projects. This section should be considered the base conditions, or standard practices that can expected for any Orsted or Orsted partnership project. Project-specific details or modifications to these practices are provided in subsequent PSMMP sections which provides the agreed upon and regulatory frameworks for implementing Orsted and Orsted partnerships mitigation and monitoring programs.

2 Standard Conditions for Mitigation and Monitoring

2.1 Defining Mitigation and Monitoring

For purposes of the PSMMP, mitigation and monitoring are defined as follows:

- **Mitigation** – defined as the set of personnel, equipment, and protocols that are in place to minimize the risk of any potential impacts to marine mammals that could result from Project activities.

- **Monitoring** – defined in two ways:

    1) Mitigation monitoring associated with ***mitigation activities***. Mitigation monitoring is typically comprised of protected species observers (PSOs) who visually and acoustically monitor specified zones (**Section 2.1.1**), during Project activities; and
    2) Ecological Monitoring to ***assess the effectiveness of mitigation measures***. Ecological monitoring is used within the context of long-term or ecosystem-based assessments outside of any mitigation requirements. While the same or similar methods and equipment as mitigation monitoring may be used, ecological monitoring typically addresses different questions or actions than mitigation monitoring. In this context, we use the term ecological monitoring in the PSMMP to differentiate the two monitoring regimes.

2.1.1 Zone Definitions

Throughout the PSMMP, zones are described that identify either an impact range, or areas within which mitigation and/or monitoring occurs. The size of the zones and the actions (if necessary) taken within each zone will be project-, species-, and activity-specific and are identified in each Project activity section for marine mammals and in the applicable Appendices for other species. Not all zones may be incorporated for all projects or activities. If additional zones are necessary for a project outside of the standard conditions, they will be defined in the associated activity sections of that project's PSMMP and in applicable Appendices for other species. The zones applicable to this Project are defined below.

- **Level A[1] Zone** – the area encompassing the waters from a sound source to an isopleth that meets a threshold at which the **onset of a permanent threshold shift (PTS)** can occur. Level A zones may result from an instantaneous exposure, exposure over a 24-hour period, exposure to a single-strike or pulse, or other defined metric. Level A zones may be calculated or modeled, and their extent

[1] Level A refers to marine mammal harassment defined in the Marine Mammal Protection Act (MMPA) that could potentially cause PTS onset.

can be defined by acoustic ranges[2] or by exposure ranges[3]. Entry by an animal into the Level A zone may or may not require mitigation measures be taken. Marine mammals detected between the sound source and the outer range limit of the Level A zone under the specified exposure conditions may constitute Level A exposure. Unless otherwise stated, the Level A zones for marine mammals use the following metrics:

- Cumulative sound exposure level (SEL_{cum}) and peak sound pressure level (SPL_{pk}) PTS thresholds as defined by the National Marine Fisheries Service (NMFS), (2018).

- **Level B[4] Zone** – the area encompassing the waters from a sound source to an isopleth that meets a threshold at which **onset of a behavioral disturbance can occur**. Level B zones may result from an instantaneous exposure, exposure to a single-strike or pulse, or other defined metric. Level B zones may be calculated or modeled, and their extent can be defined by acoustic ranges or by exposure ranges. Entry by an animal into the Level B zone may or may not require mitigation measures be taken. Marine mammals detected within this zone under the specified exposure conditions may constitute Level B exposure. Unless otherwise stated, the Level B zones for marine mammals use the following metrics:
  - Level B zone encompasses the distance from the sound source to an unweighted received root-mean-square sound pressure level (SPL_{rms}) of 160 decibels (dB) referenced to (re) 1 micropascal (µPa) when impulsive or sweep sources are considered; and an unweighted SPL_{rms} of 120 dB re 1 µPa when non-impulsive sources are considered (NMFS, 2019).

- **Pre-start Clearance Zone** – the area that must be visually clear of protected species **prior to starting an activity** that produces sound at frequencies and amplitudes that could result in Level A or Level B exposures. Clearance zones may also be implemented after a shutdown in sound-producing activities prior to restarting the source. The size of the clearance zone is dependent on the activity and permit conditions. The clearance zone will be specific to species and/or faunal groups and may be larger than the species/faunal group-specific exclusion zone (described below).

- **Exclusion Zone (EZ)** – the area in which shutdown or other active mitigation measures must be implemented **once a source is active**. The size of the EZ is dependent on the activity and permit conditions. The EZ may or may not encompass other zones. EZs will be specific to species and/or faunal groups.

[2] Acoustic range: Range to acoustic thresholds calculated using only propagation modeling which assumes a stationary receiver

[3] Exposure range: Ranges to acoustic thresholds calculated using acoustic modeling which considers animal movement and behavior

[4] Level B refers to marine mammal harassment defined in the Marine Mammal Protection Act (MMPA) that could potentially cause behavioral disturbance.

- **Monitoring Zone** – encompasses the **waters around an activity to be visually and/or acoustically monitored** for the presence of marine protected species. The monitoring zone represents the farthest extent practicable that can be monitored for marine mammals. There are no mitigation or visibility requirements associated with the monitoring zone; however, all species detected within the monitoring will be recorded. The minimum size of the monitoring zone will help inform the appropriate monitoring methods that will be employed during activities. Monitoring zones can be considered an area of situational awareness for the project that carry no specific regulatory requirements.

- **Buffer Zone** – an area added to any existing zone, usually prior to specific operations, to enhance the effectiveness of mitigation such that there is a buffer in space and time within which marine mammals may monitored and appropriate mitigation can be applied. If an animal enters the buffer zone, mitigation measures may be required, or it may initiate a period of heightened awareness such that mitigation measures should be made ready.

- **Zone of Influence (ZOI)** – this is not a defined area for mitigation or monitoring purposes; rather, it is the area within which potential impacts to species are assessed and estimated. The ZOI would not be greater than the maximum Level B zone. While the ZOI provides the needed information to establish the other zones, it does not play an additional role in mitigation and monitoring during Project activities.

2.2 Permits and Agreements

Permits and agreements pertaining to the Project will define and modify the mitigation and monitoring requirements through the various stages of the permitting process. The permits and agreements in place for the Project are detailed in the individual Project activity sections.

2.3 Personnel

Dedicated personnel may be required for carrying out mitigation and monitoring efforts onboard Project vessels. These roles are generally required to be filled by NMFS-approved and BOEM-accepted PSOs and passive acoustic monitoring (PAM) operators.

All personnel in the field have a responsibility to support these activities and will receive Project-specific training. A Permits and Environmental Compliance Plan (PECP) manual which will include the PSMMP will be prepared to describe species expected to occur in the Project Area, monitoring and mitigation measures, data collection and reporting measures, equipment specifications, etc.

The Project will conduct standardized pre-activity environmental awareness training for all crew members (e.g., PECP training). The training will summarize the PECP and other relevant topics including:

- The responsibilities of each party;
- Definition of the chains of command;
- Communication procedures;
- An overview of monitoring purposes;
- Review of operational procedures;
- Procedures for sighting, reporting, and protection of marine mammals and other protected species;
- General review of protected species anticipated in the region; and
- Review of additional environmental requirements and awareness elements relevant to the Project.

2.3.1 Protected Species Observers

Protected species observers will, at a minimum, meet the observer standards outlined in Baker et al. (2013) and will have the appropriate approvals from NMFS for conducting PSO duties during wind farm activities. The Project will deploy a PSO team consisting of PSOs with appropriate skills and in sufficient numbers to meet all mitigation and monitoring requirements.

The PSO field team will have a lead monitor (Lead PSO) who will have experience in the northwestern Atlantic Ocean on similar projects. The PSO team will also have one PSO supervisor who may work in the field or shore side for the duration of the mitigation activities. The remaining PSOs will have previous PSO experience on similar projects and the ability to work with the relevant software and equipment.

In addition to the PECP training indicated above, PSOs will also complete a two-day training and refresher session with the PSO provider and Project compliance representatives to review in detail the protected species expected in the Project Area and associated regulatory requirements to be conducted shortly before the anticipated start of Project-related activities.

2.3.2 Passive Acoustic Monitoring Operators

If real-time PAM is employed as a mitigation monitoring protocol, a PAM operator or PAM team will be deployed. PAM operators will have the qualifications and relevant experience to meet the needs of the PAM program including safe deployment and retrieval of equipment as necessary, set-up and monitoring of acoustic processing software, and knowledge in detecting and localizing marine mammal vocalizations. Like the PSO team, the PAM team will have a lead monitor (PAM Lead) who will have experience in the Northwestern Atlantic Ocean on similar projects. The remaining PAM operators will have previous PAM experience on similar projects and the ability to work with the relevant software and equipment. Resumes for all PAM team members will be submitted to NMFS for review prior to the start of mitigation monitoring activities.

In addition to the PECP training indicated above, PAM operators will also complete a 2-day training and refresher session with the PSO provide and Project compliance representatives to review in detail the protected species expected in the Project Area and associated regulatory requirements to be conducted shortly before the anticipated start of Project-related activities.

2.3.3 Environmental Compliance Monitor

PSOs will be employed by a third-party provider. However, non-third-party observers who act as environmental compliance monitors in support of a Lead PSO may be approved by NMFS on a case-by-case basis for limited, specific duties in support of approved, independent PSOs.

2.3.4 PSO & PAM Operator Responsibilities

Prior to Project commencement, senior-level Lead PSOs will be designated for each team of PSOs on each asset (i.e., Project vessel or platform). These individuals shall have the experience and skill set to manage the team of PSOs on that asset and to make decisions related to monitoring, including potential exposure assessments for each sighting as needed. This person will be the single point-of-contact (POC) for PSO activities on that specific asset. The Lead PSO for each asset will report to the PSO Project Manager or Vessel Project Manager. The Lead PSOs shall provide daily sightings and mitigation summary reports to the designated Project Manager which is reported through to Project representatives for the previous day's operations. Any subsequent changes made to any reports submitted by the Lead PSO shall be documented in a change log and the review and acceptance by the lead PSO noted. The Lead PSO is also responsible for quality assurance (QA)/quality control (QC) and management of data collection utilizing electronic data collection and embedded QA/QC processes with software such as Mysticetus in the field on their asset. They are the primary representative of observations, reports, and mitigation actions taken by the PSO team.

The PSO supervisor will oversee data collection at the highest level of all the PSO and PAM teams. The Lead PSOs and PAM Leads will be responsible for communicating to the vessel and client POCs directly or through agreed upon Project Management intermediaries and will ensure that the communication protocols established for the Project are maintained at all times and that all personnel are trained on the communication protocols. These communication duties shall include the final responsibility for calling for a mitigation action.

Prior to the start of Project-related activities, the Lead PSO will work with the vessel captain and crew (i.e., operations team) on the vessel (the latter as applicable) to achieve compliance with all applicable regulatory documents and provide training when necessary to the vessel captain and crew.

Following established BOEM and NMFS standards, the PSO/PAM team(s) will work in designated shifts during monitoring. For PSOs, shifts will be set up such that no individual

will work more than 4 consecutive hours without a 2-hour break, or longer than 12 hours during any 24-hour period. The Project will provide each PSO with one 8-hour break per 24-hour period to sleep or rest, depending on onsite conditions (e.g., weather). An example rotation is provided in **Attachment 1**. Actual rotations will be Project-, activity-, and vessel-specific, and implemented rotations will be documented with the Project's final PSO report.

For PAM operators, minimum standard shifts are typically restricted to no more than 3 hours, but can be reduced if NMFS or BOEM directs a shorter shift. Typically, there is a "floater" PAM operator on the vessel who can rotate in to allow the PAM operator on shift to rest or eat. In some cases where vessels work under 24-hour operations, 4-hour PAM operator rotations may be scheduled. In the cases where PAM systems are monitored remotely (i.e., shore side) alternative rotations to the above may be requested on a case-by-case basis.

The combined PSO and PAM team will conduct monitoring efforts onboard Project vessels and, in some cases, shore side for remote and autonomously monitored systems. At all times during monitoring efforts, at least one dedicated vessel will be used to monitor for marine mammals relative to the activity being conducted. Autonomous, remotely operated systems may also be deployed to support the monitoring program. It is expected that during most activities, monitoring will take place from more than one platform.

The PSOs will watch for marine mammals from the best available vantage point on the vessels. Ideally this vantage point is a stable, elevated platform from which the PSOs have an unobstructed 360° view of the water. The PSOs will systematically scan with the naked eye and 7x50 reticle binoculars, supplemented with night-vision equipment when needed (see below). During activities with large monitoring zones, 25X 150 millimeter (mm) "big eye" binoculars may be used. New or inexperienced PSOs will be paired with an experienced PSO qualified to mentor new PSOs so that the quality of marine mammal observations and data recording is kept consistent. All vessel personnel are provided the guidance "*If you see something, say something*" and are responsible for reporting to the PSO team any opportunistic sightings made as soon as able and safe to do so.

2.4 Equipment

The PSOs will be equipped with reticle binoculars and will have the ability to estimate distances to marine mammals located in proximity to their respective zones using range finders. Digital single-lens reflex camera equipment will be used to record sightings and verify species identification. During night operations, night-vision equipment (night-vision goggles with thermal clip-ons) and infrared technology will be used. Position data will be recorded using hand-held or vessel global positioning system (GPS) units for each sighting. Recent studies have also concluded that the use of infrared (IR) thermal imaging technology may allow for the detection of marine mammals at night as well as

improve the detection during all periods with automated detection algorithms (Weissenberger, 2011; Smith et al., 2020; Zitterbart et al., 2020).

The exact equipment complement used by the PSO/PAM team will vary by the activity, mitigation and monitoring requirements, and observation platform constraints. Additional equipment may be added as necessary. The PSO/PAM team will typically use some combination of the following equipment for observation efforts:

- 7x50 reticle binoculars;
- 25x150 "big eye" binoculars;
- Handheld GPS units;
- High-definition digital single-lens reflex cameras with a minimum 300-mm zoom lens;
- Hard drives to back up data;
- Laser rangefinder;
- Rangefinder stick;
- Night vision devices (NVDs);
- Mounted IR thermal imaging cameras;
- Hand-held IR thermal imaging cameras;
- PAM hydrophone arrays and/or corresponding monitoring stations;
- PCs/laptops/tablets; and
- Computer-based PSO data recording system (e.g., Mysticetus).

Specific equipment requirements for individual Project-related activities are provided in **Sections 4** through **8**. Descriptions of the primary hardware used during mitigation and monitoring activities for all phases of wind farm development are provided below in **Sections 2.4.1** through **2.4.3**.

2.4.1 IR Thermal Camera Systems

Studies have indicated that IR thermal camera performance is independent of daylight and has demonstrated effectiveness ranges exceeding 3 kilometers (km). Results of studies demonstrate that IR thermal imaging can be used for reliable and continuous marine mammal protection (Zitterbart, 2013; Zitterbart et al., 2020; Smith et al., 2020). For this reason, the Project finds that use of IR thermal camera systems for mitigation purposes warrants additional application in the field as both a stand-alone tool and in conjunction with other alternative monitoring methods (e.g., night vision binoculars, PAM, visual monitoring).

2.4.2 Night Vision Devices

NVDs work on a different principle than IR thermal cameras. NVDs enhance available light to provide an image of what is being viewed through the device in such a way that it resembles viewing during higher light conditions. In this way, NVDs are less dependent on temperature differentials necessary for the IR thermal camera systems. Their drawback, however, are their narrow fields of view and short effective ranges.

Equipment selected will be tailored to the size of the zones being monitored for the Project. Specifications for representative NVD and IR thermal camera will be provided for individual projects as needed. Specific NVD and IR thermal camera equipment models will be subject to availability.

2.4.3 PAM Systems

A PAM system is defined as any system or device that uses hydrophones or arrays of hydrophones, or other sensors (e.g., vector sensors such as Directional Frequency Analysis and Recording devices [DIFAR] capable sonobuoys), to detect sounds produced by marine mammals. A review of PAM systems that are under consideration are provided in **Attachment 2** which gives a general overview of the different types of applicable PAM systems including some of their advantages and disadvantages.

Within environmental impact statements and mitigation guidelines, there is often a general presumption that animal vocalizations will be consistently detected regardless of operator experience or background noise conditions encountered (Barkaszi and Kelly, 2019; Ludwig et al., 2016; Verfuss et al., 2018). Impact estimates and risk assessments also rely on the assumption that animals within an EZ will be detected and localized immediately, so that sound exposures over certain criteria thresholds can either be avoided or enumerated (Barkaszi and Kelly, 2019; Verfuss et al., 2018). In reality, detection performance at a given distance can be highly variable due to variability in the frequency, amplitude, directionality, and repetition rate of marine mammal vocalizations; as well as the continually changing background noise levels that effectively reduce the ability to detect signals generated within a monitoring zone (Andriolo et al., 2018; Clausen et al., 2019; Parks et al, 2009; Thode and Guan, 2019; Van Parijs et al., 2009). Furthermore, localization, when required, often relies on the detection of multiple high-quality signals. When the detection performance of signals is diminished, the actual time required to localize an animal or group of animals might be prolonged or impossible (Abadi et al., 2017; Barkley et al., 2016; Thode and Guan, 2019). The types and configurations of PAM systems considered for all monitoring on Orsted and Orsted Partnership projects are discussed in **Sections 2.4.3.1** through **2.4.3.2** and in **Attachment 2**.

2.4.3.1 PAM Systems for Real-Time Mitigation Monitoring

PAM is widely used to monitor mitigation zones around vessels and other platforms during survey and installation activities that could negatively impact marine mammals. The priority of mitigation monitoring is the ability for compliance personnel to detect and spatially localize marine mammals such that a mitigation decision can be made in a matter of minutes. The complexity of acoustic detection and localization is further hindered by practical operational conditions that are common for mitigation monitoring, described further below.

The real-time requirement limits the types of PAM technologies that can be used to those systems that are either cabled, satellite, or radio-linked. The system chosen will

dictate the design and protocols of the PAM operations. Seafloor cabled PAM systems are not considered here, due to high installation and maintenance costs, environmental issues related to cable laying, permitting, and other reasons.

Towed PAM systems are cabled hydrophone arrays that are deployed from a vessel and typically monitor directly from the tow vessel. By and large, towed PAM systems are the mainstay of mitigation PAM applications due to the relatively low cost, high mobility, and ease and reliability of operation. However, the main challenge of a towed PAM system is the fact that it is usually towed from a vessel that may not be fit-for-purpose that may also be towing other equipment, operating sound sources, and is working in patterns that are permit and Project-driven rather than driven by acoustic monitoring needs; all of which can result in less than optimal conditions in which to employ PAM systems. In particular, detection and localization of low-frequency signals (e.g., baleen whale calls) can be challenging in many commercial deployment configurations. One significant value of towed PAM systems, however, is their ability to work in unison with visual monitoring efforts along transects. The ability to coordinate call types and call rates with visually detected species and group sizes provides important information for analyzing data from non-towed systems. While towed PAM systems have a place in mitigation monitoring (e.g., in support of visual observation), alternative PAM systems are required for long-range and low frequency signal monitoring.

Mobile and hybrid PAM systems utilizing autonomous surface vehicles (ASVs) and radio-linked autonomous acoustic recorders (AARs) shall be considered when they can meet monitoring and mitigation requirements in a cost-effective manner. Mobile systems are defined here as systems that are not fixed (e.g., moored or bottom-mounted) at one location. Examples of mobile systems include autonomous underwater vehicles (AUVs), ASVs, and drifting PAM buoys. Examples of drifting PAM buoys include sonobuoys, the Que-phone, Drifting Autonomous Spar Buoy Recorders (DASBRS), and SonarPoint in the drifter configuration). Due to their drifting nature, these systems are typically deployed in pelagic environments, or for very short periods (e.g., sonobuoys). A review for ASVs and AUVs was recently conducted by Verfuss et al. (2019).

Real-time (e.g., radio-linked) PAM buoys can be used for regional monitoring of large areas and have an advantage over AARs in that they can telemeter data to shore or a monitoring station nearby in real, or near real-time. Examples of real-time PAM buoys are also provided in **Attachment 2**.

2.4.3.1.1 Placement of Mitigation PAM Systems

Ideally, deployment of a mitigation PAM array will be outside the perimeter of the EZ to optimize the PAM system's capability to monitor for the presence of animals potentially entering these zones. The total number of PAM stations and array configuration will depend on the size of the zone to be monitored, the amount of noise expected in the

area, and the characteristics of the signals being monitored. There is no single optimal array configuration for all animal call types or noise conditions.

In general, large cetaceans such as baleen whales that produce relatively loud, low-frequency vocalizations can be monitored with a few hydrophones that can be separated by several hundreds of meters or more, whereas smaller cetaceans such as toothed whales and dolphins produce shorter, lower level signals (e.g., whistles, echolocation clicks) that require hydrophones to be spaced more closely, tens of meters to less than a meter apart, and thus may require more hydrophones in an array.

Using closely-spaced clusters of hydrophones (i.e., an array) or vector sensors will allow the direction and, in some cases, the range to vocalizing animals to be estimated. However, this approach adds greater complexity and costs to both the hardware and software, can reduce reliability of the system, and can make real-time monitoring and mitigation difficult for PAM operators. Of course, detection and localization of animals is only possible if they are vocally active.

2.4.3.2 PAM Systems for Ecological Monitoring

The type of system chosen for any ecological monitoring programs will depend on the monitoring priorities (i.e., species and areas to be monitored), the environment (e.g., water depths), bottom fishing (e.g., trawling) in the area to be monitored, and other factors which contribute to detection probabilities.

AARs are a good option for long-term ecological monitoring. AARs are available in a variety of configurations and specifications (**Attachment 2**) (Sousa-Lima et al., 2013). Typically, AARs are deployed on the seafloor for some period of time from several days, weeks, months, up to one year. They are later retrieved from the seafloor, and the data are downloaded. An acoustic release device is typically used to release the recorder from the seafloor, however, grappling methods can also be used in some shallow water environments (usually 50 meters [m] or less). Some shallow water systems can also be retrieved with divers, but this approach is becoming less common due to safety issues and availability of more reliable and low-cost release devices. Once retrieved, the recording devices can be serviced, the data downloaded, and then re-deployed for additional missions. One major disadvantage of AARs over other PAM systems is that the recorders must be periodically retrieved in order to access the data because they record and store data internally and therefore are not capable of real-time monitoring. However, due to their autonomous nature, an advantage of these systems is that an infinite variety of deployment configurations are possible.

Most AARs consist of a single omni-directional hydrophone, and therefore it is not possible to obtain bearings or localizations to sound sources from this type of single device. However, other advanced systems utilize a directional hydrophone/sensor (e.g., DIFAR), or multiple hydrophones connected to a single multi-channel recorder (e.g., a hydrophone array) and thus can localize. In some systems, multiple AAR units can be precisely time-synchronized (e.g., using an acoustic pinger or electronic cable),

so that bearings can be obtained and in some deployment configurations localizations of sound sources is thus possible. If an animal or tightly clustered group of animals (e.g., a small pod of dolphins) vocalize consistently through time, it may also be possible to track their movements. In general, the more hydrophones that receive the calls, the higher certainty there will be in the animal locations and tracks, until the increased complexity of processing multiple channels of data in real time becomes an issue.

One downside of AARs is that if a failure occurs (e.g., electronic malfunction, flooding, or a failure to retrieve them) significant volumes of data can be lost. This issue is of particular concern for long-term deployments. Also, the data storage and batteries required for extended deployment periods increase the size and costs of these systems.

Finally, there is a cost associated with deployment and retrieval which typically requires a vessel with a hoist, A-frame, or other heavy machinery. The size of the vessel required depends on size and ease of deployment of the AAR system. Some smaller systems can be deployed from a small boat or rigid-hulled inflatable boat, while others might require a large and costly research or other type of vessel with an A-frame. Finally, the fact that data must be post-processed results in additional analysis expense. However, depending on the level of and type of processing, this approach is usually cheaper (per unit of data collected) than real-time monitoring, which typically requires experienced and relatively costly personnel working on vessels or platforms at sea.

There are also hybrid systems that have some components of both real-time and autonomous systems. For example, many types of real-time systems also record data internally, so they can function both as a real-time system, and as autonomous recorders in case the radio or satellite link is not reliable. Some hybrid systems only send status reports or whale-call detection summaries to shore or a vessel nearby via the radio or satellite-link.

The optimal system will depend on cost considerations, the target species, the length of deployment desired, and a variety of other factors. It is important to realize that there is no single system that is capable of mitigation and monitoring of all species of marine mammals for all areas and noise conditions, so it is possible that several systems, or combinations of systems will be needed.

2.5 Software & Informational Tools

During Project-related activities when a marine mammal is detected (either visually or acoustically), data will be collected using software designed for such collection. Software systems exist or are being developed that allow for real-time or near real-time uploads into internet-based cloud storage systems, enabling that information to be downloaded by other vessels or PSOs/PAM operators in the area. This regular and ongoing sharing of sighting data and acoustic detections across platforms will integrate into a Project-wide *Situational Awareness System* that will also include, as feasible, a Marine Operation Centers vessel monitoring system, external sources of information

such as WhaleAlert and the NMFS Sight Advisory System (SAS), detections from external sources of sighting information such as any existing North Atlantic right whale (NARW) Listening Network detections, 3rd party sightings, and any designated and overlapping designated seasonal and dynamic management areas (SMA and DMA).

The overall goal will be to create a Common Operating Picture (i.e., the ability to describe current conditions or species presence in real time or near real time) viewable by project personnel across multiple project assets and provide a mechanism to manage multiple assets or activities throughout the Project Area in a systematic way. The system as named supports increased situational awareness of marine mammals and facilitates active whale avoidance (Gende et al., 2019) which is an *active and adaptive* mitigation approach for marine mammal monitoring and supports quick decision making for vessel operators, Project crew, or PSO/PAM operators during Project activities. The software selected for this Project is described further in **Section 2.5.1**.

As a secondary measure, PSOs will check at least once per 4 hours (or as otherwise requested by the Project) additional available information sources including WhaleAlert and the NMFS SAS.

2.5.1 Mysticetus Software

Mysticetus is field-tested technology specifically designed to facilitate PSO operations and enhance protective measures for marine mammals. Mysticetus provides a standardized data collection system customized for data collection protocols specified by the Project across all vessel operators and PSO providers. The standardized data collection includes effort, Project updates, and animal detection data forms and can be updated as needed. Some of the Mysticetus capabilities that enhance Project situational awareness include:

- Real-time graphical display of all relevant information from all boats in the network and 3rd party data feeds defined by the Project.
- Graphically displayed content includes current EZs around work boats, work zones, and survey areas.
- Display that enables instantaneous mitigation decision support features including display of sighting distances and prediction paths of both animals and vessels, enabling informed PSO decisions for survey path adjustment, operational shutdowns, clearance delays, etc.
- Instantaneous sharing of sightings and alerting between all Mysticetus stations in the network (i.e., any animal sighted by any observer shows up on the maps of all nearby Project vessels) creates a multiplying effect of "eyes on water," and is used by vessel crews to actively avoid animals.
- Automatic display of NMFS NARW DMAs on heads-up display map.

- Standardized QA and reporting processes and tools for all PSOs, regardless of which PSO provider or vessel sub-contractor they work for.

- Email and text message instant alerts in the case of sightings of dead, injured, or entangled animals, as well as all NARW sightings.

- Automatic, accurate localization of sighted animals based on reticle binoculars or inclinometer readouts, including deck and PSO eye height, taking into account curvature of the earth.

- IR thermal camera integration of video recording, animal localization support, effort, etc.

- PAM integration and the recording of PAM effort and acoustic detections to Project-specified data collection standards.

2.6 Recording

As part of all monitoring programs, PSOs, PAM operators, and crew members (as applicable) will record all sightings of marine mammals sighted anywhere within the monitoring zone. For mitigation monitoring, data on all PSO observations will be recorded based on standard PSO data collection requirements and specific permit conditions. A data collection software system (e.g., Mysticetus) will be used to record and collate data obtained from visual and acoustic observations during mitigation monitoring. The PSOs and PAM operators will enter the data into the selected data entry program (e.g. Mysticetus) installed on field laptops/tablets. PSO data records will include:

- The presence and location (if determinable) of any marine mammal detected by PSOs, PAM operators, or crew members.

- Identification of marine mammal species, numbers of individuals, and behaviors as able. PAM detections are rarely suitable for enumeration or behavior of animals unless verified by visual detections.

- Detections will be annotated with information regarding vessel activity, environmental conditions, and by other operational parameters (e.g., number of vessels in areas, equipment start and stop times, operational duration, etc.).

- Size of all regulatory and monitoring zones.

- Implementation of vessel strike avoidance measures.

- Implementation of clearance, ramp-up, and shutdown measures as applicable for exclusion and monitoring zones.

- Implementation of specific NARW mitigation measures.

- Observations of any potential injured or dead protected species (e.g., stranding events).

- The following information about each marine mammal detection will be carefully and accurately recorded:
  - Species, group size, age/size/sex categories (if determinable), and physical description of features that were observed or determined not to be present in the case of unknown or unidentified animals;
  - Behavior when first sighted and during any subsequent sightings;
  - Heading (if consistent), bearing, and distance from observer;
  - Location of confirmed acoustic detections within Project Area (if PAM operator is able to localize the animal);
  - Tracks of marine mammals derived from PAM systems if accurate localization is attainable;
  - Entry of animal into any regulatory or monitoring zones and duration in those zones;
  - Closest point of approach to the applicable activities and/or vessels and assets;
  - Apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.) with annotations regarding animal headings, pace, or other information that could help assess changes in behavior;
  - Time, location, speed, and Project activity/active sound sources in operation;
  - How the animal was detection (i.e., with what monitoring method) and if the animal was detected by any other monitoring method; and
  - Mitigation measures requested and implemented (if any).

- At regular intervals and at each detection the following information will be recorded by PSOs and PAM operators when the information is determinable:
  - Sea state, visibility, and sun glare;
  - Noise performance of PAM systems and effective detection ranges for species;
  - Vessel or Project activities and location (if mobile);
  - PSO shift changes;
  - Monitoring equipment being used; and
  - Any NARW SMA or DMAs place during that particular watch.

2.7 Reporting

The following situations would require immediate reporting to appropriate POCs:

- In the event of a sighting of a stranded, entangled, injured, or dead protected species, the sighting shall be reported within 24 hours to the NMFS SAS hotline as stipulated in **Attachment 3**.

- In the event a protected species is injured or killed as a result of Project activities, the vessel captain or PSO on board shall report immediately to NMFS Office of Protected Resources and Greater Atlantic Regional Fisheries Office no later than within 24 hours as stipulated in **Attachment 3**.

- Any NARW sightings should be reported as soon as feasible and no later than within 24 hours to the NMFS SAS hotline or via the WhaleAlert App.

Data and Final Reports will be prepared using the following protocols:

- All vessels will utilize a standardized data entry format.

- A QA/QC'd database of all sightings and associated details (e.g., distance from vessel, behavior, species, group size/composition) within and outside of the designated Exclusion Zones, monitoring effort, environmental conditions, and Project-related activity will be provided after field operations and reporting are complete.

- Final reports will follow a standardized format for PSO reporting from activities requiring marine mammal mitigation and monitoring.

- An annual report will be provided to NMFS and to BOEM on April 1 every calendar year summarizing the prior year's activities.

2.8 Noise Mitigation Systems

Noise mitigation systems (NMS) are employed during pile driving activities to reduce the sound pressure levels that are transmitted through the water in an effort to reduce ranges to acoustic thresholds and minimize acoustic impacts resulting from pile driving activities.

There are two categories of NMS, primary and secondary. A primary NMS is used to reduce the level of noise produced by the pile driving activities at the source, typically by adjusting parameters related to the pile driving methods or the impulse produced by a hammer strike. However, primary NMS are not fully effective at eliminating all harmful noise levels that can propagate from construction activities (e.g., $\geq$1 km), so a secondary NMS is typically employed to further mitigate pile driving noise. A secondary NMS is a device or devices employed to reduce the noise as it is transmitted through the water (and through the seabed) from the pile. The noise is typically reduced by some sort of physical barrier that either reflects or absorbs sound waves and therefore decreases the distance over which higher energy sound is propagated through the water column.

Primary NMS are still evolving and will be considered for mitigation when mature with demonstrated efficacy in commercial projects. There are generally three types of secondary NMS considered for impact pile driving within the PSMMP. The final selection of the single or suite of technologies that comprise the NMS will be dependent upon the

pile and environmental characteristics of the piling location. The demonstrated effectiveness of these systems is described in Bellmann et al., (2020). The three NMS technologies considered for the Project include:

1) Big bubble curtain (BBC):
   A BBC consists of a flexible tube fitted with special nozzle openings and installed on the seabed around the pile. Compressed air is forced through the nozzles producing a curtain of rising, expanding bubbles. These bubbles effectively attenuate noise by scattering sound on the air bubbles, absorbing sound, or reflecting sound off the air bubbles.
2) Hydro-Sound Damper (HSD):
   An HSD system consists of a fisher net with different sized elements are laid out at various distances from each other which encapsulates the pile. HSD elements can be foam plastic or gas-filled balloons. Noise is reduced as it crosses the HSD due to reflection and absorption.
3) AdBm, Helmholz resonator:
   The AdBm system consists of large arrays of Helmholtz resonators, or air fill containers with an opening on one side that can be set to vibrate at specific frequencies to absorb noise, deployed as a "fence" around pile driving activities.

There are other available systems, however, these may not be technically feasible for the Project (e.g., noise mitigation screen), are either in early stages of development, or have yet to demonstrate their expected performance during field tests and are therefore not being currently considered for use during construction. The Project is committed to achieving the modeled ranges associated with 10dB of noise attenuation.

The configuration of any secondary NMS will optimize its efficacy based on the location, operations, and environmental and oceanographic parameters of the project. For the context of this report, the ***standard*** BBC configuration is defined as a BBC that has been professionally deployed and further optimized after initial deployment based on local conditions and *in-situ* measurement results.

2.9 Vessel Strike Avoidance Policy

The project will implement a vessel strike avoidance policy for all vessels under contract to reduce the risk of vessel strikes, and the likelihood of death and/or serious injury to marine mammals that may result from collisions with vessels. In addition to vessels transiting and working (e.g., HRG surveys, construction, O&M) within the Project Area, there will be vessels transiting to and from the Project Area transporting materials, equipment, and personnel. A project-specific vessel strike avoidance plan is provided in **Attachment 5**.

Marine mammals may not be able to avoid vessels, especially fast-moving ones, and may have difficulty identifying the direction of the source of the vessel noise due to sound propagation characteristics in the marine environment.

All vessels will comply with the vessel strike avoidance measures as specified below, except under extraordinary circumstances when complying with these requirements would put the safety of the vessel or crew at risk.

1) Vessel operators and crews shall receive protected species identification training. This training will cover sightings of marine mammals and other protected species known to occur or which have the potential to occur in the Project Area. It will include training on making observations in both good weather conditions (i.e., clear visibility, low wind, low sea state) and bad weather conditions (i.e., fog, high winds, high sea states, glare). Training will include not only identification skills but information and resources available regarding applicable federal laws and regulations for protected species. It will also cover any Critical Habitat requirements, migratory routes, seasonal variations, behavior identification, etc.

2) Vessel operators and crews will maintain a vigilant watch for marine mammals and other protected species and change course, respond with the appropriate action (e.g., slow down, steer away from the animal) to avoid striking marine mammals.

3) Vessel operators will monitor the Project's *Situational Awareness System* and as necessary, WhaleAlert and the NMFS SAS for the presence of NARWs once every 4-hour shift during Project-related activities.

4) All vessels will comply with NMFS regulations and speed restrictions and state regulations as applicable for NARW.

5) All vessels 65 ft (20 m) or longer subject to the jurisdiction of the U.S. will comply with the 10-knot speed restriction when entering or departing a port or place subject to U.S. jurisdiction, and in any SMA[5] during NARW migratory and calving periods from November 1 to April 30; also in the following feeding areas as follows: from January 1 – May 15 in Cape Cod Bay; from March 1 – April 30 off Race Point and from April 1 – July 31 in the Great South Channel.

6) When whales are sighted, the vessel shall maintain a distance of 91 m (100 yards) or greater between the whale(s) and the vessel; for smaller cetaceans or sea turtles, a distance of 45 m (50 yards) or greater is best; for right whales this distance is 457 m (500 yards).

[5] Compliance Guide for Right Whale Ship Strike Reduction Rule (50 CFR 224.105), available at: https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-ship-strikes-north-atlantic-right-whales#seasonal-management-areas---mid-atlantic

7) All attempts shall be made to remain parallel to the animal's course when a travelling marine mammal is sighted in proximity to the vessel in transit. All attempts shall be made to reduce any abrupt changes in vessel direction until the marine mammal has moved beyond its associated separation distance (as described above).

8) If an animal or group of animals is sighted in the vessel's path or in close proximity to it, or if the animals are behaving in an unpredictable manner, all attempts shall be made to divert away from the animals or, if unable due to restricted movements, reduce speed and shift gears into neutral until the animal(s) have moved beyond the associated separation distance (with the exception of voluntary bow riding dolphin species).

Additionally, all vessel operators will be briefed to ensure they are familiar with the measures listed above and discussed throughout this Plan. The Project will continue to support external initiatives to further mitigate marine traffic impacts and currently is a supporter of the WhaleAlert system and is investing in development and advancement of whale listening network.

2.9.1 Vessel Types Expected During Construction

Vessels associated with construction (i.e., HRG surveys, pile driving, cable laying), are described in **Table 1**.

Table 1. General vessel types expected during construction.

Vessel Type	Installation Foundations	Installation Export Cable
Survey Vessel (offshore)	❍	
Survey Vessel (nearshore)		❍
Heavy Lift Crane Vessel	❍	
Derrick Barge Crane Vessel	❍	
Jack-up Installation Vessel	❍	
Jack-up Material Feeder Barge	❍	❍
Floating Material Barge	❍	❍
Jack-up Crane Work Vessel	❍	❍
Floating Crane Work Vessel	❍	❍
Towing Tug	❍	❍
Anchor Handling Tug	❍	❍
Rock Dumping/Fallpipe Vessel (FPV)	❍	
Fuel Bunkering Vessel	❍	❍
Cable Laying Vessel	❍	❍
Crew Transport Vessel	❍	❍
Support Vessel/Inflatable Boat	❍	❍
Cable Installation Equipment	❍	❍

3 South Fork Wind Farm Project Area

3.1 Applicable Project Area

The area covered by the PSMMP includes Lease Area OCS-A 0517, some ports of mobilization, transit corridors and the SFEC. Subject to Construction and Operations Plan (COP) conditions. All operations occurring in coordinate with the COP. For the purpose of this PSMMP, the Project Area is defined as the state and federal waters in the vicinity of the SFWF and the SFEC (**Figure 1**).

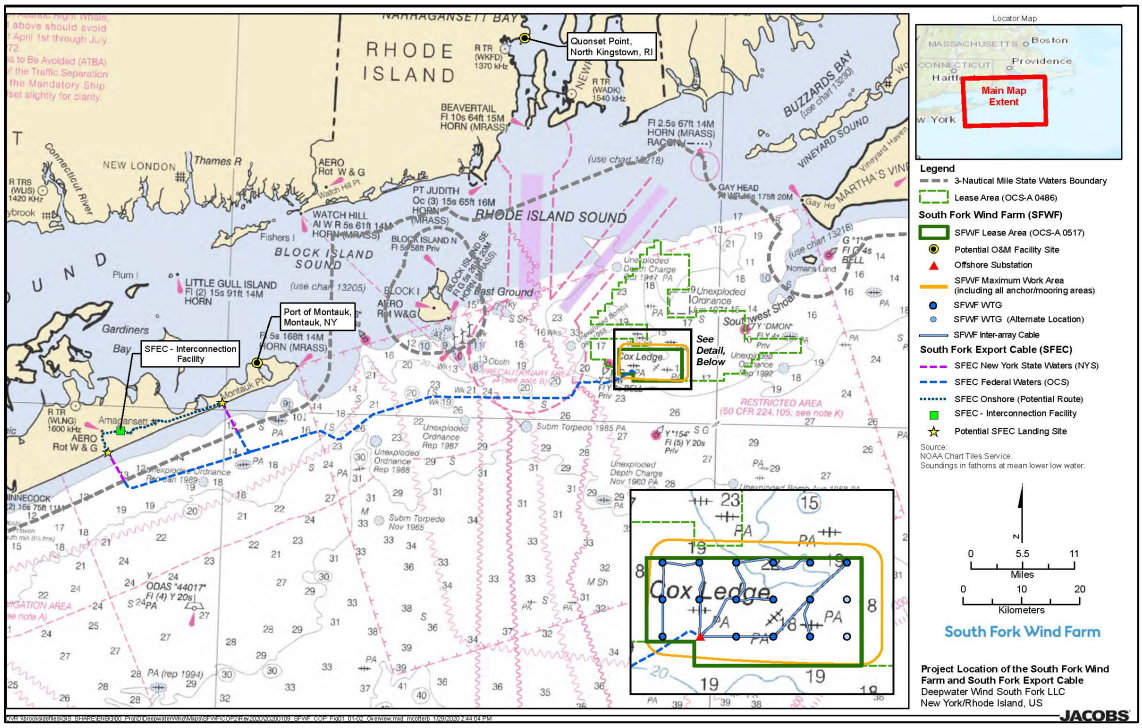

Figure 1. Map of Project Area.

4 HRG Survey Monitoring and Mitigation

HRG survey activities may be required during construction and O&M phases of the Project. During such surveys, activities would include, but are not limited to the following:

- Depth sounding (multibeam depth sounders) to determine water depths and general bottom topography (currently estimated to range from approximately 1 to 55 m, in depth below mean lower low water);
- Magnetic intensity measurements for detecting local variations in regional magnetic field from geological strata and potential ferrous objects on and below the seabed;
- Seafloor imaging (side-scan sonar surveys) for seabed sediment classification purposes to identify natural and man-made acoustic targets resting on the bottom as well as any anomalous features;
- Sub-bottom profiler surveys to map the near surface stratigraphy; and
- Ultra-High Resolution Seismic (UHRS) equipment to map deeper sub-surface stratigraphy as needed.

HRG survey operations will be conducted over 24-hour periods. To provide survey flexibility, specific locations and vessel numbers to be utilized for such surveys will be determined at the time of contractor selection.

The mitigation procedures outlined in this section have evolved from protocols and procedures that have been previously implemented for similar offshore wind projects HRG surveys within the Lease Area and approved by NMFS. Unless otherwise specified, the following mitigation measures apply to HRG survey activities for this Project.

NOTE: The mitigation and monitoring for HRG surveys apply only to sound sources with operating frequencies below 200 kHz. There are no mitigation or monitoring protocols required for sources operating >200 kHz.

4.1 Monitoring and Mitigation Zones

The monitoring and mitigation zones established in IHAs, lease conditions, and best practices are provided in **Table 2** and displayed in **Figure 2**.

Table 2. Standard monitoring and mitigation zones established for HRG survey activities.

Species	Level A Zone (SEL_{cum})	Level A Zone (SPL_{pk})	Maximum extent of Zone in meters (m) from all potential HRG sound sources					Vessel Separation Distance
			Level B Zones		Monitoring Zone[a]	Pre-Start Clearance Zone	Exclusion Zone	
			Innomar	All Other Equipment				
Low-frequency Cetaceans								
Fin whale*	<1	<1	50	141	500	100	100	100
Minke whale	<1	<1	50	141		100	100	100
Sei whale*	<1	<1	50	141		100	100	100
Humpback whale	<1	<1	50	141		100	100	100
N.A. right whale*	<1	<1	50	141		500	500	500
Blue whale*	<1	<1	50	141		100	100	100
Mid-frequency Cetaceans								
Sperm whale*	<1	<1	50	141	500	100	100	100
Atlantic spotted dolphin	<1	<1	50	141		100	-	50
Atlantic white-sided dolphin	<1	<1	50	141		100	-	50
Common dolphin	<1	<1	50	141		100	-	50
Risso's dolphin	<1	<1	50	141		100	-	50
Bottlenose dolphin	<1	<1	50	141		100	-	50
Long-finned pilot whale	<1	<1	50	141		100	-	50
High-frequency Cetaceans								
Harbor porpoise	36.5	4.7	50	141	500	100	100	50
Phocid Pinnipeds in Water								
Gray seal	<1	<1	50	141	500	100	-	50
Harbor seal	<1	<1	50	141		100	-	50

* = denotes species listed under the Endangered Species Act; SEL_{cum} = cumulative sound exposure level in units of decibels referenced to 1 micropascal squared second; SPL_{pk} = peak sound pressure level in units of decibels referenced to 1 micropascal.
- = No exclusion zone mitigation measures will be applied.
[a] 500 m is the minimal monitoring zone applicable. Monitoring zone extends to maximum visible distance.
[b] Dolphin and pinniped species have a required 100-m exclusion zone; however, shut down requirements are waived for these species.

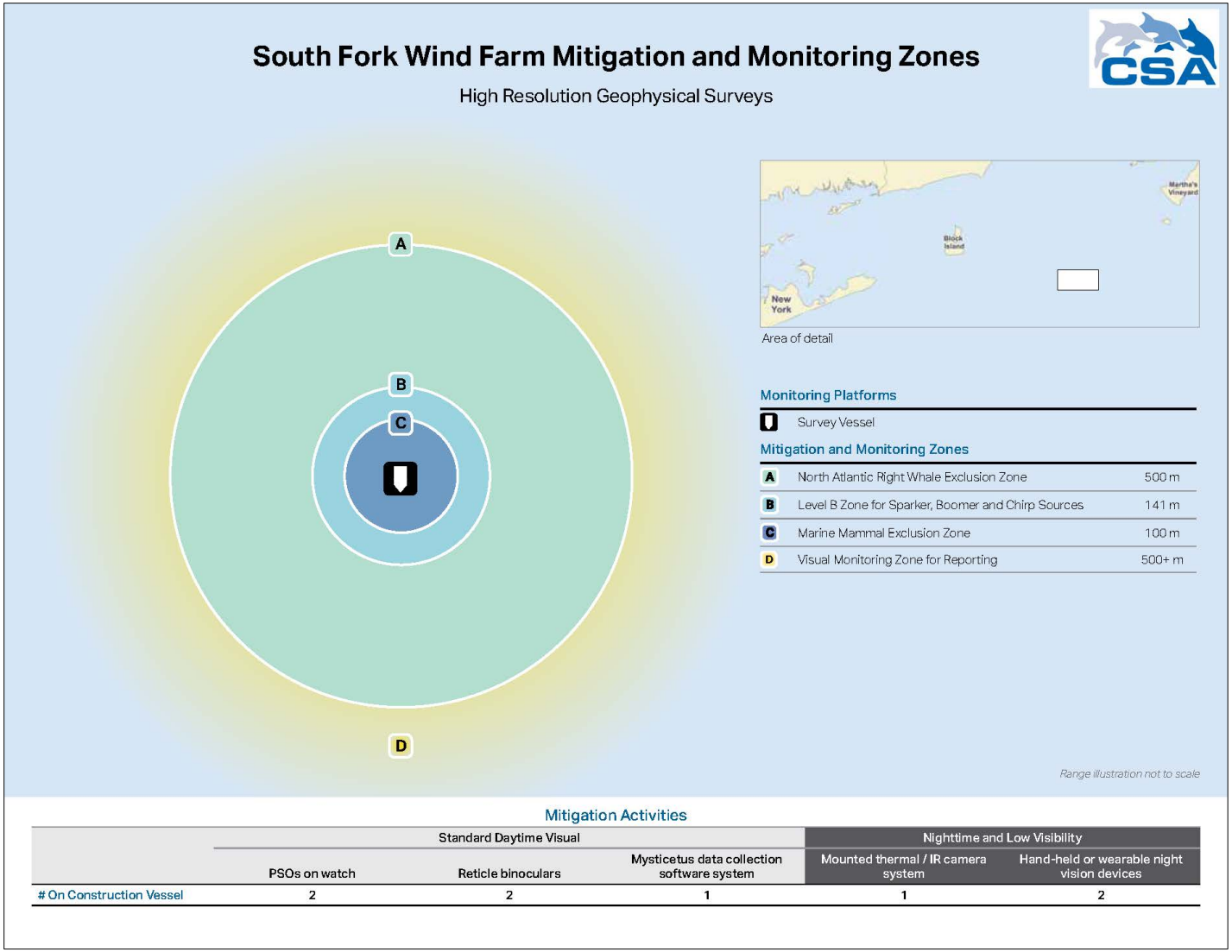

Figure 2. Marine mammal mitigation and monitoring zones for high-resolution geophysical surveys.

Note to Figure: The 100-m marine mammal exclusion zone is also the clearance zone for all species except North Atlantic right whales (NARW) and is an exclusion zone (shutdown zone) for only large whales except the NARW which has a 500-m exclusion zone.

4.2 Project Monitoring and Mitigation Protocols

HRG surveys using sound sources with operating frequencies below 200 kHz are subject to the mitigation and monitoring protocols described in the following subsections.

There will be four to six visual PSOs on all 24-hr survey vessels, and two to three visual PSOs on all 12-hour survey vessels[6]. **Table 3** provides the list of the personnel on watch and monitoring equipment available onboard each HRG survey vessel.

Table 3. Personnel and equipment compliment for monitoring vessels during HRG surveys.

Item	# on Survey Vessel
PSOs on watch	1
Reticle binoculars	2
Mounted thermal/IR camera system	1
Hand-held or wearable NVD	2
IR spotlights	2
Mysticetus data collection software system	1
PSO-dedicated VHF radios	2
Digital single-lens reflex camera equipped with 300-mm lens	1

IR = infrared; NVD = night vision devices; PSO = protected species observer; VHF = very high frequency.

4.2.1 Visual Observation Protocols and Methods

The following visual observation protocols will be implemented by all PSOs employed on Project vessels:

- Visual monitoring of the established EZs and monitoring zone will be performed by PSO teams on each survey vessel.
- Observations will take place from the highest available vantage point on all the survey vessels. General 360° scanning will occur during the monitoring periods, and target scanning by the PSO will occur if cued to a marine mammal. PSOs will adjust their positions appropriately to ensure adequate coverage of the entire exclusion and monitoring zones around the respective sound sources.
- PSOs will work in shifts such that no one PSO will work more than 4 consecutive hours without a 2-hour break or longer than 12 hours during any 24-hour period.
- The PSOs will begin observation of the EZs prior to initiation of HRG survey operations and will continue throughout the survey activity and/or while equipment operating below 200 kHz are in use.

[6]A 24-hour vessel is considered any vessel expected to conduct operations after daylight hours; a 12-hour vessel is considered a vessel that conducts operations during daylight hours only.

- The PSOs will be responsible for visually monitoring and identifying marine mammals approaching or entering the established zones during survey activities.
- It will be the responsibility of the Lead PSO on duty to communicate the presence of marine mammals as well as to communicate and enforce the action(s) that are necessary to ensure mitigation and monitoring requirements are implemented as appropriate.

4.2.1.1 Daytime Visual

The following protocols will be applied to visual monitoring during daytime surveys:

- One PSO on watch during pre-clearance periods and all source operations.
- PSOs will use reticle binoculars and naked eye to scan the monitoring zone for marine mammals.

4.2.1.2 Nighttime and Low Visibility Visual Observations

Visual monitoring during nighttime surveys or periods of low visibility will utilize the following protocols:

- The lead PSO will determine if conditions warrant implementing reduced visibility protocols.
- Two PSOs on watch during pre-clearance periods and all operations.
- Each PSO should use the most appropriate available technology (e.g., IR camera and NVD) and viewing locations to monitor the EZs and maintain vessel separation distances.

4.2.1.3 ASV Operations

Should an ASV be utilized during surveys, the following procedures will be implemented:

- PSOs will be stationed aboard the mother vessel to monitor the ASV in a location which will offer a clear, unobstructed view of the ASV's exclusion and monitoring zones.
- When in use, the ASV will be within 800 m of the primary vessel while conducting survey operations.
- For monitoring around an ASV, if utilized, a dual thermal/high definition (HD) camera will be installed on the mother vessel facing forward and angled in a direction so as to provide a field of view ahead of the vessel and around the ASV.
- PSOs will be able to monitor the real-time output of the camera on hand-held iPads. Images from the cameras can be captured for review and to assist it verifying species identification.

- A monitor will also be installed on the bridge displaying the real-time picture from the thermal/HD camera installed on the front of the ASV itself, providing an additional forward field of view of the craft.

- Night-vision goggles with thermal clip-ons, as mentioned above, and a hand-held spotlight will be provided such that PSOs can focus observations in any direction around the mother vessel and/or the ASV.

4.2.2 Pre-Start Clearance

- PSOs will implement a 30-minute clearance period of the EZs prior to the initiation of equipment ramp-up (**Section 4.2.3**).

- The EZ's must be visible using the naked eye or appropriate visual technology during the entire clearance period for operations to start. If the EZs are not visible, source operations <200 kHz may not commence.

- Ramp-up may not be initiated if any marine mammal(s) is detected within its respective EZ.

- If a marine mammal is observed within its respective EZ during the pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting its respective EZ or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

4.2.3 Ramp-up

- Where technically feasible, a ramp-up procedure will be used for HRG survey equipment capable of adjusting energy levels at the start or re-start of HRG survey activities. Ramp-up procedures provide additional protection to marine mammals near the Project Area by allowing them to vacate the area prior to the commencement of survey equipment use.

- The ramp-up procedure will not be initiated during periods of inclement conditions or if the EZs cannot be adequately monitored by the PSOs, using the appropriate visual technology for a 30-minute period.

- A ramp-up would begin with powering up the smallest acoustic HRG equipment at its lowest practical power output appropriate for the survey. When technically feasible, the power would then be gradually turned up and other acoustic sources added as able.

- Ramp-up activities will be delayed if a marine mammal(s) enters its respective EZ. Ramp-up will continue if the animal has been observed exiting its respective EZ or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

4.2.4 Operations Monitoring

- PSOs will monitor Mysticetus and/or appropriate data systems for DMAs established within their survey area.

- PSOs will also monitor the NMFS NARW reporting systems including WhaleAlert and SAS once every 4-hour shift during Project-related activities within, or adjacent to, SMAs and/or DMAs.

4.2.5 Shutdown Protocols

- An immediate shutdown of the HRG survey equipment operating at frequencies <200 kHz will be required if a marine mammal is sighted at or within its respective EZ.

- The vessel operator must comply immediately with any call for shutdown by the Lead PSO. Any disagreement between the Lead PSO and vessel operator should be discussed only after shutdown has occurred.

- Subsequent restart of the survey equipment can be initiated if the animal has been observed exiting its respective EZ within 30 minutes of the shutdown or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

4.2.6 Pauses And Silent Periods

- If the acoustic source is shutdown for reasons other than mitigation (e.g., mechanical difficulty) for less than 30 minutes, it may be activated again without ramp-up if PSOs have maintained constant observation and no detections of any marine mammal have occurred within the respective EZs.

- If the acoustic source is shutdown for a period longer than 30 minutes or PSOs were unable to maintain constant observation, then ramp-up procedures will be initiated as described in **Section 4.2.3**.

4.2.7 Vessel Strike Avoidance

- The Project will follow vessel strike avoidance measures outlined previously in the *Vessel Strike Avoidance Policy* section (**Section 2.9**) and in project-specific Vessel Strike Avoidance Plan provided in **Attachment 5**.

4.2.7.1 Vessel Speed Restrictions

- The Project will follow vessel strike avoidance measures outlined previously in the *Vessel Strike Avoidance Policy* section (**Section 2.9**) and in project-specific Vessel Strike Avoidance Plan provided in **Attachment 5**.

4.2.8 Data Recording

- All data recording will be conducted using Mysticetus or similar software.

- Operations, monitoring conditions, observation effort, all marine mammal detections, and any mitigation actions.

- Members of the monitoring team must consult NMFS' NARW reporting systems for the presence of NARWs in the Project Area as previously described.

4.3 Reporting

- The Project will follow reporting measures as stipulated in **Section 2.7**.

4.3.1 DMAs

- DMAs will be reported across all vessels.

4.3.2 Injured and Dead Protected Species

- The Project will follow reporting measures as stipulated in **Section 2.7**.

5 Construction – Impact Pile Driving Monitoring and Mitigation

Up to 15 wind turbine generators (WTG) and one offshore substation (OSS) will be installed on either monopile or jacket foundations using impact pile driving. Impact pile driving will take up to 4 hours to install each monopile foundation and 16 hours for each jacket foundation. After completion of the pile-driving activities for each foundation, the installation vessel will move to the next position and a secondary vessel will complete installation (i.e., attachment of external and internal platforms, commissioning, etc.).

5.1 Monitoring and Mitigation Zones

The Level A exposure ranges and Level B acoustic ranges along with the mitigation zones are provided in **Table 4** and displayed in **Figure 3**. These zones and ranges are based on the modeled piling scenario with inclusion of a difficult pile and with an NMS that assumes 10 dB broadband noise attenuation. Monitoring zones implemented during the project may be modified, with NMFS approval, based on measurements of the received sound levels during piling operations. The sound field measurement plan is described in detail in **Attachment 4**.

Table 4. Table of mitigation and monitoring zones[1] during impact pile driving with a noise mitigation system.

Species	Level A Zone (m) (SEL_{cum})[3]	Level A Zone (m) (SPL_{pk})	Monitoring and mitigation zones in meters (m)[2]				Vessel Separation Distance (m)
			Level B Zone	Monitoring Zone (situational awareness zone)	Pre-start Clearance Zone[4]	Exclusion Zone[5]	
Low-frequency Cetaceans							
Fin whale*	1,769	≤10	4,684	>4,684	2,200	2,000	100
Minke whale	1,571	≤10	4,684	>4,684	2,200	2,000	100
Sei whale*	1,756	≤10	4,684	>4,684	2,200	2,000	100
Humpback whale	3,642	≤10	4,684	>4,684	2,200	2,000	100
North Atlantic right whale*	1,621	≤10	4,684	>4,684	4,684	2,000	500
Blue whale*[6]	1,769	≤10	4,684	>4,684	2,200	2,000	100
Mid-frequency Cetaceans							
Sperm whale*	-	≤10	4,684	>4,684	2,200	2,000	100
Atlantic spotted dolphin	-	≤10	4,684	>4,684	100	50	50
Atlantic white-sided dolphin	-	≤10	4,684	>4,684	100	50	50
Common dolphin	-	≤10	4,684	>4,684	100	50	50
Risso's dolphin	-	≤10	4,684	>4,684	100	50	50
Bottlenose dolphin	-	≤10	4,684	>4,684	100	50	50
Long-finned pilot whale	-	≤10	4,684	>4,684	100	50	50
High-frequency Cetaceans							
Harbor porpoise	365	301	4,684	>4,684	450	450	50
Phocid Pinnipeds in Water							
Gray seal	117	≤10	4,684	>4,684	150	150	50
Harbor seal	85	≤10	4,684	>4,684	150	150	50

* = denotes species listed under the Endangered Species Act; dB = decibel; SEL_{cum} = cumulative sound exposure level SPL_{pk} = peak sound pressure level.

[1]Zones are based upon the following modeling assumptions:

- 11-m monopile installation with inclusion of a difficult to install pile that requires approximately 8,000 hammer strikes and mitigated with10 dB broadband noise attenuation from a noise mitigation system. Only 1 pile out of the 16 total monopiles is expected to be a difficult pile.

[2] Zone monitoring will be achieved through a combined effort of passive acoustic monitoring and visual observation.

[3] The Level A zone represents the exposure ranges of species derived from animal movement modeling.

[4] The pre-start clearance zone for large whales, porpoise, and seals is based upon the maximum non-humpback whale Level A zone plus 20% buffer and rounded up for PSO clarity. The North Atlantic right whale zone was set equal to the Level B zone to avoid any unnecessary take; Mid-frequency cetacean zones were set using precautionary distances and will extend to the distances listed or just beyond the noise mitigation system, whichever is further.

[5] The exclusion zone for large whales (including North Atlantic right whale), porpoise, and seals is based upon the maximum Level A zone plus 10% buffer and rounded up for PSO clarity. Mid-frequency cetacean zones were set using precautionary distances and will extend to the distances listed or just beyond the noise mitigation system, whichever is further.

[6]No Level A exposures were calculated for blue whales resulting in no expected Level A exposure range; therefore, the exposure range for fin whales was used as a proxy due to similarities in species.

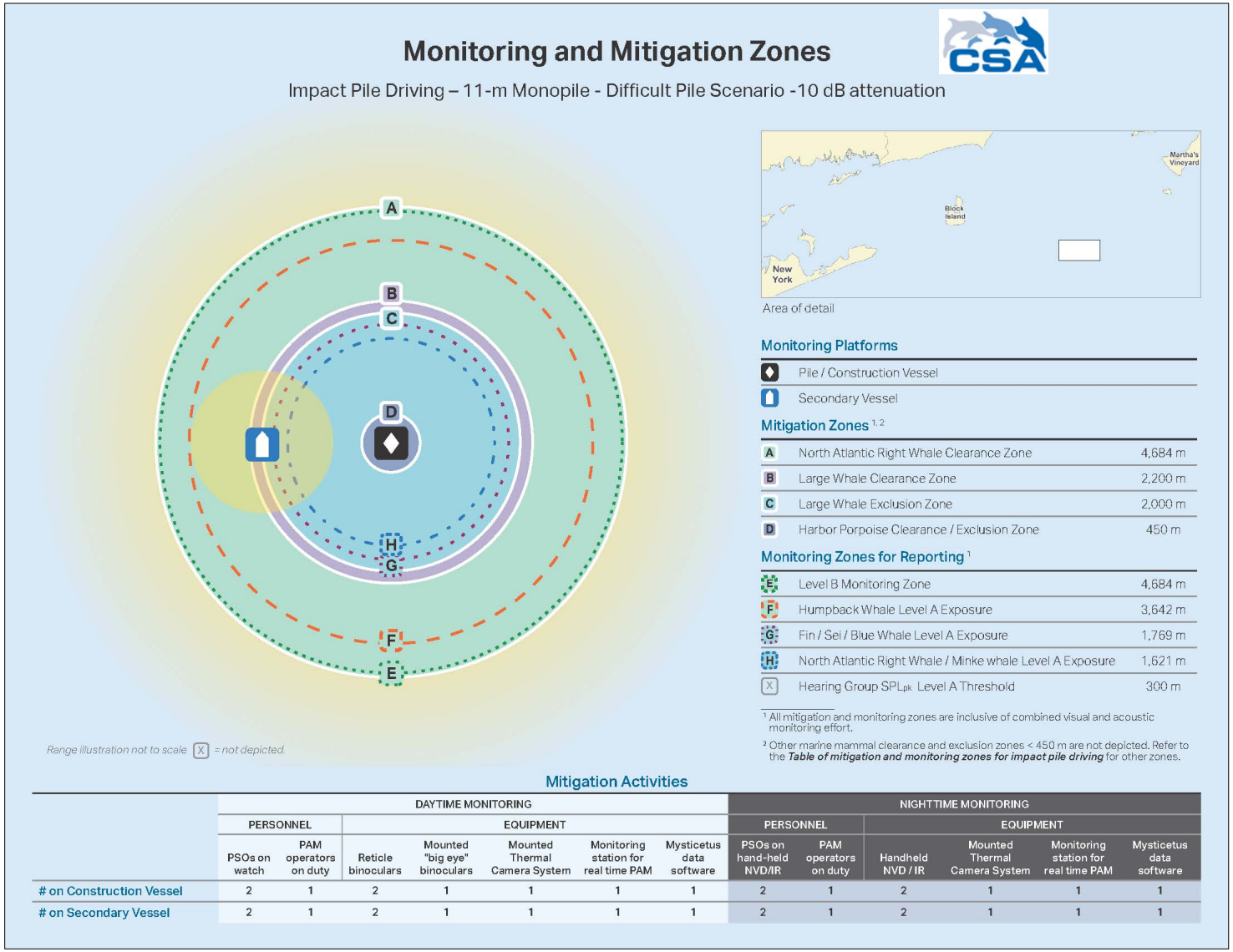

Figure 3. Marine mammal mitigation and monitoring zones during impact pile driving with a noise mitigation system.

5.2 Project Monitoring and Mitigation Protocols

There are four primary mitigation and monitoring efforts associated with impact pile driving:

1) Vessel-based visual PSOs and associated visual monitoring tools stationed on the construction vessel and on any secondary marine mammal monitoring vessels;

2) PAM operators and an associated mitigation PAM array in support of the visual PSOs;

3) Noise attenuation systems; and

4) Acoustic measurement data collection to verify distances to regulatory or mitigation zones.

Monitoring and mitigation protocols applicable to impact pile driving activities during SFWF construction are described further in the following subsections. Impact pile driving may be initiated after dark or during reduced visibility periods following the protocols in **Sections 5.2.1** through **5.2.4** and include utilization of alternative monitoring methods.

There will be a team of six to eight visual and acoustic PSOs on the pile driving vessel, and a team of four to eight visual and acoustic PSOs on any secondary marine mammal monitoring vessel (secondary vessel). PAM operators may be located remotely/onshore. **Table 5** provides the list of the personnel on watch and the PSO and PAM monitoring equipment available onboard the construction vessel and the secondary vessel.

Table 5. Personnel and equipment use for all marine mammal monitoring vessels during pre-start clearance, impact pile driving, and post piling monitoring.

Item	Standard Daytime		Monitoring for Nighttime and Low Visibility	
	# on Construction Vessel	# on Secondary Vessel	# on Construction Vessel	# on Secondary Vessel
Visual PSOs on watch	2	2	2	2
PAM operators on duty[1]	1	1	1	1
Reticle binoculars	2	2	0	0
Mounted thermal/IR camera system[2]	1	1	1	1
Mounted "big-eye" binocular	1	1	0	0
Monitoring station for real time PAM system[3]	1	1	1	1
Hand-held or wearable NVDs	0	0	2	2

Table 5. (Continued)

Item	Standard Daytime		Monitoring for Nighttime and Low Visibility	
	# on Construction Vessel	# on Secondary Vessel	# on Construction Vessel	# on Secondary Vessel
IR spotlights	0	0	2	2
Mysticetus data collection software system	1	1	1	1
PSO-dedicated VHF radios	2	2	2	2
Digital single-lens reflex camera equipped with 300-mm lens	1	1	0	0

IR = infrared; NVD = night vision device; PSO = protected species observer; VHF=very high frequency.
[1]PAM operator may be stationed on the vessel or at an alternative monitoring location.
[2] The camera systems will be automated with detection alerts that will be checked by a PSO on duty; however, cameras will not be manned by a dedicated observer.
[3]The selected PAM system will transmit real time data to PAM monitoring stations on the vessels and/or a shore side monitoring station.

5.2.1 Daytime Visual Monitoring

Visual monitoring will occur from the construction vessel and a secondary vessel. Daytime visual monitoring is defined by the period between nautical twilight rise and set for the region. The intent of the visual monitoring program is to provide complete visual coverage of the EZs during impact pile driving using the following protocols:

- During the pre-start clearance period, throughout pile driving, and 30-minutes after piling is completed, two PSOs will maintain watch at all times on the construction vessel; likewise, two PSOs will also maintain watch during the same time periods from the secondary vessel.

- The total number of observers will be dictated by the personnel necessary to adhere to standard shift schedule and rest requirements while still meeting mitigation monitoring requirements for the Project. A sample crew rotation is provided in **Attachment 1**.

- It is expected the full complement of PSOs will not always be required (i.e., full coverage will be in place during piling activities, however, in between piling events, the PSO team can consist of only one PSO on duty). Piling is anticipated to take a maximum of 4 hours per piling event (i.e., 4 hours at a given foundation location) after which the construction vessel moves away to a new location for the next piling event. PSOs will monitor for 30 minutes before and after each piling event.

- During daytime observations, two PSOs on each vessel will monitor the EZ with the naked eye and reticle binoculars. One PSO will periodically scan outside the EZ using the mounted big eye binoculars.

- Visual monitoring zones are as follows:
  - PSOs will visually monitor, the maximum (non-humpback) Level A zone plus an additional 20% buffer (**Table 3**) which constitutes the pre-start clearance zone. This zone encompasses the maximum Level A exposure ranges for all marine mammal species except the humpback whale.
  - PSOs will visually monitor the harbor porpoise, pinniped, and dolphin EZs. (**Table 3**)
  - The secondary vessel will be positioned and circling at the outer limit of the Large Whale EZ (**Figure 3**).
  - PSOs stationed on the secondary vessel will ensure the outer portion of the EZs and pre-start clearance zone are visually monitored.
  - There will be a PAM operator on duty (see **Section 5.2.4**) conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods, piling, and post-piling monitoring periods. Acoustic monitoring, as described in **Section 5.2.4,** will include extend beyond the Large Whale Pre-Start Clearance Zone.

5.2.2 Daytime Periods of Reduced Visibility

- If the monitoring zone is obscured, the two PSOs on watch on each vessel will continue to monitor the EZ utilizing thermal camera systems and handheld night vision devices as able.

- There will be a PAM operator on duty (see **Section 5.2.4**) conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods, piling, and post-piling monitoring periods.

- All on-duty PSOs will be in contact with the PAM operator on-duty who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area.

5.2.3 Nighttime Visual: Construction and Secondary Vessel

- During nighttime operations, visual PSOs on-watch will rotate in pairs: one observing with an NVD and one monitoring the IR thermal imaging camera system.

- The mounted thermal cameras may have automated detection systems or require manual monitoring by a PSO.

- PSOs will focus their observation effort during nighttime watch periods within the EZs and waters immediately adjacent to the vessel.

- If possible, deck lights will be extinguished or dimmed during night observations when using the NVDs (strong lights compromise the NVD detection abilities); alternatively, if the deck lights must remain on for safety reasons, the PSO will attempt to use the NVDs in areas away from potential interference by these lights.

- There will be a PAM operator on duty (see **Section 5.2.4**) conducting acoustic monitoring in coordination with the visual PSOs. All on-duty PSOs will be in contact with the PAM operator on-duty who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area.

5.2.4 Passive Acoustic Monitoring

Visual monitoring will be supplemented by PAM during all pre-start clearance, piling operations and post monitoring periods. A PAM Operator will be on duty and will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area. A combination of alternative monitoring measures, including PAM has been demonstrated to have comparable detection rates to daytime visual detections for several species (Smith et al., 2020).

PAM devices proposed for monitoring during Project impact pile driving activities are not likely to be towed from the vessel, but rather will be independent (e.g., autonomous or moored remote) stations located around the area to be monitored. The specific placement of PAM devices or systems will be determined based on the final mitigation zones determined in the regulatory review process. As detailed in **Attachment 2** there are multiple available PAM systems with demonstrated capability for monitoring and localizing marine mammal calls, including large whales, within the proposed monitoring and mitigation zones (e.g. sonobuoy arrays or similar retrievable buoy systems).

PAM will be used to monitor the following zones during piling:

- PSOs will acoustically monitor a zone that encompasses the Level B zone for all marine mammals, which also encompasses the Level A zones for all marine mammal species (**Table 3**).

In general, the following monitoring protocols related to PAM will be followed for this Project:

- It is expected there will be a PAM operator stationed on at least one of the dedicated monitoring vessels in addition to the PSOs; or located remotely/onshore.

- PAM operators must complete specialized training for operating PAM systems prior to the start of monitoring activities.

- All on-duty PSOs will be in contact with the PAM operator on-duty. who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area.

- For real-time PAM systems, at least one PAM operator will be designated to monitor each system by viewing data or data products that are streamed in real-time or near real-time to a computer workstation and monitor located on a Project vessel or onshore.

- The PAM operator will inform the Lead PSO on duty of animal detections approaching or within applicable ranges of interest to the pile-driving activity via the data collection software system (i.e., Mystcetus) who will be responsible for requesting that the designated crewmember implement the necessary mitigation procedures.

- Acoustic monitoring will complement visual monitoring (e.g., visual PSOs and thermal cameras) and will cover an area of at least the EZ around each foundation.

- PAM monitoring will follow a similar shift schedule as PSO monitoring unless otherwise requested and approved.

5.2.5 Mitigation Measures During Impact Pile Driving

Mitigation measures implemented during a piling event include pre-start clearance by the PSOs, ramp up or soft start of the pile strikes, post-piling monitoring, shutdowns, and delays in soft start. The parameters of these mitigation measures are summarized in **Table 6** and detailed in the subsequent sections.

- Mitigation zones established for all species including the NARW will be applied during all months of the year.

Table 6. Summary of mitigation measures during impact pile driving with a noise mitigation system.

	Piling with an NMS, 10 dB broadband attenuation				
	NARW	Large Whale	Delphinids	Harbor Porpoise	Seals
Pre-Start Clearance Zone[1]	4,684 m	2,200 m	100 m	450 m	150 m
Clearance Duration	60 min visual monitoring, 60 min PAM monitoring; zone must be clear for 30 min				
Soft Start	All Piles				
Post-piling monitoring	30 min				
Exclusion (Shutdown) Zone[2]	2,000 m	2,000 m	50 m	450 m	150 m

m=meters; min=minutes; NARW=North Atlantic right whale; NMS=Noise Mitigation System
[1] Clearance and Shutdown zones will be monitored using a combination of visual and acoustic methods.
[2] Shutdowns may be initiated by either visual or acoustic detection. Only acoustic detections that meet criteria (e.g. localization) for determining that the call originated inside the given zone will be considered for mitigation.

5.2.5.1 Pre-Start Clearance

There is a 60-minute pre-start clearance period that will be implemented for impact pile driving activities. Clearance and Shutdown zones will be monitored using a combination of visual and acoustic methods. Visual PSOs will begin surveying the monitoring zone at least 60 minutes prior to the start of pile driving. PAM monitoring will also begin at least 60-minutes prior to the start of piling.

- The large whale EZ must be fully visible for at least 30 minutes prior to commencing ramp-up. (**Table 6**).

- All marine mammals must be confirmed to be out of the clearance zone prior to initiating ramp up.

- If a marine mammal is observed entering or within the relevant clearance zones prior to the initiation of pile driving activity, pile driving activity must be delayed.

- Impact pile driving may commence when either the marine mammal(s) has voluntarily left the respective clearance zone and been visually confirmed beyond that clearance zone, or, when 30 minutes have elapsed without redetection for mysticetes, sperm whales, Risso's dolphins, and pilot whales; or 15 minutes have elapsed without re-detection of all other marine mammals.

5.2.5.2 Ramp up (Soft Start)

Every monopile installation will begin with a soft start procedure of a minimum of 20-minute duration. The soft start procedure is detailed in **Table 7**.

- Soft start of pile driving will not begin until the Clearance Zone has been cleared by the visual PSO or PAM operators when applicable.

- If any marine mammals are detected within the applicable EZ prior to or during the soft start, activities will be delayed until the animal has been observed exiting the EZ or until an additional time period has elapsed with no further sighting.

Table 7. Generic soft start procedure overview.

% of max hammer blow energy	Soft Start
	10–20%
Monopile blow energy	600–800 kJ
Strike Rate	4–6 strikes/min
Duration	Minimum of 20 minutes or greater until pile verticality/self-stability is secured.

kJ=kilojoule.

5.2.5.3 Post Operations Monitoring

- PSOs will continue to survey the monitoring zone using visual and acoustic protocols throughout the pile installation and for a minimum of 30 minutes after piling has been completed.

5.2.5.4 Shutdown Protocols

For reference, a generic piling procedure has been broken down into five different steps where blows, strike ratio and duration envelopes are defined. The Piling Procedure is summarized in **Table 8** and follows these general criteria:

1) The hammer reaches the max. blows/min rate possible before moving to the next energy level.

2) The piling schedule (and therefore resulting sound field) does not exceed the maximum scenario modelled for regulatory authorizations.
3) Refusal criteria is not exceeded
   (i) 125cl/25 centimeters (cm) over an increment of 6 × 25 cm
   (ii) 200bl/25 cm over an increment of 2 × 25 cm
   (iii) 325bl/25 cm over an increment of 1 × 25 cm.
4) The hammer drives the pile to target penetration.

Table 8. Generic piling procedure and expected net duration (4,000 kJ hammer).

% of Max Hammer Blow Energy	Piling Schedule				
	20%	40%	60%	80%	100%
Monopile blow energy	800 kJ	1,600 kJ	2,400 kJ	3,200 kJ	4,000 kJ
Blow count	500–1,600	600–1,800	1.000–1,800	1,000–1.800	1,000
Strike Rate	10–60 bl/min	20–50 bl/min	30–40 bl/min	35 bl/min	30–32 bl/min
Duration	15–45 min	15–45 min	15–45 min	15–45 min	15–45 min

bl=blow (i.e, strike); kJ=kilojoule.

- If a marine mammal is visually or acoustically detected entering or within the respective EZs after pile driving has commenced, an immediate shutdown of pile driving will be implemented unless SFW and/or its contractor determines shutdown is not feasible due to an imminent risk of injury or loss of life to an individual; or risk of damage to a vessel that creates risk of injury or loss of life for individuals.

- There are two scenarios, approaching pile refusal and pile instability, where this imminent risk could be a factor (*See Deferred Shutdown Scenarios*).
  (i) If shutdown is called for but SFW and/or its contractor determines shutdown is not feasible due to risk of injury or loss of life, reduced hammer energy must be implemented.
  (ii) After a shutdown, pile driving must only be initiated once all EZs are confirmed by PSOs to be clear of marine mammals for the minimum species-specific time periods.

- **Deferred Shutdown Scenarios:** Scenarios that would prevent shutdown of piling operations typically have a low likelihood of occurrence based on Orsted's extensive pile driving experience and low occurrence of these situations.

  - **Scenario 1**: **Pile Refusal**: The pile driving sensors indicate the pile is approaching refusal, and a shutdown would lead to a stuck pile which then poses an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals.

    - **Risk Likelihood/Mitigation**: Each pile is specifically engineered to manage the sediment conditions at the location at which it is to be driven, and therefore designed to avoid and minimize the potential for piling refusal. Orsted uses these pre-installation engineering assessments and design

together with real-time hammer log information during installation to track progress and continuously judge whether a stoppage would cause a risk of injury or loss of life. ***Due to this advanced engineering and planning, circumstances under which piling could not stop if a shutdown is requested are very limited.***

- **Scenario 2: Pile Instability**: For a specified project and installation vessel, weather conditions criteria will be established that determine when a piling vessel would have to "let go" of a pile being installed for safety reasons. A pile may be deemed unstable and unable to stay standing if the piling vessel were to "let go". During these periods of instability, the lead engineer may determine a shutdown is not feasible because the shutdown combined with impending weather conditions may require the piling vessel to "let go" which then poses an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals.

  - **Risk Likelihood/Mitigation**: To reduce the risk that a requested shutdown would not be possible due to weather, Orsted actively assesses weather, using two independent forecasting systems. Initiation of piling also requires a *Certificate of Approval* by the Marine Warranty Supervisor. In addition to ensuring that current weather conditions are suitable for piling, this *Certificate of Approval* process considers forecasted weather for 6 hours out and will evaluate if conditions would limit the ability to shut down and "let go" of the pile. If a shutdown is not feasible due to pile instability and weather, piling would continue only until a penetration depth sufficient to secure the pile is achieved. ***As piling instability is most likely to occur during the soft start period, and soft start cannot commence till the Marine Warranty Supervisor has issued a Certificate of Approval that signals there is a current weather window of at least 6 hours, the likelihood is low for the pile to not achieve stability within the 6 hour window inclusive of stops and starts.***

5.2.5.5 Pauses and Silent Periods

- The EZ must be continuously monitored by PSOs and PAM during any pauses in pile driving.

- If marine mammals are sighted within the EZ during a pause in piling, activities will be delayed until the animal(s) has moved outside the EZ and no marine mammals are sighted for a period of 30 minutes.

5.2.6 Vessel Strike Avoidance

- The Project will follow vessel strike avoidance measures outlined previously in the *Vessel Strike Avoidance Policy* section (**Section 2.9**) and in project-specific Vessel Strike Avoidance Plan provided in **Attachment 5**.

5.2.6.1 Vessel Speed Restrictions

- The Project will follow vessel strike avoidance measures outlined previously in the *Vessel Strike Avoidance Policy* section (**Section 2.9**) and in project-specific Vessel Strike Avoidance Plan provided in **Attachment 5**.

5.2.7 Data Recording

- All data recording will be conducted using Mysticetus software.
- Operations, monitoring conditions, observation effort, all marine mammal detections, and any mitigation actions will be recorded.
- Members of the monitoring team must consult NMFS' NARW reporting systems for the presence of NARWs in the Project Area.

5.3 Reporting

- The SFW will follow reporting measures as stipulated in **Section 2.7**.

5.3.1 DMAs

- DMAs will be reported across all Project vessels.

5.3.2 Injured and Dead Protected Species

- The Project will follow reporting measures as stipulated in **Section 2.7**.

5.4 Noise Attenuation

- The Project will use an NMS for all piling events and is committed to achieving the modeled ranges associated with 10 dB of noise attenuation (See **IHA Section 1.2.1**).

5.5 Sound Measurements

Received sound measurements will be collected during driving of at least 1 pile using an NMS. The measurement plan is provided in **Attachment 4**.

- The goals of the of field verification measurements using an NMS include: verification of selected acoustic ranges (e.g., Level B range); and providing sound measurements of impact pile driving using International Organization for Standardization (ISO)-standard methodology to build data that are comparable among projects.
- Potential modification of Clearance and EZs:
  - Based on the sound field measurement results the Project may request a modification of the clearance and/or EZs.

6 Construction – Vibratory Pile Driving Monitoring and Mitigation

The sea-to-shore transition will include a new onshore transition vault, cable installed using horizontal directional drilling under the beach and intertidal water, and may also include a temporary cofferdam located offshore beyond the intertidal zone. If Project conditions require a cofferdam, it will be installed using either sheet pile installed via vibratory pile driving or gravity cell.

6.1 Monitoring and Mitigation Zones

Table 9 provides the ranges to all thresholds and monitoring zones applied during vibratory pile driving for cofferdam installation; no noise attenuation is proposed due to the short time period of the activities. Animal movement modeling resulted in no Level A exposures for any species and no Level A exposures are expected from vibratory pile driving; however acoustic ranges were modeled for reference. The Level A ranges are acoustic ranges and therefore represent the maximum distance at which a stationary receiver (i.e., animal) could exceed SEL_{cum} thresholds over a 24-hour period. Exposure ranges (which were not modeled for vibratory pile driving) are expected to be small enough such that no Level A exposures are anticipated. However, a precautionary approach is being applied with a pre-start clearance zone and an EZ for all large whales that equals the 24-hour acoustic ranges.

Table 9. Threshold ranges, mitigation, and monitoring zones in meters for marine mammal species during Project vibratory pile driving activities.

Species	Level A Acoustic Range Extent (SEL_{cum})	Monitoring and Mitigation Zones in meters (m)				Vessel Separation Distance (m)
		Level B Zone (SPL_{rms})	Monitoring Zone (situational awareness zone)	Pre-start Clearance Zone	Exclusion Zone	
Low-Frequency Cetaceans						
Fin whale*	1,470	36,766	1,500	1,500	1,500	100
Minke whale	1,470	36,766	1,500	1,500	1,500	100
Sei whale*	1,470	36,766	1,500	1,500	1,500	100
Humpback whale	1,470	36,766	1,500	1,500	1,500	100
N.A. right whale*	1,470	36,766	1,500	1,500	1,500	500
Blue whale*	1,470	36,766	1,500	1,500	1,500	100
Mid-Frequency Cetaceans						
Sperm whale*	0	36,766	1,500	1,500	1,500	100
Atlantic spotted dolphin	0	36,766	1,500	100	50	50
Atlantic white-sided dolphin	0	36,766	1,500	100	50	50
Common dolphin	0	36,766	1,500	100	50	50
Risso's dolphin	0	36,766	1,500	100	50	50
Bottlenose dolphin	0	36,766	1,500	100	50	50

Table 9. (Continued).

Species	Level A Acoustic Range Extent (SEL_{cum})	Monitoring and Mitigation Zones in meters (m)				Vessel Separation Distance (m)
		Level B Zone (SPL_{rms})	Monitoring Zone (situational awareness zone)	Pre-start Clearance Zone	Exclusion Zone	
Long-finned pilot whale	0	36,766	1,500	100	50	50
High-Frequency Cetaceans						
Harbor porpoise	63	36,766	1,500	100	100	50
hocid Pinnipeds in Water						
Gray seal	103	36,766	1,500	100	100	50
Harbor seal	103	36,766	1,500	100	100	50

* = denotes species listed under the Endangered Species Act; SEL_{cum} = cumulative sound exposure level in units of decibels referenced to 1 micropascal squared second; SPL_{rms} = root-mean-square sound pressure level in units of decibels referenced to 1 micropascal.

6.2 Project Monitoring and Mitigation Protocols

Visual monitoring protocols will be in place for all vibratory piling activities. All observations will take place from one of the construction vessels stationed at or near the vibratory piling location. No PAM operations will be utilized due to the likelihood of masking effects of the vibratory pile driving activities which will result in ineffective acoustic monitoring opportunities. **Table 10** provides the list of the personnel on watch and monitoring equipment available onboard the construction vessel.

Table 10. Personnel and equipment compliment for monitoring vessels during impact pile driving.

Item	# on Construction Vessel
PSOs on watch	2
Reticle binoculars	2
Mounted thermal/IR camera system	1
Mounted "big-eye" binocular	1
Hand-held or wearable NVDs	2
IR spotlights	2
Mysticetus data collection software system	1
PSO-dedicated VHF radios	2
Digital single-lens reflex camera equipped with 300-mm lens	1

IR = infrared; NVD = night vision device; PSO = protected species observer; VHF = very high frequency.

6.2.1 Visual Observation Protocols and Methods

6.2.1.1 Daytime Visual

- Visual monitoring will occur from the construction vessel to provide complete visual coverage of the marine mammal EZs during impact pile driving.

- During the pre-start clearance period (**Section 6.2.2**), throughout vibratory pile driving, and 30-minutes after piling is completed, two PSOs will maintain watch at all times on the construction vessel.

- Two PSOs will conduct observations concurrently. The total number of observers will be dictated by the personnel necessary to adhere to standard schedule and rest requirements while meeting Project mitigation monitoring requirements. A sample crew shift rotation is shown in **Attachment 1**.

- PSOs will visually monitor the EZs.

- During daytime observations one observer will monitor the EZ with the naked eye and reticle binoculars. One PSO will monitor in the same way but will periodically scan outside the EZ using the mounted big eye binoculars.

6.2.1.2 Daytime Visual during Periods of Low Visibility

- During daytime low visibility conditions, one PSO will monitor the EZ with the mounted IR camera while the other maintains visual watch with the naked eye / binoculars.

6.2.1.3 Nighttime Visual

- During nighttime, two PSOs will monitor the EZ with the mounted IR camera and hand-held/wearable NVDs.

6.2.2 Pre-Start Clearance

- PSOs will monitoring the clearance zone for 30 minutes prior to start of vibratory pile driving.

- If a marine mammal is observed entering or within the respective EZs piling cannot commence until the animal has exited the EZ or time has elapsed since the last sighting (30 minutes for large whales, 15 minutes for dolphins, porpoises, and pinnipeds).

6.2.3 Ramp-up

- Ramp-up procedures provide additional mitigation to marine mammals in the Project Area by enabling them to leave the area prior to the start of vibratory pile driving activities.

- Ramp-up procedures will not be initiated if the clearance zone cannot be adequately monitored (i.e., obscured by fog, inclement weather, poor lighting conditions) for a 30-minute period.

6.2.4 Operations Monitoring

- PSOs will continue to survey the EZ using visual protocols throughout the cofferdam installation and for a minimum of 30 minutes after piling has been completed.

6.2.5 Shutdown Protocols

- If a marine mammal is observed entering or within the respective EZs after cofferdam installation has commenced, a shutdown must be implemented.

6.2.6 Pauses and Silent Periods

- The EZ must be continuously monitored by PSOs during any pauses in vibratory pile driving.
- If marine mammals are sighted within the respective EZ during a pause in vibratory pile driving, activities will be delayed until the animal(s) has moved outside the EZ and no marine mammals are sighted for a period of 30 minutes.

6.2.7 Vessel Strike Avoidance

The Project will follow vessel strike avoidance measures outlined previously in the *Vessel Strike Avoidance Policy* section (**Section 2.9**) and in project-specific Vessel Strike Avoidance Plan provided in **Attachment 5**.

6.2.7.1 Vessel Speed Restrictions

The Project will follow vessel strike avoidance measures outlined previously in the *Vessel Strike Avoidance Policy* section (**Section 2.9**) and in project-specific Vessel Strike Avoidance Plan provided in **Attachment 5**.

6.2.8 Data Recording

- All data recording will be conducted using Mysticetus software.
- Operations, monitoring conditions, observation effort, all marine mammal detections, and any mitigation actions.
- Members of the monitoring team must consult NMFS' NARW reporting systems for the presence of NARWs in the Project Area.

6.3 Reporting

The Project will follow reporting measures as stipulated in **Section 2.7**.

6.3.1 DMAs

DMAs will be reported across all vessels.

6.3.2 Injured and Dead Protected Species

The Project will follow reporting measures as stipulated in **Section 2.7**.

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Attachment 1: PSO/PAM operator example team shift schedules

Period a/	Hour	Lead PSO (1)	PSO (2)	PSO (3)	PSO (4)	PAM Lead (1)	PAM (2) /
Daylight	**07:00**	Sleep	Sleep	Visual	IR	PAM	Sleep
	08:00	Sleep	Sleep	IR	Visual	PAM	Sleep
	09:00	Sleep	Sleep	Visual	Off	Sleep	Sleep
	10:00	Visual	Sleep	Off	Sleep	Sleep	Sleep
	11:00	Visual	Sleep	Visual	Sleep	Sleep	Sleep
	12:00	Visual	Sleep	Off	Sleep	Sleep	Sleep
	13:00	Off	Sleep	Visual	Sleep	Sleep	Sleep
	14:00	Off	Sleep	Visual	Sleep	Sleep	Sleep
	15:00	Off	Visual	Off	Sleep	Sleep	Sleep
	16:00	Visual	IR	Sleep	Sleep	Sleep	PAM
Darkness	**17:00**	IR	NVD	Sleep	Sleep	Sleep	PAM
	18:00	NVD	Off	Sleep	IR	Off	PAM
	19:00	Off	IR	Sleep	NVD	PAM	Off
	20:00	IR	NVD	Sleep	Off	PAM	Off
	21:00	NVD	Off	Sleep	IR	PAM	Off
	22:00	Off	NVD	Sleep	Off	PAM	IR
	23:00	Off	IR	Sleep	NVD	Off	PAM
	00:00	Off	NVD	Off	IR	Reporting & PAM Lead Tasks	PAM
	01:00	Reporting & PSO Lead Tasks	Off	IR	NVD	PAM	Off
	02:00	Sleep	IR	NVD	Off	PAM	Off
	03:00	Sleep	Off	Off	NVD	PAM	IR
	04:00	Sleep	Off	NVD	IR	Off	PAM
	05:00	Sleep	NVD	IR	Off	Off	PAM
	06:00	Sleep	IR	Off	Off	NVD	PAM

a/ Periods of daylight and darkness are subject to change based on location and time of year.
b/ The red lines represent a pile-driving event, which is anticipated to include no more than 4 hours of active pile driving per foundation. PSOs/PAMs will be on duty before and after the installation event as appropriate.
c/ PAM rotations in this example are 4-hour periods but actual schedules will likely be reduced to 3-hour shifts.

IR = infrared; NVD = night vision device; PAM = passive acoustic monitoring; PSO = protected species observer.

Attachment 2: Review of PAM systems

PAM HARDWARE SPECIFICATIONS AND CAPABILITIES TABLE Last updated 9-Oct 2019[1]																		
Manufacturer/ Provider	System name/ Model(s)	System Type	Data Viewable in Real-Time?	Modular/ multiple hydrophone types?	Calibrated?	Type of Calibration	Multi-Channel (Y/N/UNK)	Max # of channels	Max Sample Rate (kHz)	Bit-rate (resolution)	Dynamic Range (dB)	Max Storage Capacity (TB)	Max Battery Duration	Max Depth (m)	Form Factor	Dimensions	Battery Type	Deployment Vessel
WHOI (Baumgartner)	DMON Buoy	AAR,RTB	Y(near-r-t)	Y(LF,MF,HF)	Can be	NR	Y	3	500 kHz	16 bits	NR	32 GB	up to 18 months	200	NR	NR	Alkaline	>70 ft.
WHOI (Baumgartner)	Robots4whales Waveglider	ASV,RTB	Y(near-r-t)	Y(LF,MF,HF)	Can be	NR	Y	3	500 kHz	16 bits	NR	32 GB	up to 4 months	1,000	NR	NR	Lithium	Any
Cornell-BRP (Klinck)	Rockhopper (formerly MARU)	AAR	N	custom	Y	UNK	N	NA	380	24-bit	UNK	10.5 TB	6 months (@ 200 Khz sample rate)	3,500	Spherical	UNKN	Lithium	Small Boat (RHIB)
Cornell-BRP (Klinck)	AutoBuoy	AAR, RTB	Y	UNK	UNK	UNK	UNK	NA	UNK	16-bit	UNK	NA	UNK	moored, so limited to shallow water	Large Buoy	UNK	UNK	Large ship
JASCO Applied Sciences	AMARG4	AAR	N	Y: 4	UNK	UNK	Y	4 acoustic, 7 oceanographic sensors	8-512 Khz	24-bit	UNK	10 TB	18 months	6,700	Spherical	43.2 cm3	D-cell	UNK
JASCO Applied Sciences	SPARBuoy	AAR,RTB	Y(near-r-t)	Y(LF,MF,HF)	Can be	NR	Y	16	512 HHz	24-bit	NR	10 TB	up to 6 months	200	Cylindrical	NR	Alkaline or Lithium?	>70 ft.
JASCO Applied Sciences	3M Observer Buoy	AAR,RTB	Y(near-r-t)	Y(LF,MF,HF)	Can be	NR	Y	16	512 HHz	24-bit	NR	10 TB	up to 18 months	200	NR	NR	Alkaline or Lithium?	>70 ft.
JASCO Applied Sciences	0.6M Observer Buoy	AAR,RTB	Y(near-r-t)	Y(LF,MF,HF)	Can be	NR	Y	16	512 HHz	24-bit	NR	10 TB	up to 18 months	200	NR	NR	Alkaline or Lithium?	>70 ft.
JASCO Applied Sciences	Datamaran Observer-Saildrone	USV,RTB	Y(near-r-t)	Y(LF,MF,HF)	Can be	NR	Y	16	512 HHz	24-bit	NR	6 TB	up to 4 months	1,000	Catamaran	NR	Alkaline or Lithium?	>70 ft.
JASCO Applied Sciences	Waveglider Observer	USV,RTB	Y(near-r-t)	Y(LF,MF,HF)	Can be	NR	Y	16	512 HHz	24-bit	NR	6 TB	up to 4 months	200	Waveglider	NR	Alkaline or Lithium?	>70 ft.
SMRU Consulting	CAB	AAR, RTB	Y	Y	Y	Individual	Y	Up to 3 per CAB Platform	500	UNK	UNK	1 TB	2-3 weeks	45	Cylindrical	110 cm × 56 cm	Lithium	Small Boat
RTSYs	Resea	AAR	N	Y	Y	Individual?	Y	4	3 hz-500 kHz	24-bit	>100 dB	2 TB	UNK	700	Cylindrical	12 cm × 32 cm	alkaline or Li-SOCl2	Small Boat
RTSYs	Multhy	AAR	N	Y	Y	Individual?	Y	16	3 hz-500 kHz	24-bit	>100 dB	2 TB	UNK	700	Cylindrical	55 cm × 12 cm	rechargable battery pack	UNK
RTSYs	Sylence	AAR	N	Y	UNK	UNK	N	1	39 to 1250 kHz	16 or 24-bit	UNK	128 GB	45 days, possibly more	200	Cylindrical	12 cm × 55 cm	18 alkaline or Li-SoCl2 D cell	small boat
Seiche Ltd.	Autonaut PAM	ASV	Y	Y	Y	electro-acoustic (full system)	Y	4 ch	500	16-bit	90	4 TB	months	20 (customizable tow cable length)	Vessel	5 m × 0.8 m	24 V lead-acid	ship / slipway / beach
Seiche Ltd.	Modular buoy system	RTB	Y	Y	Y	electro-acoustic (full system)	Y	4 ch	500	16-bit	90	essentially unlimited as data recorded are at the telemetry receiver station	20 h (lead-acid), 80 h (lithium)	customizable cable length	Buoy		12 V lead-acid or lithium	ship
Seiche Ltd. / ASV Global	ASV PAM	USV (motorized)	Y	Y	Y	electro-acoustic (full system)	Y	4 ch	500	16-bit	UNK	4 TB	several days; limited by fuel capacity of USV	220 (customizable tow cable length)	UNK	models available from 4-12 m LOA	110-240 V invertor	ship / slipway / beach
Greenridge Sciences	ASAR	AAR	N	UNK	UNK	1 omnidirectional, 2 directional	Y	3	1 kHz	16-bit	UNK	60 GB	116 days, continuous recording, no data compression	100	UNK	26" × 26" square base, ~26" high (includes frame)	custom alkaline D-cell battery pack	UNK

PAM HARDWARE SPECIFICATIONS AND CAPABILITIES TABLE Last updated 9-Oct 2019[1]																		
Manufacturer/ Provider	System name/ Model(s)	System Type	Data Viewable in Real-Time?	Modular/ multiple hydrophone types?	Calibrated?	Type of Calibration	Multi-Channel (Y/N/UNK)	Max # of channels	Max Sample Rate (kHz)	Bit-rate (resolution)	Dynamic Range (dB)	Max Storage Capacity (TB)	Max Battery Duration	Max Depth (m)	Form Factor	Dimensions	Battery Type	Deployment Vessel
Greeneridge Sciences	DASAR	AAR	N	UNK	UNK	1 omnidirectional, 2 directional	Y	2	up to 96 kHz	16-bit	UNK	2 TB	200 days for 1-channel continuous recording @ 96 kHz sample rate, assuming 60% data compression; 100 days for 2-channel continuous recording @ 96 kHz sample rate, assuming 60% data compression	750 (2,100 without transponders)	UNK	35" × 8" (60" long with frame)	custom alkaline C-cell battery pack	UNK
Greeneridge Sciences	DASAR-CI	AAR	N	UNK	UNK	3 omnidirectional	Y	3	5 kHz	16-bit	UNK	512 GB	145 days, continuous recording, no data compression	100	UNK	triangular base w/57" sides, 20" high (includes frame)	5 rechargeable batteries	UNK
Wildlife Acoustics	Song Meter 4 (SM4) Series	AAR	N	Y (hydrophones by HTI)	Y	UNK	Y	2	96 kHz	16-bit		1 TB (2x 512 SD cards)	400 days (duty cycled?)	UNK	Cylindrical	UNK	Alkaline or NiHM (4 D cell)	
DBV Technologies	Customized	AAR,RTB	P	UNK	Y	UNK	Y	UNK	User defined	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK
DesertStar Systems	SonarPoint / Multiple models& configurations	AAR, RTB**	Y*	Y	Y	Y	Y (units can be time-synchronized))	UNK	415 kHz	16-bit	95 dB	8 TB (up to 8 SD cards)	For -8 (eight slot/quad battery) version: 115 days @ 25kHz sample rate, 96 days @ 100kHz sample rate, 56 days @ 416 kHz sample rate	300 or 1,000	Cylindrical	6.5"L x 2.5"D (-2 version), 15.7"L x 2.5"D (-8 version)	Rechargeable lithium ion	small boat
Ocean Instruments	SoundTrap ST300	AAR, RTB	N	UNK	Yes	Factory OCR Calibration Certificate, self-calibration check, pistonphone coupler available	UNK	UNK	STD Model: 20 to 60 Hz; HF model: 20 to 150 Hz	16-bit	UNK	256 GB	70 days	500	Cylindrical	200 mm x 60 mm	D-cell batteries	UNK
Ocean Instruments	SoundTrap ST4300	AAR	N	Y	Yes	Self-calibration check	Y	4	288 kHz x 4; 20 Hz-90 kHz ± 3dB	4 x 16-bit SAR	UNK	128 GB	30 Days	500	Cylindrical	200 mm x 60 mm	D-cell batteries	UNK
Ocean Instruments	SoundTrap ST500	AAR	N	UNK	Yes	Factory calibration certificate	UNK	UNK	288 kS/sec; 20 Hz–90 kHz	16-bit	UNK	1 TB	180 Days	500	Cylindrical	350 mm x 100 mm	D-cell batteries	UNK
SIO/UCSD	HARP	AAR	N	Y, custom	Y	UNK	Can Be	UNK	>400 kHz	UNK	UNK	>1 TB	Several months	>1000	Cylindrical	Depends on platform used	Lithium Batteries	Large Vessel with A-frame

PAM HARDWARE SPECIFICATIONS AND CAPABILITIES TABLE Last updated 9-Oct 2019[1]																	
Manufacturer/ Provider	System name/ Model(s)	System Type	Data Viewable in Real-Time?	Modular/ multiple hydrophone types?	Calibrated?	Type of Calibration	Multi-Channel (Y/N/UNK)	Max # of channels	Max Sample Rate (kHz)	Bit-rate (resolution)	Dynamic Range (dB)	Max Storage Capacity (TB)	Max Battery Duration	Max Depth (m)	Form Factor	Dimensions	Battery Type	Deployment Vessel
MTE	AURAL-M2	AAR	N	UNK	UNK	UNK	UNK	UNK	10 to 16,384 kHz	16-bit	UNK	1 TB	365 days	300	Cylindrical	5.75" x 35.375" or 47.375" or 70"	12V Zinc	UNK
MTE	µAURAL	AAR	N	UNK	UNK	UNK	UNK	UNK	UNK	24-bit	UNK	32 GB	300 hours	100	Cylindrical	3" x 18"	Rechargeable NiMH	UNK
Thayer-Mahan	Outpost	ASV	Y		Y	J-9 Projector Calibration	Y	32 / 64 (1)	2.52 kHz	25.2	109	4 TB	>1 year (2)	183 (3)	Linear Array	38.4 / 76.8 m acoustic section	Li-ion	Various
Autonomous Marine Systems Inc. (AMS)	Datamaran	ASV	Yes	Y	Y	N/A	Y	No limit	Whatever the attached PAM equipment is capable of. The DM can transmit 4 channel, 24-bit, 100kHz sampled acoustic waveforms to shore when within 200 kms	24-bit	Depends on specific hydrophone + pre-amp system selected	Practically unlimited. Tens of Terabytes	Unlimited as 1980Watt PV panel name-plate rating and 3072WHr battery capacity available	Can tow array at 100 ft	Catamaran (See website for dimensions of equipment that can be located inside hulls of Datamaran)	1 m x 0.2 m x 0.2 m?	N/A	UNK
RS Aqua	Orca	AAR,RTB	Yes	1 to 5	Y	Multipoint frequency response	Y	5	384	16-bit	95.5	4 TB	155 days (continuous recording)	3,500	cylindrical with cabled hydrophone option	17.8 cm diameter, 28 – 77.5 cm length, 6.7-39 kg	Alkaline or Lithium	UNK
RS Aqua	Porpoise	AAR, RTB	Yes (both real time and autonomous options)	1	N	Single point frequency response	N	1		24 bit	110	4 TB	293 days continuous recording	2,000	cylindrical with cabled hydrophone option	7 cm diameter x 23.3 cm length, 4.5 lb	Alkaline or Lithium	UNK
Liquid Robotics/SMRU Instrumentation/Teledyne-Reson	Blackbeard (AWG)	ASV	Y(only spectral band metrics that are sent in small burst data report; wav audio files not available in real-time)	1	Y(possible to add more hydrophones)	calibration by Reson and SAIL	Yes	4	500 kHz	24-bit	UNK	512 GB	>1 month	10	liquid robotics waveglider towing decimus towbody		lithium-ion	small boat
Ocean Sonics	IcListen AF(L)	AAR	Y*	Y (ocean Sonics Hydrophones)	Y	UNK	N	1	512 kHz	16 or 24-bit	106	128 GB	10 hrs	200 or 3,500 (plastic or titanium housing)	Cylindrical	48 x 165 mm	UNK	small boat
Ocean Sonics	IcListen AF	AAR	Y*	Y (ocean Sonics Hydrphones)	Y	UNK	N	1	512 kHz	16 or 24-bit	106	129 GB	10 hrs	201 or 3,500 (plastic or titanium housing)	Cylindrical	49 x 165 mm	UNK	small boat
Ocean Sonics	IcListen HF(L)	AAR	Y*	Y (ocean Sonics Hydrphones)	Y	UNK	N	1	512 kHz	16 or 24-bit	95	130 GB	10 hrs	202 or 3,500 (plastic or titanium housing)	Cylindrical	50 x 165 mm	UNK	small boat
Ocean Sonics	IcListen HF	AAR	Y*	Y (ocean Sonics Hydrphones)	Y	UNK	N	1	512 kHz	16 or 24-bit	95	131 GB	10 hrs	203 or 3,500 (plastic or titanium housing)	Cylindrical	51 x 165 mm	UNK	small boat

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Manufacturer/ Provider	System name/ Model(s)	System Type	Data Viewable in Real-Time?	Modular/ multiple hydrophone types?	Calibrated?	Type of Calibration	Multi-Channel (Y/N/UNK)	Max # of channels	Max Sample Rate (kHz)	Bit-rate (resolution)	Dynamic Range (dB)	Max Storage Capacity (TB)	Max Battery Duration	Max Depth (m)	Form Factor	Dimensions	Battery Type	Deployment Vessel
Ocean Sonics	IcListen X2	AAR	Y*	Y (ocean Sonics Hydrphones)	Y	UNK	N	1	512 kHz	16 or 24-bit	95	132 GB	10 hrs	204 or 3,500 (plastic or titanium housing)	Cylindrical	52 x 165 mm	UNK	small boat
Ocean Sonics	IcListen R-Type	AAR	Y*	Y (Reson hydrophone)	UNK	UNK	N	1	512 kHz	16 or 24-bit	90	133 GB	10 hrs	900	Cylindrical	53 x 165 mm	UNK	small boat
Loggerhead Instruments	Snap	AAR	N	Y(3 hydrophone models from HTI)	Y	UNK	N	1	96 kHz	UNK	Depends on gain settings and hydrophones	128 GB	8 days (continuous); 190 days (10min on/off duty cycled)		cylindrical	16 x 2.875"	3 alkaline D-cell batteries	small boat
Loggerhead Instruments	LS1 Multi-Card Recorder	AAR	N	Y (HTI hydrophones)	Y	UNK	Y (Stero possible)	2	97 kHz	UNK	Depends on gain settings and hydrophones	256 GB(expandable)	50 days (continuous)	300	cylindrical	17"x4.5"	12 alkaline D-cell batteries	small boat
Loggerhead Instruments	LS1x Multi-Card Recorder	AAR	N	Y (HTI hydrophones)	Y	UNK	Y (Stero possible)	2	98 kHz	UNK	Depends on gain settings and hydrophones	256 GB (expandable)	100 days? (LS1X has 2x battery capacity of LS1)	3,000 (aluminum housing)	cylindrical	25"x4.5"	24 alkaline D-cell batteries	small boat
Loggerhead Instruments	Medusa	RTB (noise calculations)	Y	UNK	UNK	UNK	N	1	44.1 kHz	UNK	UNK	64 GB	UNK	1 m?	Cylindrical	24" x 3"	lithium ion (8x 5Ah; Rechargeable)	small boat
MSEIS	WISDOM Data	RTB	Y	Y, hi and low sensitivity options	Upon request	Dependant on customer requirement	Y	4	1,000 kHz	16-bit	Dependant on hydrophones used	120 GB (expandable)	40+ hours in darkness, indefinite when solar powered	TBC	Cylindrical buoy	1250mm diameter x 2.5m height above water	2x 12V SLA 22Ah	Deployment by crane

Legend/ Abbreviations:	N	No	UNK	unknown or unavailable
	Y	Yes	AAR	Autonomous Acoustic Recorder
	P	Possible	RTB	Radio Telemetered (Moored, Acoustic) Buoy
	NR	N response to request	AUV	Autonomous Underwater Vehicle
	NA	Not applicable or relevant	ASV/USV	Autonomous Surface Vehicle/Unmanned Surface Vehicle (e.g., waveglider)

[1]Information compiled by Tom Norris, Biowaves, Inc.

			Monitoring Type				
			Mitigation		Regional Long-Term	Tracking	
PAM Technology	Vehicle		Pile Driving	Other?		Local	Regional
PAM	Autonomous Recorders and Real-time Systems	Seafloor			X	X	P
		Moored	X	X	X	X	P
	Passively (buoyancy/ wind) powered AV	AUV		X	P		
		ASV	P	X	P	P	P
	Drifter		P	X	P	P	P

X = capable of monitoring.
P = possible under certain conditions or circumstances (e.g. low currents or sea states, or if numerous devices are deployed and data can be integrated).

Attachment 3: Protected Species Reporting Contact Information for the Project

The following contact information may change in the course of the regulatory approval process. Final contact information will be stipulated by the regulatory agencies at the time of issuance of authorizations.

U.S. Coast Guard

USCG District	Phone Numbers for Right Whale Sightings, or for Entangled, Stranded, Injured or Dead Marine Mammals and Sea Turtles	
TBD		

National Marine Fisheries Service

NMFS Contact	Phone Number and email for Right Whale Sightings, or for Entangled, Stranded, Injured or Dead Marine Mammals and Sea Turtles	
Office of Protected Resources (OPR)	TBD by agency	TBD by agency
Greater Atlantic Regional Fisheries Office (GARFO)	TBD by agency	TBD by agency
Marine Mammal Stranding Program/Regional Stranding Coordinator (New England)	TBD by agency	TBD by agency

BOEM

NMFS Contact	Phone Number and email for Right Whale Sightings, or for Entangled, Stranded, Injured or Dead Marine Mammals and Sea Turtles	
BOEM Offshore Wind Division	TBD by agency	TBD by agency

Attachment 4: Acoustic Measurement Plan

Introduction

In connection to the planned foundation installation activities for US offshore wind projects, underwater noise plan for sound field verification is proposed.

Purpose

The aim of the proposed measurement exercise is to obtain dataset that can be used to verify prognosed sound levels submitted in underwater noise assessment and used as input to predict ranges to acoustic thresholds that may result in injury or behavioral disruption of cetaceans, sea turtles and fish near the construction area. It is, therefore, necessary to conduct underwater noise measurements to verify the prognosed sound levels were comparable/lower than those measured in field and any estimated animal exposures were accurate/conservative enough. Impact pile driving is considered as the installation method for the proposed measurement plan. Amendments to the plan for other installation methods are discussed in the end of this document.

Specifics of the measurement plan

All measurements will be performed according to the ISO 18406:2017 standard. The foundation installation noise will be measured using omnidirectional hydrophones capable of measuring frequencies between 20 Hz and 20 kHz. The hydrophone signals will be verified before deployment and after recovery by means of a pistonphone calibrator on deck or similar method. Each measurement position will consist of two hydrophones at approximately mid depth and 2 m above the seafloor. Deployment will be made using a heavy weight as anchor - to prevent equipment drifting (typically total ballast weight exceeding 100 kg) – as depicted in **Figure4-1**. Deployment and retrieving position of each hydrophone will be recorded using hand-held GPS equipment, or alternative precise method. The hydrophones will be placed at various distances from the installation location as depicted in **Figure 4-2**.

The equipment, methodology, placement and analysis will be the same for all pile measurements. Output results will include sound pressure level and frequency context. Measurements will be conducted in a detailed configuration at the beginning of installation. An example of the measurement configuration is provided in **Figure 4-2.**

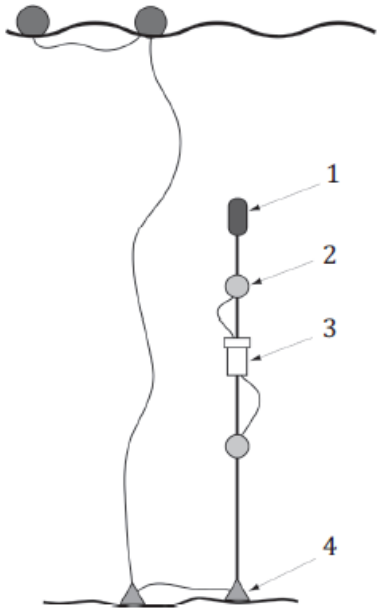

Figure 4-1. Principle sketch of hydrophone deployment. 1 is the float, 2 is the hydrophone, 3 is the recorder and 4 is the bottom weight(s). From ISO 18406:2017.

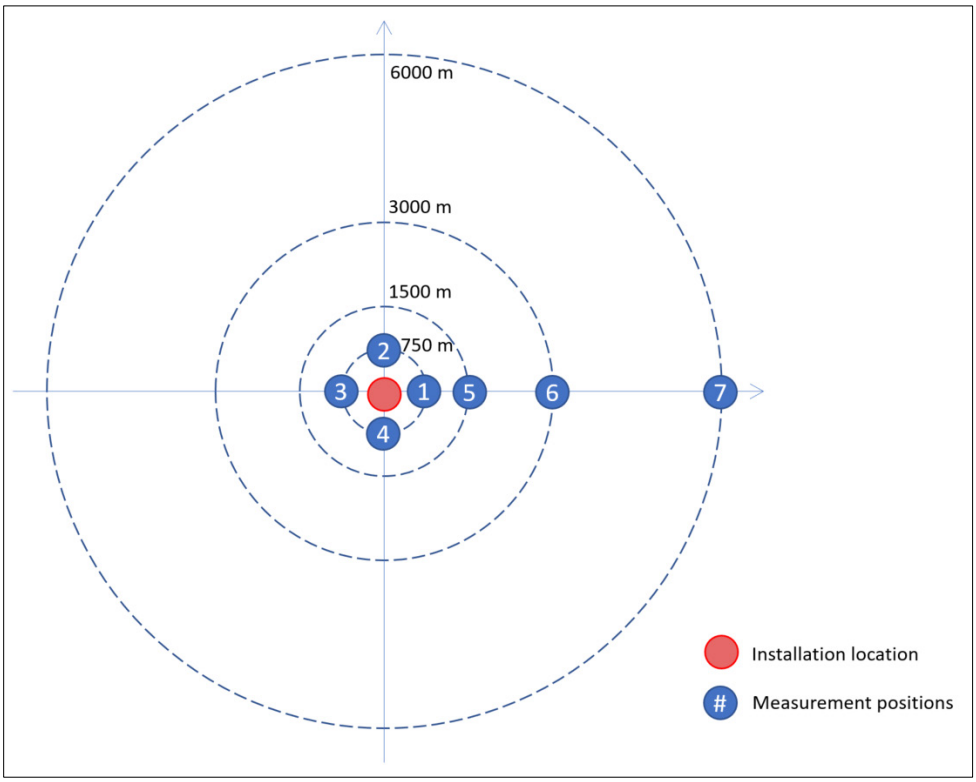

Figure 4-2 Sample sound field verification showing layout of proposed measurement locations. Specific locations are only examples and may change.

Modification of exclusion and monitoring zones

SFW may request a modification to the size of exclusion and monitoring zones based on the results of pile measurements. The zones will be determined as follows:

- The large whale pre-start clearance zone will be calculated as a 20% increase in the radius of the maximum Level A exposure range of any mysticete excluding humpback whales.
- The right whale pre-start clearance zone will be equal to the marine mammal Level B zone.
- The large whale, including right whale, exclusion zone will be calculated as a 10% increase in the radius of the maximum Level A exposure range of any mysticete excluding humpback whales.
- The harbor porpoise and seal pre-start clearance zone and EZ will be determined as the extent of the level A exposure range plus a 20% buffer for the clearance zone and 10% buffer for the EZ.
- For dolphins, no Level A zone is expected as the maximum dolphin exposure range for piling without an NMS is 24 m; and all piles will use an NMS. Therefore, the pre-start clearance zone will be determined as 100 m plus 20% or the exterior edge of the bubble curtain, whichever is greater. The dolphin EZ will be determined as 50 m plus 10% or the exterior edge of the bubble curtain, whichever is greater.

In the case of expanded clearance and EZs, zone monitoring will be achieved through a combined effort of passive acoustic monitoring and visual observation. Based on the results of the sound field verification (SFV) measurements, the secondary vessel will be placed at the outer limit of the subsequent Large Whale Exclusion Zone as described in **Figure 3** of the PSMMP. No additional PSOs or PSO vessels are proposed to visually monitor the expanded zones.

The placement of PAM will sufficiently cover any expanded clearance or exclusion zones. As described in the PSMMP, the total number of PAM stations and array configuration will depend on the size of the zone to be monitored, the amount of noise expected in the area, and the characteristics of the signals being monitored. Acoustic monitoring will include and extend beyond the Large Whale Pre-Start Clearance Zone. Orsted will be prepared to flex the PAM configuration to be capable of monitoring the resulting measured (SFV) zone up to the maximum potential Level B zone.

Attachment 5: Vessel Strike Avoidance Plan

To mitigate potential impacts of vessel strikes, SFW will adhere to the following *Base Conditions*.

Base Conditions:

- **Training**: All personnel working offshore will receive training on marine mammal, sea turtle, and Atlantic sturgeon awareness.

- **Speed/Approach Constraints**: All vessels will adhere to current NOAA vessel guidelines and regulations in place.

- **Approach Constraints**: Vessels will maintain, to the extent practicable, separation distances of 500 m for North Atlantic right whales, 100 m for other whales, and 50 m for dolphins, porpoises, seals, and sea turtles.

- **Monitoring/Mitigation**: Vessel operators and crew will maintain a vigilant watch for marine mammals and sea turtles, and slow down or maneuver their vessels as appropriate to avoid a potential intersection with a marine mammal or sea turtle.

- **Situational Awareness/Common Operating Picture**: SFW will establish a situational awareness network for marine mammal and sea turtle detections through the integration of sighting communication tools such as Mysticetus, Whale Alert, WhaleMap, etc. Sighting information will be made available to all project vessels through the established network. SFW's Marine Coordination Center will serve to coordinate and maintain a Common Operating Picture. In addition, systems within the Marine Coordination Center, along with field personnel, will:
  - Monitor the NMFS North Atlantic right whale reporting systems daily;
  - Monitor Coast Guard VHF Channel 16 throughout the day to receive notifications of any sighting; and
  - Monitor any existing real-time acoustic networks.

In addition to the above *Base Conditions*, SFW will implement a *Standard Plan* or an *Adaptive Plan* as presented below. SFW intends for these plans to be interchangeable and implemented throughout both the construction and operations phases of the project.

Standard Plan:

- Implement *Base Conditions* described above.

- Vessels of all sizes will operate port to port at 10 knots or less between November 1 and April 30, except for vessels while transiting in Narragansett Bay or Long Island Sound which have not been demonstrated by best available science to provide consistent habitat for North Atlantic right whales.

- Vessels of all sizes will operate at 10 knots or less in any Dynamic Management Areas (DMAs).

Adaptive Plan:

An *Adaptive Plan* will be developed in consultation with NMFS to allow modification of speed restrictions for vessels. Should SFW chose not to implement this *Adaptive Plan* or a component of the *Adaptive Plan* is offline (e.g., equipment technical issues), SFW will default to the *Standard Plan* (described above).

Proposed measures may include:

- Implement *Base Conditions* described above.
- A semi-permanent acoustic network comprising near real-time bottom mounted and/or mobile acoustic monitoring platforms will be installed year-round such that confirmed North Atlantic right whale detections are regularly transmitted to a central information portal and disseminated through the situational awareness network.
- Year-round, if any DMA is established that overlaps with an area where a project vessel would operate, that vessel, regardless of size when entering the DMA, will transit that area at a speed of 10 knots or less unless a trained, dedicated person-on-watch and alternative visual detection system (e.g., thermal cameras) are present.
- If PAM and/or thermal systems are offline, the *Standard Plan* measures will apply for the respective zone (where PAM is offline) or vessel (if thermal systems offline).
- The transit corridor and wind development area (WDA) will be divided into detection action zones.
- Localized detections of North Atlantic right whales in an action zone would trigger a slow-down to 10 knots or less in the respective zone for the following 12 h. Each subsequent detection would trigger a 12-h reset. A zone slow-down expires when there has been no further visual or acoustic detection in the past 12 h within the triggered zone.
- A trained, dedicated person-on-watch and alternative visual detection system (e.g., thermal cameras) will be stationed on all vessels during transits that intend to operate at greater than 10 knots from November 1 through April 30. The primary role of the person-on-watch is to alert the vessel navigation crew to the presence of marine mammals and sea turtles and to report transit activities and protected species sightings to the designated SFW information system.