Ocean Wind 1 Offshore Wind Farm Biological Assessment

For National Marine Fisheries Service

July 2022, Revised September 2022

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

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ABBREVIATIONS AND ACRONYMS

Abbreviation	**Definition**
°C	degrees Celsius
°F	degrees Fahrenheit
AC	alternating current
ALARP	As Low As Reasonably Practical
ALWTRP	Atlantic Large Whale Take Reduction Plan
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMP	Alternative Monitoring Plan
APM	Applicant Proposed Measure
Applicant	Ocean Wind, LLC; *also* Ocean Wind
ASV	autonomous surface vehicle
AUV	autonomous underwater vehicle
BA	biological assessment
BBC	big bubble curtain
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BRUV	baited remote underwater video
BSEE	Bureau of Safety and Environmental Enforcement
C	construction (phase)
CFR	Code of Federal Regulations
CHIRP	compressed high-intensity radiated pulses
cm	centimeters
CO_2	carbon dioxide
COP	Construction and Operations Plan
CPA	closest point of approach
CTV	crew transfer vessel
D	decommissioning (phase)
dB	decibels
dB re 1 µPa-m	decibels relative to 1 micropascal measured at 1 meter
dB re 1 µPa	decibels relative to 1 micropascal
dB re 1 µPa^{2}s	decibels relative to 1 micropascal squared second
dB re 1 µPa^2	decibels relative to 1 micropascal squared
DBBC	double big bubble curtain
DC	direct current
DMA	Dynamic Management Area
DO	dissolved oxygen
DPS	distinct population segment
EBS	Environmental Baseline Study
eDNA	environmental deoxyribonucleic acid
EEZ	exclusive economic zone
EIS	Environmental Impact Statement
EMF	electromagnetic field

Abbreviation	Definition
EPA	U.S. Environmental Protection Agency
ER95%	95th percentile exposure range
ESA	Endangered Species Act
F/V	Fishing Vessel
FHWG	Fisheries Hydroacoustic Working Group
FR	Federal Register
ft/s	feet per second
GARFO	Greater Atlantic Regional Fisheries Office
HDD	horizontal directional drilling
HRG	high-resolution geophysical
HSD	Hydro Sound Damper
Hz	hertz
IR	infrared
J	joules
kg	kilograms
kHz	kilohertz
km	kilometers
km^2	square kilometers
kV	kilovolts
L_E	sound exposure level
$L_{E,24h}$	cumulative sound exposure level
Lease Area	BOEM Renewable Energy Lease Area OCS-A 0498
L_{eq}	equivalent sound levels
LFC	low-frequency cetacean
LiDAR	Light Detection and Ranging
LOA	Letter of Authorization
L_{pk}	peak sound pressure level
L_{rms}	root mean squared sound pressure level
m/s	meters per second
m^3	cubic meters
MEC	munitions and explosives of concern
MFC	mid-frequency cetacean
mG	milligauss
mg/L	milligrams per liter
mi^2	square miles
MLLW	mean lower low water
MMPA	Marine Mammal Protection Act of 1972
mV/m	millivolts per meter
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NARW	North Atlantic right whale
NEAMAP	Northeast Area Assessment and Monitoring Program
NEFOP	Northeast Fisheries Observer Program

Abbreviation	Definition
NEFSC	Northeast Fisheries Science Center
NJ WEA	New Jersey Wind Energy Area
NJDEP	New Jersey Department of Environmental Protection
nm	nautical mile
nm^2	square nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSRA	Navigation Safety Risk Assessment
NVD	night vision device
O&M	operations and maintenance
Ocean Wind	Ocean Wind LLC; *also* the Applicant
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
Ørsted	Ørsted Wind Power North America, LLC
OSS	offshore substation
Pa	pascals
PAH	polycyclic aromatic compounds
PAM	passive acoustic monitoring
PATON	private aid to navigation
PBF	physical and biological feature
pCO_2	partial pressure of carbon dioxide
ppt	parts per trillion
pre-C	pre-construction (phase)
Project	Ocean Wind 1 Offshore Wind Farm Project
Proposed Action	Ocean Wind 1 Offshore Wind Farm Project
PSO	protected species observer
PSU	practical salinity unit
PTS	permanent threshold shift
Q	Quarter
R/V	Research Vessel
RAL	radar-activated light
rms	root mean squared
ROV	remotely operated vehicle
SAP	site assessment plan
SAV	submerged aquatic vegetation
SBP	sub-bottom profiler
SEL	sound exposure level
SES	surface effect ship
SMA	Seasonal Management Area
SPI/PV	sediment profile and plan view imaging
SPL	sound pressure level
SST	sea surface temperature
STSSN	Sea Turtle Stranding and Salvage Network

Abbreviation	Definition
TSS	total suspended sediment
TTS	temporary threshold shift
turbine	wind turbine generator; *also* WTG
U.S. Navy	U.S. Department of the Navy
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U. S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
WDA	Wind Development Area
WEA	Wind Energy Area
WTG	wind turbine generator; *also* turbine
yd^3	cubic yards
μPa	micropascal
μT	microteslas
μV/m	microvolts per meter

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1. INTRODUCTION

The Energy Policy Act of 2005, Public Law No. 109-58, added Section 8(p)(1)(C) to the Outer Continental Shelf Lands Act (OCSLA), which grants the Secretary of the Interior the authority to issue leases, easements, or rights-of-way on the Outer Continental Shelf (OCS) for the purpose of renewable energy development (43 United States Code [USC] § 1337(p)(1)(C)). The Secretary delegated this authority to the former Minerals Management Service, now the Bureau of Ocean Energy Management (BOEM). On April 22, 2009, BOEM (formerly the Bureau of Ocean Energy Management, Regulation, and Enforcement) promulgated final regulations implementing this authority at 30 Code of Federal Regulations (CFR) § 585.

This Biological Assessment (BA) has been prepared pursuant to Section 7 of the Endangered Species Act (ESA) to evaluate potential effects of the Ocean Wind 1 Offshore Wind Farm Project (Project, or Proposed Action) described herein on ESA-listed species under the jurisdiction of the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) (50 CFR 402.14). This BA provides a comprehensive description of the Proposed Action, defines the Action Area, describes species potentially affected by the Proposed Action, and provides an analysis and determination of how the Proposed Action may affect listed species and/or their habitats. The activities being considered include all proposed federal actions associated with the construction, operations, and decommissioning of the proposed Project including approving the Construction and Operations Plan (COP) for the Ocean Wind 1 offshore wind energy facility on the OCS offshore of New Jersey. Effects on ESA-listed species under the oversight of the U.S. Fish and Wildlife Service (USFWS) are analyzed under a separate BA document for consultation.

Ocean Wind LLC, an affiliate of Ørsted Wind Power North America LLC, (Ocean Wind, or the Applicant), has submitted the COP for the Ocean Wind 1 Offshore Wind Farm Area and offshore export cable corridors to BOEM for review and approval. Consistent with the requirements of 30 CFR 585.620 to 585.638, COP submittal occurs after BOEM grants a lease for the Proposed Action and the Applicant completes all studies and surveys defined in their site assessment plan (SAP). BOEM's renewable energy development process is described in the following section.

The Project would include up to 98 wind turbine generators (WTGs, or turbines) with a total capacity of approximately 1,100 megawatts (MW), up to three offshore substations (OSSs), and a submarine transmission cable network connecting the WTGs (inter-array cables) to the OSS(s), all of which would be located in BOEM Renewable Energy Lease Area OCS-A 0498 (Lease Area), located within the New Jersey Wind Energy Area (NJ WEA). The Lease Area is located on the OCS approximately 15 miles (13 nautical miles [nm], 24.1 kilometers [km]) southeast of Atlantic City, New Jersey.

1.1. RENEWABLE ENERGY PROCESS

Under BOEM's renewable energy regulations, the issuance of leases and subsequent approval of wind energy development on the OCS is a phased decision-making process. BOEM's wind energy program occurs in four distinct phases, defined below. Phases 1 through 3 have already been completed for the Ocean Wind 1 Offshore Wind Farm Area and offshore export cables; the Proposed Action addressed in this consultation represents Phase 4 for the development:

1. Planning and Analysis (complete). The first phase of the renewable energy process is to identify suitable areas to be considered for wind energy leases through collaborative, consultative, and analytical processes using the state's task forces; public information meetings; and input from the states, Native American tribes, and other stakeholders.
2. Lease Issuance (complete). The second phase is the issuance of a commercial wind energy lease. The competitive lease process is set forth at 30 CFR 585.210 to 585.225, and the noncompetitive process is set forth at 30 CFR 585.230 to 585.232. A commercial lease gives the lessee the exclusive right to

subsequently seek BOEM's approval for the development of the leasehold. The lease does not grant the lessee the right to construct any facilities; rather, the lease grants the right to use the leased area to develop its plans, which must be approved by BOEM before the lessee can move on to the next phase of the process (30 CFR 585.600 and 585.601).

3. Approval of SAP (complete). The third phase of the renewable energy development process is the submission of an SAP, which contains the lessee's detailed proposal for the construction of a meteorological tower and/or the installation of meteorological buoys on the leasehold (30 CFR 585.605 to 585.618). The lessee's SAP must be approved by BOEM before the these "site assessment" activities can be conducted on the leasehold. BOEM may approve, approve with modification, or disapprove a lessee's SAP (30 CFR 585.613). As a condition of SAP approval, meteorological towers will be required to have visibility sensors to collect data on climatic conditions above and beyond wind speed, direction, and other associated metrics generally collected at meteorological towers. These data will assist BOEM and the USFWS with evaluating the impacts of future offshore wind facilities on threatened and endangered birds, migratory birds, and bats.
4. Approval of COP (Proposed Action). The fourth and final phase of the process is the submission of a COP, a detailed plan for the construction and operation of a wind energy farm on the Lease Area (30 CFR 585.620 to 585.638). BOEM's approval of a COP is a precondition of the construction of any wind energy facility on the OCS (30 CFR 585.628). As with an SAP, BOEM may approve, approve with modification, or disapprove a lessee's COP (30 CFR 585.628). This phase is the focus of the Proposed Action, including the Ocean Wind 1 Offshore Wind Farm Area and offshore export cables.

The regulations also require that a lessee provide the results of surveys with its SAP or COP, including a shallow hazards survey (30 CFR 585.626 (a)(1)), geological survey (30 CFR 585.616(a)(2)), geotechnical survey (30 CFR 585.626(a)(4)), and archaeological resource survey (30 CFR 585.626(a)(5)). BOEM refers to these surveys as "site characterization" activities. Although BOEM does not issue permits or approvals for these site characterization activities, it will not consider approving a lessee's SAP or COP if the required survey information is not included (BOEM 2015). The history of BOEM's planning and leasing activities offshore of New Jersey is summarized in Table 1-1.

The Proposed Action addresses Phase 4 of the renewable energy process. The Applicant has completed site characterization activities and has developed a COP in accordance with BOEM regulations. BOEM is consulting on the proposed approval of the COP for the Ocean Wind 1 Offshore Wind Farm Area and offshore export cables, as well as other permits and approvals from other agencies that are associated with the approval of the COP. BOEM is the lead federal agency for purposes of Section 7 consultation; the other action agencies are the Bureau of Safety and Environmental Enforcement (BSEE), the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (EPA), the U.S. Coast Guard (USCG), and the NMFS Office of Protected Resources. This BA considers the potential effects of the Proposed Action on ESA-listed whales, sea turtles, fish, and designated critical habitat in the Action Area.

The mission of the BSEE is to enforce safety, environmental, and conservation compliance with any associated legal and regulatory requirements during Project construction and future operations. The BSEE will be in charge of the review of facility design and fabrication and installation reports and will oversee inspections/enforcement actions as appropriate, closeout verification efforts, facility removal inspections/monitoring, and bottom clearance confirmation.

Table 1-1 History of Bureau of Ocean Energy Management Planning and Leasing Offshore of New Jersey

Year	Milestone
2011	On April 20, 2011, BOEM published a Call for Information and Nominations for Commercial Leasing for Wind Power on the OCS Offshore New Jersey in the Federal Register. The public comment period for the call closed on June 6, 2011. In response, BOEM received 11 commercial indications of interest. After analyzing AIS data and holding discussions with stakeholders, BOEM removed OCS Blocks Wilmington NJ18–02 Block 6740 and Block 6790 (A, B, C, D, E, F, G, H, I, J, K, M, N) and Block 6840 (A) to alleviate navigational safety concerns resulting from vessel transits out of the New York Harbor.
2012	On February 3, 2012, BOEM published in the Federal Register a Notice of Availability of a final EA and FONSI for commercial wind lease issuance and site assessment activities on the Atlantic OCS offshore of New Jersey, Delaware, Maryland, and Virginia.
2014	On July 21, 2014, BOEM published a Proposed Sale Notice requesting public comments on the proposal to auction two leases offshore of New Jersey for commercial wind energy development.
2015	On September 23, 2015, BOEM announced that it published a Final Sale Notice, which stated that a commercial lease sale would be held on November 9, 2015, for the WEA offshore of New Jersey. The New Jersey WEA was auctioned as two leases. RES America Developments, Inc. was the winner of Lease Area OCS-A 0498, and US Wind, Inc. was the winner of lease OCS-A 0499.
2016	On April 14, 2016, BOEM received an application to assign 100% of the commercial lease OCS-A 0498 to Ocean Wind. BOEM approved the assignment on May 10, 2016.
2017	On February 14, 2017, BOEM received a request to extend the preliminary term for commercial lease OCS-A 0498 from March 1, 2017, to March 1, 2018. BOEM approved the request on March 1, 2017.
2018	On September 15, 2017, Ocean Wind submitted a Site Assessment Plan for commercial wind lease OCS-A 0498, which was subsequently revised on November 10, 2017; January 25, 2018; and February 23, 2018. BOEM approved the Site Assessment Plan on May 17, 2018.
2019	On August 15, 2019, Ocean Wind submitted its COP for the construction, operation, and conceptual decommissioning of the Project within a portion of the Lease Area. Updated versions of the COP were submitted on March 13, 2020; September 24, 2020; March 24, 2021, and November 16, 2021/December 10, 2021, and May 27, 2022.
2020	On December 8, 2020, Ocean Wind submitted an application to BOEM to assign the portion of lease OCS-A 0498 that is not covered by the COP to Ørsted Wind Power North America, LLC. BOEM approved the assignment on March 26, 2021. The lease area assigned to Ørsted Wind Power North America, LLC now carries the new lease number OCS-A 0532.
2021	On March 30, 2021, BOEM published a Notice of Intent to Prepare an EIS for Ocean Wind's Proposed Wind Energy Facility Offshore New Jersey (86 FR 16630).

Source: BOEM 2021a
AIS = Automatic Identification System; BOEM = Bureau of Ocean Energy Management; COP = Construction and Operations Plan; EA = Environmental Assessment; EIS = environmental impact statement; FONSI = Finding of No Significant Impact; Ocean Wind = Ocean Wind, LLC; OCS = Outer Continental Shelf; Project = Ocean Wind 1 Offshore Wind Farm Project; WEA = Wind Energy Area

The USACE regulates work that is authorized or permitted through Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. Ocean Wind has applied for authorization from the USACE to construct up to 98 offshore WTGs, scour protection around the base of the WTGs, up to three OSSs, inter-array cables connecting the WTGs to the OSS(s), and offshore export cables. The cable route(s) would originate from the OSS(s) and would connect to the electric grid in Ocean and Cape May Counties, New Jersey. Ocean Wind submitted the pre-construction notification/application to USACE on

April 27, 2022, and it was deemed complete on May 11, 2022 (USACE file number NAP-2017-00135-84). BOEM and BSEE will enforce COP conditions and ESA terms and conditions on the OCS. USACE will enforce ESA terms and conditions landward of the Submerged Lands Act (SLA) boundary.

The "OCS Air Regulations," presented in 40 CFR 55, establish the applicable air pollution control requirements, including provisions related to permitting, monitoring, reporting, fees, compliance, and enforcement, for facilities subject to Section 328 of the Clean Air Act; the EPA issues OCS air permits. Emissions from Project activities on the OCS would be permitted as part of an OCS air permit and must demonstrate compliance with National Ambient Air Quality Standards (NAAQS). Ocean Wind submitted an application to EPA for the OCS Air Permit on March 29, 2022.

The USCG administers the permits for private aids to navigation (PATONs) located on structures positioned in or near navigable waters of the United States. PATONs and federal aids to navigation, including radar transponders, lights, sound signals, buoys, and lighthouses, are located throughout the Project area. USCG approval of additional PATONs during construction of the WTGs and OSSs, and along the offshore export cable corridor, would be required. These aids serve as a visual reference to support safe maritime navigation. Federal regulations governing PATONs are presented in 33 CFR 66 and address the basic requirements and responsibilities. Ocean Wind anticipates requesting PATON authorization in 2022.

The Marine Mammal Protection Act of 1972 (MMPA) as amended and its implementing regulations (50 CFR 216) allow, upon request, the incidental take of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region. Incidental take is defined under the MMPA (50 CFR 216.3) as, "harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following: The collection of dead animals, or parts thereof; the restraint or detention of a marine mammal, no matter how temporary; tagging a marine mammal; the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; and feeding or attempting to feed a marine mammal in the wild."

NMFS received a request for authorization to take marine mammals incidental to construction activities related to the Project, which NMFS may authorize under the MMPA. NMFS's issuance of an MMPA incidental take authorization is a major federal action and, in relation to BOEM's action, is considered a connected action (40 CFR 1501.9(e)(1)). The purpose of the NMFS action—which is a direct outcome of Ocean Wind's request for authorization to take marine mammals incidental to specified activities associated with the Project (e.g., pile driving)—is to evaluate Ocean Wind's request under requirements of the MMPA (16 USC 1371(a)(5)(D)) and its implementing regulations administered by NMFS and to decide whether to issue the authorization.

On October 1, 2021, Ocean Wind submitted a request for a rulemaking and Letter of Authorization (LOA) pursuant to Section 101(a)(5) of the MMPA and 50 CFR § 216 Subpart I to allow for the incidental harassment of marine mammals resulting from the installation of WTGs and OSSs; installation and removal of cofferdams at locations of export cable route to landfall transitions; potential detonations of unexploded ordnance (UXO); and performance of high-resolution geophysical (HRG) site characterization surveys operating at less than 180 kilohertz (kHz) (HDR, Inc. 2022a). Ocean Wind is including activities in the LOA request that could cause acoustic disturbance to marine mammals during construction of the Project area pursuant to 50 CFR § 216.104. The application was reviewed and considered complete on February 11, 2022. NMFS published a Notice of Receipt in the Federal Register on March 7, 2022.

1.1.1 Endangered Species Act Section 7 Consultation History

BOEM prepared a draft BA pursuant to Section 7 of the ESA to evaluate potential effects of the Project on ESA-listed species under the jurisdiction of NMFS. The proposed Project includes up to 98 wind turbine generators with a total capacity of approximately 1,100 megawatts, up to three offshore substations, and a submarine transmission cable network connecting the WTGs to the OSS(s), all of which would be located in BOEM Renewable Energy Lease Area OCS-A 0498, located within the NJ WEA. The Lease Area is located on the OCS approximately 15 miles (13 nm, 24.1 km) southeast of Atlantic City, New Jersey. Export cables would extend from the Lease Area to interconnection points at the Oyster Creek substation in Ocean County, New Jersey, and the BL England substation in Cape May County, New Jersey.

Pre-consultation coordination with NMFS resulted in the establishment of a mutually agreed upon permitting timeline and associated milestones, which are publicly available on the FAST-41 Permitting Dashboard. In accordance with this permitting timeline and the FAST-41 Permitting Dashboard milestones, BOEM transmitted the draft BA for NMFS review on February 11, 2021. NMFS provided its review comments on the draft BA and request for additional information to BOEM on April 11, 2022. BOEM submitted a revised BA and request to initiate Section 7 consultation on July 14, 2022, in accordance with NMFS' nominal timeline requesting that the revised BA be provided to NMFS 60 days prior to NMFS' FAST-41 Permitting Dashboard milestone to determine the consultation package complete and initiate formal consultation.

1.2. PROJECT AREA

The proposed Project area is located in and off of the southern tip of New Jersey (Figure 1-1). Environments where Project components would be located include upland and coastal nearshore habitats of southern New Jersey, adjacent New Jersey state waters, and ocean habitats in the NJ WEA on the OCS offshore of New Jersey. Coastal onshore habitats and federally listed species under the jurisdiction of the USFWS are evaluated in a separate BA. Although most Project-related activities would occur in the Lease Area and along the proposed cable routes, vessels would travel locally between ports and the wind farm site. Some vessels used during construction may transit from Europe.

Under ESA Section 7 consultation regulations (50 CFR 402.02), the Action Area refers to the area affected by the Proposed Action and also includes the area where all consequences to listed species or critical habitat that are caused by the Proposed Action would occur, including actions that would occur outside the immediate area involved in the action (see 50 CFR 402.17). The immediate Project area considered in this BA includes the approximately 11.5- by 8.0-mile (18.5- by 13.0-km) wind farm footprint within the Lease Area and all inter-array cable routes and transmission cable right-of-way from the OSS to shore. In addition to the immediate Project footprint, the vessel transits are considered part of the Action Area. Additionally, the Action Area includes the area affected by underwater noise, electromagnetic field (EMF), water quality impacts, benthic impacts, vessel and survey operations, and other impacts associated with the Proposed Action that have the potential for consequences that may affect listed species or critical habitat. Underwater noise associated with UXO detonations and construction-related impact pile driving is the most geographically extensive temporary noise effects that would result from the construction of the wind farm itself.

Potential vessel routes from port locations in Europe, Charleston, South Carolina, Norfolk, Virginia, Paulsboro, Port Elizabeth, and Atlantic City, New Jersey, as well as the New Jersey Wind Port in Salem County, New Jersey, are part of the Action Area since these vessel transits would not occur but for the Proposed Action and are reasonably certain to occur. The Action Area would include any vessel routes between these port locations and the Project area. The transport of some Project foundation components and/or cable staging may originate in Europe if they cannot be procured in Paulsboro, New Jersey, or Port Elizabeth, New Jersey, or Charleston, South Carolina. The exact ports to be used would not be known until additional details are available when contracts are in place. Until additional details are available, potential routes from Europe are considered part of the Proposed Action to evaluate the potential effects should these ports be used during construction. O&M vessels are not anticipated to originate in Europe. The number of ports under consideration does not increase the number of vessel trips that are likely to occur but may affect the location and length of the transits.

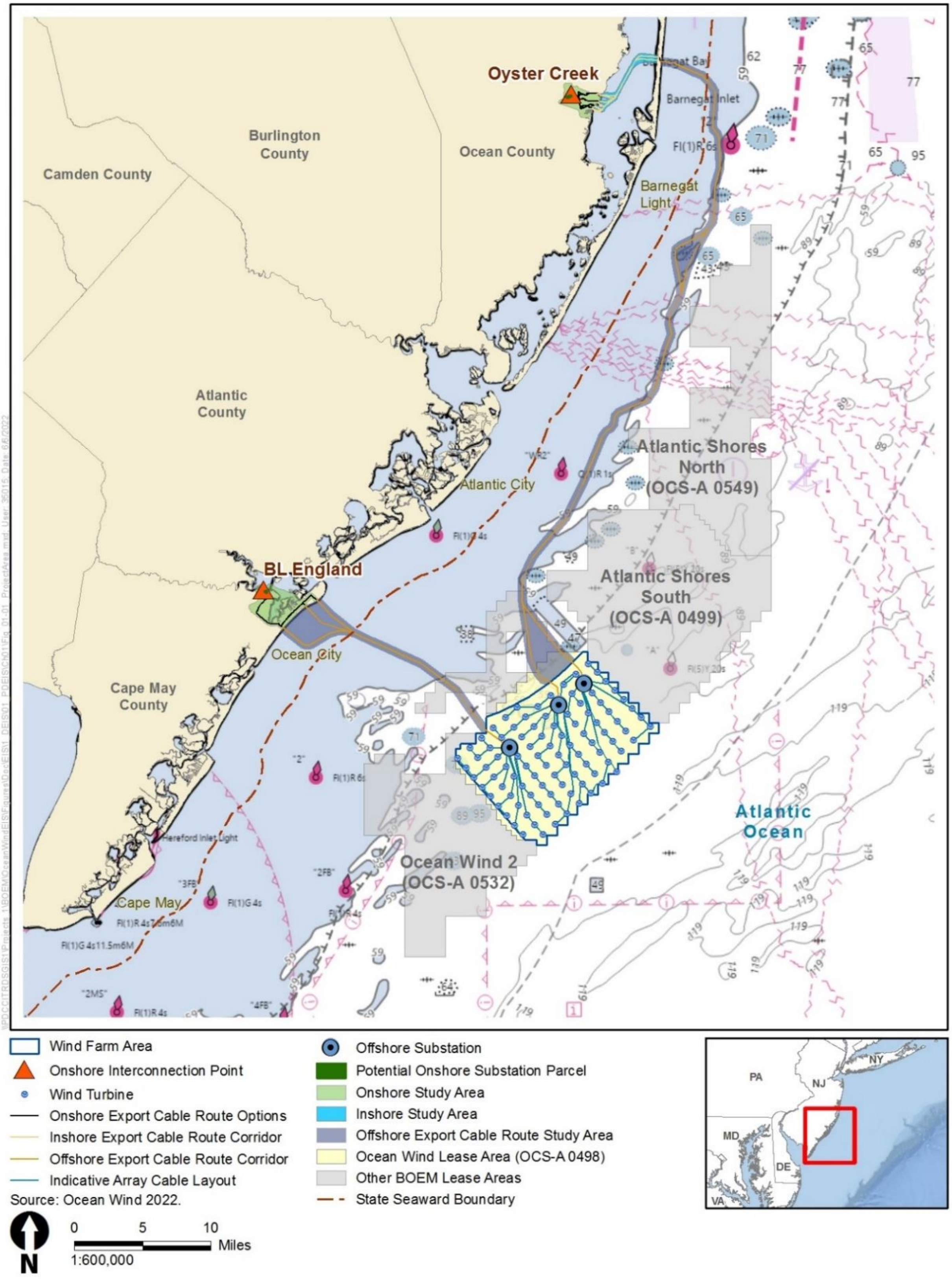


Figure 1-1 Ocean Wind 1 Project Area

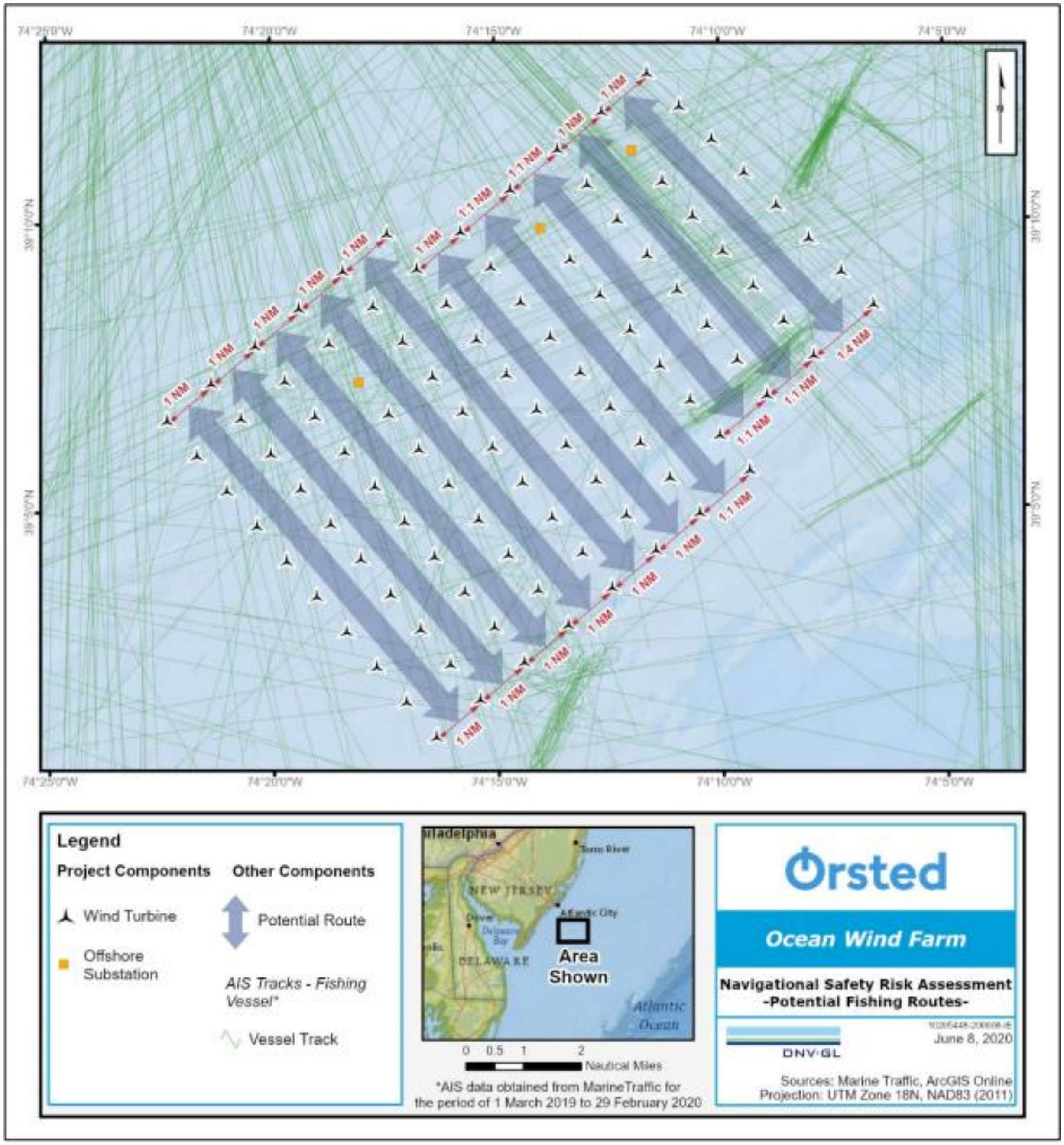
1.3. DESCRIPTION OF THE PROPOSED ACTION

As detailed in Section 2.1 of the Draft Environmental Impact Statement (EIS), the Proposed Action would allow Ocean Wind to construct, operate, maintain, and eventually decommission a wind energy facility approximately 1,100 MW in scale on the OCS offshore of New Jersey within the range of design parameters outlined in Section 4 of the COP, Volume 1 (Ocean Wind 2022, Alternative A). In-water Project components include the offshore wind farm, the offshore export cable, the inshore export cable, and OSS. The Project proposed by Ocean Wind would include up to 98 WTGs and their foundations, up to three OSSs and their foundations, scour protection for foundations, inter-array cables, and offshore export cables (these elements collectively make up the Offshore Project area). The proposed offshore Project elements are on the OCS as defined in OCSLA, except a portion of the export cables within state waters (Figure 1-2). The WTGs would extend up to 906 feet (276 meters) above mean lower low water (MLLW). Turbines are oriented in a southeast-northwest direction within the 68,450-acre (277-square-kilometer [km2]) Wind Farm Area with 10 open corridors in between of varying width. Corridor width between turbines (southwest-northeast orientation) varies depending on location within the array from 1.15 to 1.61 miles (1 to 1.4 nm, 1.9 to 2.5 km between WTGs (Figure 1-2). Southeast-northwest spacing between the turbines is 0.9 miles (0.8 nm) throughout the Wind Farm Area. Ocean Wind would mount the WTGs on monopile foundations, and OSSs would be placed on either monopile or piled jacket foundations. Maximum seabed penetration of the WTG foundation would be 164 feet (50 meters). Where required, scour protection would be placed around foundations to stabilize the seabed near the foundations, as well as the foundations themselves. The scour protection would be a maximum of 8.2 feet (2.5 meters) in height, would extend away from the foundation as far as 43 feet (13.1 meters), and would have a volume of 8,657 cubic yards (yd^3) (6,619 cubic meters [m^3]) per monopile. Each WTG would contain approximately 1,585 gallons (6,000 liters) of transformer oil and 146 gallons (553 liters) of general oil (for hydraulics and gearboxes). Other chemicals used would include diesel fuel, coolants/refrigerants, grease, paints, and sulfur hexafluoride. COP Volume I, Section 8.1 provides additional details related to proposed chemicals and their anticipated volumes (Ocean Wind 2022).

The Project would involve temporary construction laydown areas and construction ports; however, the primary ports that are expected to be used during construction have independent utility and are not solely dedicated to the Project. These ports include a construction management base in Atlantic City, New Jersey; a foundation scope base in Paulsboro, New Jersey, or Europe; a WTG scope base in Norfolk, Virginia, or Hope Creek, New Jersey; and a cable staging base in Port Elizabeth, New Jersey, Charleston, South Carolina, or Europe. The operations and maintenance (O&M) facility would be in Atlantic City, New Jersey and serve multiple Ørsted Wind Power North America, LLC (Ørsted) projects in the mid-Atlantic.

The Project’s export cables include both offshore and onshore segments. The offshore export cables would be alternating current (AC) electric cables that would connect the Project area to the mainland electric grid in Lacey Township, New Jersey, and Upper Township, New Jersey. Offshore, the export cables would be located in federal waters and New Jersey state territorial waters and would be buried to a target depth of 4 to 6 feet (1.2 to 1.8 meters) below the seabed. The onshore underground segment of the export cable would be located in Lacey, Ocean, and Upper Townships, New Jersey, and Ocean City, New Jersey.

A description of construction and installation, O&M, and decommissioning activities to be undertaken for the proposed Project is included in Sections 1.3.1, 1.3.2, and 1.3.3, below. Proposed mitigation, monitoring, and reporting conditions that are intended to minimize or avoid potential impacts to ESA-listed species are described in Section 1.3.5. Monitoring surveys to be completed before, during, and after construction are included in Section 1.3.4. For a more specific description of the Project Design Envelope, see Ocean Wind’s COP (Ocean Wind 2022). Adjustments to locations of WTGs and OSS, export cables, and array cables may occur based on results of the ongoing COP review; figures indicate current configurations.



Source: DNV-GL 2021

Figure 1-2 Ocean Wind Farm Area

1.3.1 Construction and Installation

The proposed Project would include the construction and installation of both onshore and offshore facilities. Offshore construction and installation activities, as well as any onshore activities that may result in temporary impacts to coastal waters, are discussed below. The distinct areas of the proposed Project include the offshore wind farm, offshore export cable, and inshore export cable. Components included in these areas are the WTGs (including foundations and scour protection), OSSs (including foundations and scour protection), inter-array cables (including scour protection), OSS cables, offshore export cables (including scour protection), and temporary cofferdams. Construction and installation would begin in 2023 and be completed in 2025. Ocean Wind anticipates beginning land-based construction before the offshore components. Based on the Project schedule included in COP Volume I, Chapter 4, Figure 4.5-1 (based on a record of decision anticipated for Quarter (Q)1 2023), construction and installation of offshore components would proceed on the following timeline (Figure 1-4; Ocean Wind 2022):

1. Landfall cable installation works would begin in mid-Q3 2023 and conclude in early Q2 2024;
2. Offshore export cable installation activities would begin in early Q1 2024 and conclude in early Q4 2024;
3. WTGs and OSS foundation installation would begin in Q2 2024 and conclude by Q4 2024;
4. Inter-array cable installation would begin in Q3 2024 and conclude in late Q1 2025; and
5. WTGs and OSS installation commissioning would begin mid-Q3 2024, with the array fully energized by Q4 2025.

Ocean Wind would install up to 101 foundations which includes three OSS and 98 WTGs. Installation would require up to two jack-up vessels, support vessels and barges. For the WTGs, a single vertical hollow steel monopile with a 4-inch (10.3 centimeter [cm]) wall thickness will be installed for each location using an impact hammer (IHC-4000 or IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 164 feet (50 meters). Installation of a single monopile is expected to take 9 hours (1 hour pre-clearance period, 4 hours piling, and 4 hours moving to the next location). Up to two piles are expected to be installed per 24-hour period. The tapered monopiles for WTG foundations would be 37 feet (11 meters) in diameter at the seabed and 27 feet (8 meters) in diameter at the sea surface (Figure 1-3; Ocean Wind 2022).

OSSs are generally installed in two phases: first, the foundation substructure is installed in a method similar to that described above; then, the topside structure is installed on the foundation structure. More information on installation can be found in COP Volume I, Section 6.1.2 (Ocean Wind 2022). Ocean Wind would construct up to three OSSs to collect the electricity generated by the offshore turbines. OSSs help stabilize and maximize the voltage of power generated offshore, reduce potential electrical losses, and transmit energy to shore. OSSs would consist of a topside structure with one or more decks on either a monopile or piled jacket foundation. For the OSS, a piled jacket foundation is being considered. This would involve installing 52- by 8-foot (16- by 2.44-meter) diameter piles as a foundation for each OSS foundation using an impact hammer (IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 230 feet (70 meters). Alternatively, a single monopile like the ones used for WTGs may be used for each OSS (each option was modeled). A maximum of three pin piles would be installed per 24-hour period. Each pin pile takes approximately 4 hours to install and a single OSS foundation is expected to take 6 days. A total of 98 monopiles would be installed for WTGs and 48 pin piles (or three monopiles) would be installed for OSS. For installation of both the WTG and OSS monopile foundations, installation of more than one pile at one time is not expected to occur; however, 24-hour-per-day pile driving may be conducted if approved by BOEM (see Section 1.3.5, Table 1-11 and Table 1-12 for more details).

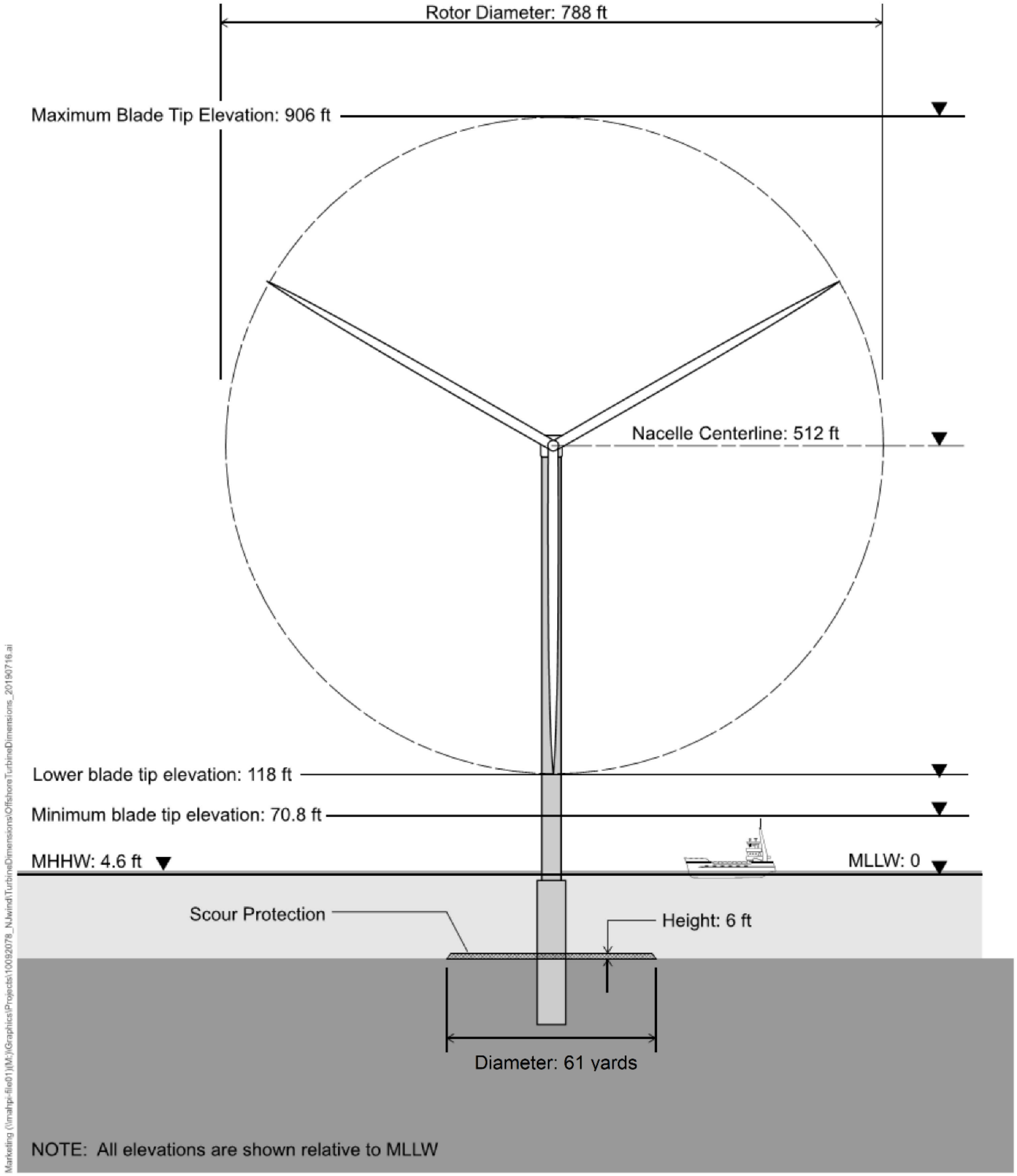


Figure 1-3 Ocean Wind 1 Maximum Design Scenario for Wind Turbines

Array cables would transfer electrical energy generated by the WTGs to the OSS(s). OSS would include step-up transformers and other electrical equipment needed to connect the 66-kilovolt (kV) inter-array cables to the 275 kV or 220 kV offshore export cables. Substations would be connected to one another via substation interconnector cables. Up to two interconnector cables with a maximum voltage of 275 kV would be buried beneath the seabed floor.

Installation of monopile and piled jacket foundations is similar, although piled jacket foundations would require more seabed preparation for each of the jacket feet. A maximum of two jack-up rigs are anticipated to be required in the Offshore Wind Area at any one time (e.g., simultaneously). However, as the acoustic modeling provided for this Project does not analyze concurrent pile driving, this BA assumes that only one monopile will be installed at a time. Pile installation would occur intermittently from May 1 through December 31 to avoid the times of year when North Atlantic right whales (NARWs; *Eubalaena glacialis*) are present in higher densities.

The WTGs and OSSs would be lit and marked in accordance with Federal Aviation Administration and USCG lighting standards and consistent with BOEM's Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021d). Ocean Wind proposes to implement an aircraft detection lighting system to automatically activate lights when aircraft approach. Ocean Wind would paint WTGs no lighter than radar-activated light (RAL) 9010 Pure White and no darker than RAL 7035 Light Grey to help reduce potential visibility against the horizon. Additionally, the lower sections of each structure would be marked with high-visibility yellow paint from the water line to an approximate height of at least 50 feet (15 meters), consistent with International Association of Marine Aids to Navigation and Lighthouse Authorities guidance.

Two offshore export cable route corridors are identified in the COP: Oyster Creek and BL England. The approximately 384 miles (618 km) of in-water transmission cables would be installed in two phases: a simultaneous lay and bury phase at a speed of 1.9 miles (3 km) per day (410 feet/hour; 125 meters/hour; 0.125 km/hour) and a post-lay burial phase at a speed of 6.0 miles (9.6 km) per day (1,312 feet/hour; 400 meters/hour), weather depending. The simultaneous lay and bury phase speed is less than the post-lay burial speed due to the requirement for the vessel to stop and perform anchor resets. Total installation of in-water cables is anticipated to occur over 386 days (Figure 1-4). Up to two offshore export cables would be buried under the seabed within the Oyster Creek export cable route corridor to make landfall and deliver electrical power to the Oyster Creek substation. The offshore export cable route corridor to Oyster Creek would begin within the Wind Farm Area and proceed northwest to the Atlantic Ocean side of Island Beach State Park with a maximum total length of 143 miles (230 km). It is anticipated that approximately 0.8 miles (1.3 km) of cable would be installed per day over a total of 179 days for the Oyster Creek offshore export cable. The inshore export cable route corridor to Oyster Creek would exit the bay side of the Island Beach State Park and cross Barnegat Bay southwest to make landfall near Oyster Creek in either Lacey or Ocean Township. One offshore export cable would be buried under the seabed within the BL England export cable route corridor to make landfall and deliver electrical power to the BL England substation. The BL England offshore export cable route corridor would begin within the Wind Farm Area and proceed west to make landfall in Ocean City, New Jersey, with a maximum total length of 32 miles (51 km). Each offshore export cable would consist of three-core 275-kV AC cables. It is anticipated that approximately 1.2 miles (2.0 km) of cable would be installed per day over a total of 26 days for the BL England offshore export cable.

Ocean Wind 1 has conducted surveys to locate any third-party infrastructure, such as existing cables, that would be crossed by the Ocean Wind 1 export cable. Ocean Wind 1 is working with the third-party infrastructure owners to develop crossing agreements. Prior to cable installation over an existing live cable, Ocean Wind 1 would install a separation layer (typically three concrete mattresses) over each live crossing location. During simultaneous lay and burial of the export cable, the burial tool would gradually transition out of the seabed on the approach to the live crossing and stop at a safe stand-off distance (to be determined in each crossing agreement). The burial tool is then brought back up to the vessel and the cable is free laid onto the seabed, over the crossing (which is covered by three concrete mattresses). The burial tool is then redeployed to the seabed at safe distance (to be determined in each crossing agreement) on the other side of the crossing and burial operations re-commence along the route. A protection layer consisting of rock placement, mattress placement, or rock bags is then installed over the unburied length of cable on either side of the crossing (see COP Volume I, Section 6.1.2.6.3 for a description of proposed cable protection measures). Where an out of service cable is crossed by the Ocean Wind 1 export cable, Ocean Wind, in agreement with the cable owner, would remove the out of service cable in accordance with International Cable Protection Committee guidelines. Cables are typically removed by pulling a grapnel through the seabed, snagging the out of service cable and cutting it. Each end of the cut cable is peeled to one side and secured on the seabed, leaving a cable free corridor along the export route.

Ocean Wind has proposed several cable route installation methods for the array and substation interconnector cables. Array cables may reach a maximum total length of 190 miles (306 km), while cables associated with linking OSSs may reach a maximum cable length of 19 miles (31 km). It is anticipated that approximately 1.7 miles (2.7 km) of array cable would be installed per day over a total of 112 days (Figure 1-4). It is further anticipated that approximately 1.5 miles (2.4 km) of OSS inter-link cable would be installed per day over a total of 13 days. Cables may be laid and buried post-lay using a jetting tool if seabed conditions allow. Under this option, cables may remain unburied on the seabed within the Wind Farm Area for up to 2 weeks. All cables procured by Ocean Wind 1 would be required to have as a minimum specific gravity of 2.2. This criterion has been demonstrated to prevent unburied cable movement on the seafloor for up to 1 month prior to burial across previous projects in the United States and North Sea. Although all cables for Ocean Wind 1 would have a specific gravity of 2.2 or above, because site-specific conditions may vary across projects, an on-bottom stability assessment would be conducted by the installation contractor for all Ocean Wind 1 cables to ensure cables would remain in place while unburied. The on-bottom stability assessment is a 3D finite element assessment per DNV Recommended Practice F109 and DNV Standard N001. In the unlikely case stability cannot be confirmed for any number of cables, Ocean Wind would assess other pragmatic operational approaches which may include, early burial or temporary stabilization for the specific cables.

Alternatively, the array cables may be laid and buried simultaneously. Under this option, array cables could be installed by using a tool towed behind the installation vessel to simultaneously open the seabed and lay the cable, or by laying the cable and following with a tool to embed the cable. Possible installation methods for these options include jetting, vertical injection, control flow excavation, trenching, and plowing. The inter-array, substation interconnector, and export cables have a target burial depth of 4 to 6 feet (1.2 to 1.8 meters), although final burial depth is dependent on a cable burial risk assessment and coordination with pertinent agencies. The installation vessel would transit to and take position at the landfall location, and the cable end would be pulled into the preinstalled duct ending in the transition junction bay. The installation vessel would transit the route toward the OSS, installing the cable by simultaneous lay and burial (plow/jetting/cutting) or surface lay and burial by a cable burial vessel (jetting/cutting/control flow excavation).

In the event that cables cannot achieve proper burial depths or where the proposed offshore export, array, or substation cables would cross existing infrastructure, Ocean Wind proposes the following cable protection methods: (1) rock placement, (2) concrete mattress placement, (3) front mattress placement, (4) rock bags, or (5) seabed spacers. When the cable has been installed, post-cable-lay surveys and depth-of-burial surveys would be conducted to determine if the cable has reached the desired depth. The remedial protection measures described above may be required in places where the target burial depth cannot be met. A maximum of 10% of offshore export, array, and substation cables is expected to require remedial protection measures. The total area of permanent and temporary disturbance to the seabed by each Project component is listed in Table 1-2 and Table 1-3, respectively.

Table 1-2 Area of Permanent Disturbance to the Seabed by Project Component

Component	Area of Permanent Disturbance	
	Acres	km^2
WTG Foundations	3	0.01
WTG Scour Protection	81	0.33
OSS Foundations	0.1	<0.001
OSS Scour Protection	3	0.01

Component	Area of Permanent Disturbance	
	Acres	km^2
Array Cables	77 (cable protection)	0.31
Substation Interconnector Cables	8 (cable protection)	0.03
Offshore Export Cables within Wind Farm Area	4 (cable protection)	0.02
Offshore Export Cables outside Wind Farm Area	82 (cable protection)	0.33

Source: Modified from COP, Volume II, Table 2.2.5.5 (Ocean Wind 2022).
Note: These are indicative estimates based on the Project Design Envelope. Potential permanent impacts will be updated based on final design
COP = Construction and Operations Plan; km^2 = square kilometers; WTG = wind turbine generator

Table 1-3 Area of Temporary Disturbance to the Seabed by Project Component

Component	Area of Temporary Disturbance	
	Acres	km^2
Array Cables	2,220	8.98
Substation Interconnector Cables	222	0.89
Offshore Export Cables within Wind Farm Area	120	0.49
Offshore Export Cables outside of Wind Farm Area	1,980	8.01
Anchoring during construction	14	0.05

Source: Modified from COP, Volume II, Table 2.2.5.5 (Ocean Wind 2022).
Note: These are indicative estimates based on the Project Design Envelope. Potential temporary impacts will be updated based on final design
COP = Construction and Operations Plan; km^2 = square kilometers

Ocean Wind is continuing to evaluate the risk of encountering unexploded ordnance (UXO)/munitions and explosives of concern (MEC). These include explosive munitions such as bombs, shells, mines, torpedoes, etc. that did not explode when they were originally deployed or were intentionally discarded to avoid land-based detonations. The risk of incidental detonation associated with conducting seabed-altering activities such as cable laying and foundation installation in proximity to UXOs jeopardizes the health and safety of Project participants.

Ocean Wind follows the industry standard As Low as Reasonably Practical (ALARP) process, which minimizes the number of potential detonations (Crussell et al. 2021). While avoidance is the preferred approach for UXO/MEC mitigation, there may be instances when confirmed UXO/MEC avoidance is not possible due to layout restrictions, presence of archaeological resources, or other factors that preclude micro-siting. In such situations, confirmed UXO/MEC may be removed through physical relocation or in-situ disposal. Physical relocation will be the preferred method but is not an option in every case. UXO/MEC may be relocated through a “Lift and Shift” operation, in which case it would be relocated to another suitable location on the seabed within the area of potential effect or previous designated disposal areas for either wet storage or disposal through low or high noise order methods as described below for in-situ disposal. Selection of a removal method will depend on the location, size, and condition of the confirmed UXO/MEC, and will be made in consultation with a UXO/MEC specialist and in coordination with the agencies with regulatory oversite of UXO/MECs. If “lift and shift” operations are required to mitigate potential hazards from confirmed UXOs, areas for relocation would be selected in consultation with BOEM and other appropriate agencies. The distance moved from the as-found location would depend on the distance to the agreed upon relocation area. Factors such as UXO size, type, and condition will be considered prior to any relocation.

HRG surveys and data analyses are still underway, and the exact number and type of UXOs in the Project area are not yet known. As a conservative approach, however, it is currently assumed that up to 10 UXOs may have to be detonated in place. If necessary, these detonations would occur on up to 10 different days (i.e., no more than one detonation would occur within a 24-hour period). The Project does not expect that 10 E12-size UXOs (largest explosive modeled) will be present, but a combination of up to 10 UXOs may be encountered, and to be conservative the larger E12 bin will be used to analyze potential effects. A UXO/MEC Risk Assessment with Risk Mitigation Strategy was conducted for the Project (Ordtek 2020). The likelihood of encountering various MEC types was analyzed for the Project area and assigned one of five possibility rankings: very unlikely, unlikely, possible, likely, and very likely. The presence of MEC was determined to be very unlikely for most MEC types but recorded as possible for small projectiles (<6 inches [15.2 cm]) both nearshore and offshore, meaning that evidence suggests that this type of explosive ordinance could be encountered within the Project area. The primary munitions with potential for occurrence in the dump area close to the Project pose a limited risk and are of low net explosive quantity. Depth charges and torpedoes were given a possibility ranking of unlikely in the Offshore Project area, meaning that some evidence of this type of explosive ordinance in the wider region exists but it would be unusual to encounter it.

If detonation is determined to be the preferred and safest method of disposal, they would only occur during daylight hours. It is expected that impacts from detonations would occur within the current limits defined for the Project Design Envelope, but would depend on the soil conditions, burial depth, and type of UXO found. UXO would be disposed of in situ with low-order (deflagration) or high-order (detonation) methods or by cutting the UXO to extract the explosive components. As outlined in the construction schedule presented in Figure 1-4, UXO detonations would begin as early as June 2023 and would only occur from May 1 through December 31 to avoid times of year when NARWs are present in higher densities. Potential locations of UXO within the Project area have not been released at the time of this assessment.

Construction and installation would require several different types of vessels to support the Project (Table 1-4). Construction vessels would travel between the Wind Farm Area and the following ports that are expected to be used during construction: Atlantic City, New Jersey, as a construction management base; Paulsboro, New Jersey, or from Europe directly for foundation fabrication and load out; Norfolk, Virginia, or Hope Creek, New Jersey, for WTG pre-assembly and load out; and Port Elizabeth, New Jersey, or Charleston, South Carolina, or directly from Europe for cable staging. During installation of array and substation interconnection cables, Ocean Wind anticipates a maximum of 18 vessels operating during a typical workday in the Wind Farm Area. Many vessels would remain in the Offshore Project area (which includes the Wind Farm Area and offshore export cable corridors) for days to weeks at a time, potentially only making infrequent trips to port for bunkering and provisioning as needed. For offshore export cable installation, Ocean Wind anticipates a maximum of 26 vessels operating in the Project area during a typical workday (Table 1-5). A number of vessels involved in cable installation would utilize dynamic positioning thrusters. A list of Applicant Proposed Measures (APMs) to avoid, minimize, or mitigate impacts can be found in Table 1-11. When considering the number of construction vessels and trips per activity (Table 1-5) in terms of when and the duration the construction activity would be expected to occur (Figure 1-4) and if equal distribution of trips occurs across each quarter, vessel activity would be spread out as shown in Table 1-6.

Table 1-4 Construction Vessel Size Summary

Construction Activity	Vessel Type
WTG Installation	
--	Installation Vessel – 476 by 197 feet (145 by 60 meters) (not including helideck, crane); Displacement: 43000Te
--	Unpowered Feeder Barges – 410 by 115 feet (125 by 35 meters); Displacement: 21000Te

Construction Activity	Vessel Type
--	Tug – 148 by 49 feet (45 by 15 meters)
Foundations	
--	MP Installation: Floating Heavy Lift Vessel – 787 by 164 feet (240 by 50 meters); Displacement: 61.000T
--	SS Installation: Jack-Up Vessel – 459 by 131 feet (140 by 40 meters); Displacement: 8.000T
--	Noise Mitigation Vessel – 295 by 66 feet (90 by 20 meters); Displacement: 4900T
Export Cable Installation	
Export Cable Lay (offshore)	Approx. Length: 427 feet (130 meters); Beam: 98 feet (30 meters); Deadweight: 10,800Te
Trenching Support	Approx. Length: 328 feet (100 meters); Beam: 66 feet (20 meters); Deadweight: 3,000Te
Export Cable Lay (Inshore)	Approx. Length: 410 feet (125 meters); Beam: 115 feet (35 meters); Depth: 26 feet (8 meters) Plus Anchor handler support vessels
Export Cable Installation – Secondary Support Vessels	
Pre-lay Grapnel Runs, Boulder Removal, mattressing, surveys	Approx. Length: 262 feet (80 meters); Beam: 66 feet (20 meters); Gross: 2,400 GT
Survey	Approx. Length: 164 feet (50 meters); Beam: 33 feet (10 meters); Gross 615 GT
Anchor Handling Tug	Approx. Length: 98 feet (30 meters); Beam: 49 feet (15 meters); Gross: 345 GT
Rock Installation	Approx. Length: 525 feet (160 meters); Beam: 131 feet (40 meters); Cargo: 24,000Te
Crew Transfer Vessel (CTV)	Approx. Length: 89 feet (27 meters); Beam: 36 feet (11 meters); Gross: 235 GT
Array Cable Installation – Primary Array Cable Installation Vessels	
Array Cable Lay	Approx. Length: 459 feet (140 meters); Beam: 98 feet (30 meters); Deadweight: 10,000Te
Trenching Support	Approx. Length: 328 feet (100 meters); Beam: 98 feet (30 meters); Displacement: 12,200Te
Array Cable Installation– Secondary Support Vessels	
Pre-lay Grapnel Runs	Approx. Length: 230 feet (70 meters); Beam: 66 feet (20 meters); Gross: 1,660 ITC
Boulder removal	Approx. Length: 312 feet (95 meters); Beam: 66 feet (20 meters); Deadweight: 3,285 LT
Survey	Approx. Length: 164 feet (50 meters); Beam: 39 feet (12 meters); Gross: 615 GT
Crew Transfer Vessel (CTV)	Approx. Length: 98 feet (30 meters); Beam: 36 feet (11 meters); Gross: 235 GT
Crew transfer and accommodation	Approx. Length: 295 feet (90 meters); Beam: 66 feet (20 meters); Deadweight: 4,870 LT
Rock Installation	Approx. Length: 525 feet (160 meters); Beam: 118 feet (36 meters); Cargo: 24,000Te

GT = gross tonnage; ITC = International Convention on Tonnage Measurement; LT = long ton; T = imperial tons; Te = metric tonne

Table 1-5 Construction Vessel Summary

Vessel Type	Maximum Number of Simultaneous (at any one time) Vessels Required in the Project Area[a]	Maximum Number of Round Trips per Vessel Type	Approximate Vessel Draft (meters)[b]	Average/ Normal Operating Speed (knots)
WTG Foundation Installation				
Scour Protection Vessel	1	50	8	6.5
Installation Vessel	4	99	13.5	10
Support Vessels	16	396	CTV: 3 SOV: 7.5 Noise Mitigation & monitoring vessel: 7	23
Transport/Feeder Vessels (including tugs)	40	396	7	4
- of which are anchored	2	198		
Helicopter Support	2	99	N/A	N/A
WTG Structure Installation				
Installation Vessels	2	99	6.5	10
Transport/Feeder Vessels	12	99	6.5	4
Other Support Vessels	24	594	7	23
Helicopters	2	75	N/A	N/A
Substation Installation[c]				
Primary Installation Vessels	2	12	13.5	10
Support Vessels	12	72	7	23
Transport Vessels	4	24	6	4
Helicopters per day per major vessel	2	21	N/A	N/A
Array Cable Installation[d]				
Main Laying Vessels	3	99	5	2.4
Main Burial Vessels	3	99	5	2.4
Support Vessels	12	594	7	23
Helicopter support (construction return trips)	2	198	N/A	N/A
Substation Inter-link Cable Installation[e]				
Main Laying Vessels	Included in numbers for export and array cables	8	5	2.4
Main Burial Vessels		8	5	2.4
Support Vessels		12	7	23
Helicopter support (construction return trips)		40	N/A	N/A

Vessel Type	Maximum Number of Simultaneous (at any one time) Vessels Required in the Project Area[a]	Maximum Number of Round Trips per Vessel Type	Approximate Vessel Draft (meters)[b]	Average/ Normal Operating Speed (knots)
Offshore Export Cable Installation[f]				
Main Laying Vessels	3	48	5	2.4
Main Cable Joining Vessels	3	36	6.5	2.4
Main Burial Vessels	3	48	5	2.4
Support Vessels	15	72	7	23
Helicopter support (construction return trips)	2	351	N/A	N/A

Notes:
a "Simultaneous" refers to the number of vessels needed for an activity and indicates that the vessels would be required at the same time for the duration of the activity.
b "Vessel draft" is approximate and represents a conservative value that is subject to change.
c Substation installation is anticipated to occur over a maximum duration of 67 days.
d Array cable installation is anticipated to occur over a maximum duration of 12 months. The installation of each cable section is anticipated to occur over 3.5 days.
e Substation inter-link cable installation is anticipated to occur over a maximum duration of 1 month. The installation of each cable section is anticipated to occur over 20 days.
d Offshore export cable installation is anticipated to occur over a maximum duration of 6 months. The installation of each cable section is anticipated to occur over 59 days.
CTV = crew transfer vessel; N/A = not applicable; SOV = surface operation vessel; WTG = wind turbine generator

Table 1-6 Construction Vessel Number and Trip Distribution per Quarter and Activity

Activity	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WTG Foundation Installation						61/ 314	61/ 314	61/ 314				
WTG Structure Installation							38/ 132	38/ 132	38/ 132	38/ 132	38/ 132	38/ 132
Substation Installation							18/ 18	18/ 18	18/ 18	18/ 18	18/ 18	18/ 18
Array Cable Installation							18/ 264	18/ 264	18/ 264			
Substation Cable Installation					NA/ 6	NA/ 6	NA/ 6					
Offshore Export Cable					24/ 68	24/ 68	24/ 68					
Total	00/ 00	00/ 00	00/ 00	00/ 00	24/ 74	85/ 388	159/ 802	135/ 728	74/ 414	56/ 150	56/ 150	56/ 150

Note: Vessel and trip numbers are represented in each cell with the top number denoting the maximum number of vessels used for that particular construction activity separated with a "/" from the bottom number denoting the maximum number of vessel trips required for that particular construction activity.
N/A = not applicable; Q = quarter; WTG = wind turbine generator

1.3.2 Operations and Maintenance

The Project is anticipated to have an operating period of 35 years.[1] Ocean Wind would use an onshore O&M facility in Atlantic City, New Jersey, sited at the location of a retired marine terminal. Ørsted plans to rehabilitate this former marina facility near Absecon Inlet to create a port facility located off the Mid-Atlantic coast that can service potential wind turbine farms. The O&M facility would include offices, control rooms, warehouses, and workshop space. Approximately 500 feet (152 meters) of dockside harbor facilities and associated parking facilities would be added. The City of Atlantic City intends to secure authorization for marina upgrades, namely, dredging in the marina and at Absecon Inlet, for the benefit of multiple marina users which will be authorized under a different project. Ørsted's rehabilitation of the former marina facility (including office and warehouse construction) and the City of Atlantic City's marina upgrades are being reviewed and authorized by the USACE, state and local agencies. These improvements are therefore not considered part of the Proposed Action.

The proposed Project would include a comprehensive maintenance program, including preventative maintenance based on statutory requirements, original equipment manufacturers' guidelines, and industry best practices. Ocean Wind would inspect WTGs, OSSs, foundations, offshore export cables, inter-array cables, onshore export cables, and other parts of the proposed Project using methods appropriate for the location and element.

Routine maintenance is expected for WTGs, foundations, and OSSs. Ocean Wind would conduct annual maintenance of WTGs, including safety surveys, blade maintenance, and painting as needed. Foundation inspections would be conducted 1 year, 2 to 3 years, and 5 to 8 years post-commissioning. Ocean Wind is developing a cable monitoring and maintenance plan which will be included in the Facility Design Report and reviewed by the Certified Verification Agent. The offshore export cables, inter-array cables, and OSS interconnector cables typically have no maintenance requirements unless a failure occurs. Cables would be surveyed during years 1, 4, and 5 after commissioning an as needed after major storm events. Episodic repairs of cable faults, failures, and exposed cables would be conducted as necessary (see COP Volume I, Section 6.1.4.4 for a description of proposed cable maintenance activities). Routine maintenance to remove marine debris is not planned at this time; however, BOEM proposed measure #23 in Table 1-11 requires the Applicant to periodically monitor and report on lost monofilament and other fishing gear around WTG foundations. OSS would be routinely maintained for preventative maintenance up to 12 times per year. Spare parts for key Project components may be housed at the O&M facility so Ocean Wind could initiate repairs expeditiously.

Ocean Wind would need to use vessels, vehicles, and aircraft during O&M activities described above. The Project would use a variety of vessels to support O&M including crew transfer vessels (CTVs), service operation vessels, jack-up vessels, and supply vessels. Approximate parameters of CTVs are presented in Table 1-7. In a year, the proposed Project would generate a maximum of 908 crew vessel trips, 102 jack-up vessel trips, and 104 supply vessel trips; and a maximum of 2,278 helicopter trips, CTV trips, or service operations vessel trips (Table 1-8; Ocean Wind 2022). Ocean Wind may also use helicopters to transport people and equipment and a hoist-equipped helicopter for O&M.

[1] For analysis purposes, BOEM assumes that the proposed Project would have an operating period of 35 years. Ocean Wind's lease with BOEM (Lease OCS-A 0498) has an operations term of 25 years that commences on the date of COP approval. (See https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/NJ/NJ-SIGNED-LEASE-OCS-A-0498.pdf; see also 30 CFR § 585.235(a)(3).) Ocean Wind would need to request and be granted an extension of its operations term from BOEM under the regulations at 30 CFR 585.425 et seq. in order to operate the proposed Project for 35 years. While Ocean Wind has not made such a request, this BA uses the longer period to avoid possibly underestimating any potential effect.

Table 1-7 Maintenance Vessel Size Summary

Vessel Type	Vessel Size Parameters
Crew Transfer Vessel	Approx. Length: 89 feet (27 meters); Beam: 36 feet (11 meters); Gross: 235 GT

GT = gross tonnage

Table 1-8 Operations and Maintenance Annual Vessel Trip Summary

Homeport	Approx. Distance to Project (nautical miles)	Vessel Type	Number of Expected Trips per year	Approximate Vessel Draft (meters)[a]	Average/ Normal Operating Speed (knots)
Atlantic City	24.4	Crew Vessel	908	3	23
Atlantic City	24.4	Jack-Up	102	5	10
Atlantic City	24.4	Supply Vessel	104	7	11
Atlantic City	24.4	Helicopter/CTV/ Service Operations	2,278	Helicopter: NA CTV: 3 SOV: 7	23

[a] Vessel draft is approximate and represents a conservative value that is subject to change.
CTV = crew transfer vessel; NA = not applicable; SOV = surface operation vessel

1.3.3 Decommissioning

Under 30 CFR Part 585 and commercial Renewable Energy Lease OCS-A 0498, Ocean Wind would be required to remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seabed of all obstructions created by the proposed Project. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (30 CFR 585.910(a)). Absent permission from BOEM, Ocean Wind would have to achieve complete decommissioning within 2 years of termination of the lease and reuse, recycle, or responsibly dispose of all materials removed. Ocean Wind has submitted a conceptual decommissioning plan as part of the COP, and the final decommissioning application would outline Ocean Wind’s process for managing waste and recycling proposed Project components (Volume I, Section 6.3; Ocean Wind 2022). Although the proposed Project is anticipated to have an operations life of 35 years, it is possible that some installations and components may remain fit for continued service after this time. Ocean Wind would have to apply for an extension if it wanted to operate the proposed Project for more than the 25-year operations term stated in its lease.

BOEM would require Ocean Wind to submit a decommissioning application upon the earliest of the following dates: 2 years before the expiration of the lease; 90 days after completion of the commercial activities on the commercial lease; or 90 days after cancellation, relinquishment, or other termination of the lease (see 30 CFR 585.905). Upon completion of the technical and environmental reviews, BOEM may approve, approve with conditions, or disapprove the lessee’s decommissioning application. This process would include an opportunity for public comment and consultation with municipal, state, and federal management agencies. Ocean Wind would need to obtain separate and subsequent approval from BOEM to retire in place any portion of the proposed Project. Approval of such activities would require compliance under the National Environmental Policy Act and other federal statutes and implementing regulations.

If the COP is approved or approved with modifications, Ocean Wind would have to submit a bond (or another form of financial assurance) that would be held by the U.S. government to cover the cost of decommissioning the entire facility in the event that Ocean Wind would not be able to decommission the facility.

For both WTGs and OSSs, decommissioning would be a "reverse installation" process, with turbine components or the OSS topside structure removed prior to foundation removal. Ocean Wind would remove monopile foundations by cutting them below the seabed level in accordance with standard practices and seabed conditions at the time of demolition. The scour protection placed around the base of each monopile, if used, would be left in place as the default option to preserve marine life that may have established itself on the substrate. Offshore cables would be left in place, removed, or a combination of both, depending on regulatory requirements at the time of decommissioning. It is anticipated that the array cables would be removed using controlled-flow excavation or a grapnel to lift the cables from the seabed.

1.3.4 Monitoring Surveys

This section outlines the surveys proposed for the Project. These include HRG surveys, geotechnical surveys, passive acoustic monitoring and biological monitoring surveys, and surveys that support the Fisheries Monitoring and Benthic Monitoring Plans and, at this time, span both construction and operation and maintenance phases (Table 1-9).

1.3.4.1. High-Resolution Geophysical and Geotechnical Surveys

HRG surveys would occur intermittently before, during, and after construction, beginning upon issuance of an LOA under the MMPA. Surveys would include equipment operating at less than 180 kHz and consist of multibeam depth sounding, seafloor imaging, and shallow- and medium-penetration sub-bottom profiling within the Project area. Potential equipment used during HRG surveys would be side-scan sonar, multibeam echosounder, magnetometers and gradiometers, parametric sub-bottom profiler (SBP), compressed high-intensity radiated pulses (CHIRP) SBP, boomers, or sparkers. Ocean Wind assumes that HRG surveys would be conducted 24 hours a day with an assumed average daily distance of 43.5 miles (70 km). A maximum of three vessels would work concurrently within a 24-hour period with an assumed transit speed of 4 knots (2.1 meters per second [m/s]). Since the regulations promulgated for an LOA are valid for 5 years, HRG survey effort is defined across 5 years (Figure 1-4 and Table 1-9).

Years 1, 4, and 5 are expected to include approximately 88 days of HRG surveys per year (47.5 survey days for the offshore wind farm and 40.5 survey days for the offshore export cable). A total of 3,797 miles (6,110 km) would be anticipated for HRG survey needs for these years, including:

1. Offshore wind farm array cable: 1,864 miles (3,000 km);
2. Oyster Creek export cable: 1,429 miles (2,300 km);
3. BL England export cable: 317 miles (510 km); and
4. OSS inter-link cable: 186 miles (300 km).

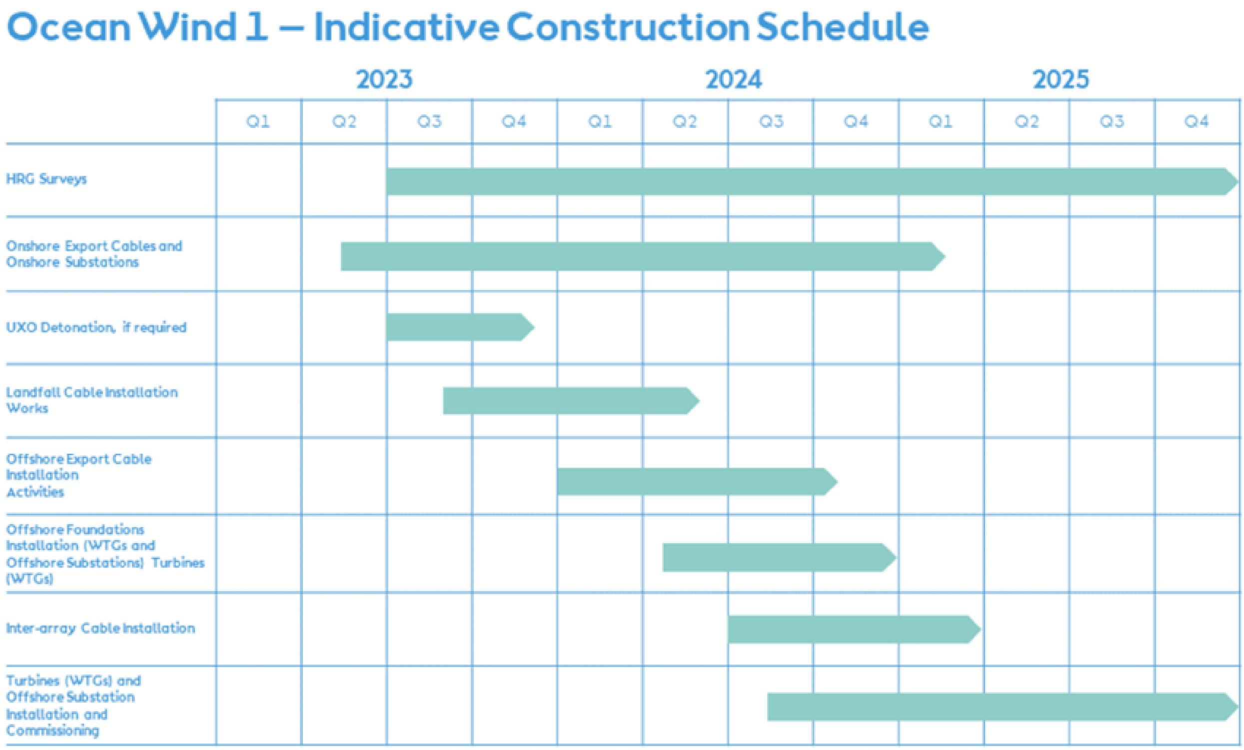
Years 2 and 3, which represent the construction and installation phase, are anticipated to include 180 days of HRG surveys per year. A total of 15,699 miles (25,265 km) would be anticipated for HRG survey needs for these years, including:

1. Export cables: 6,835 miles (11,000 km);
2. Array cables: 6,524 miles (10,500 km);
3. Foundations: 662 miles (1,065 km);
4. WTGs: 155 miles (250 km); and
5. Monitoring and verification: 1,522 miles (2,450 km).

The total HRG survey days throughout the 5 years would be 624 days. Post-construction HRG surveys, as well as multibeam echosounder bathymetry surveys, are expected during the operations phase. Ocean

Wind 1 would conduct surveys of foundations, bathymetry, scour (and associated scour protection if deployed), and cable burial. The total inspections anticipated over the life of the Project are presented in Volume 1 of the COP, in Table 6.1.4-1. Table 6.1.4-1 includes a maximum of 38 seabed surveys.

Geotechnical surveys would take place prior to construction. If additional geotechnical surveys are needed, Ocean Wind would develop a survey plan for BOEM's review. No geotechnical surveys are planned for the construction or post-construction phases.



Source: Ocean Wind 2022

Figure 1-4 Offshore Construction Activities for the First 5 Years of the Project, as Outlined in the Ocean Wind 1 COP, Vol I

Table 1-9 Ocean Wind Monitoring Survey Activities for Two Years Pre-Construction, during Construction, and the First Five Years Post-Construction

Type	2021	2022				2023				2024				2025				2026				2027				2028				2029				2030				2031			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
HRG																																									
Novel Hard Bottom																																									
Soft Bottom: WTG																																									
Soft Bottom: Cable[1]																																									
Soft Bottom: Sand Ridge[1]																																									
SAV																																									
Trawl																																									
Structure-Associated Fish																																									
Clam																																									
Oceanography[2]																																									
Pelagic Fish[2]																																									
Acoustic Telemetry (hydrophone tow)																																									

[1] Surveys for this type may be required during Years 3+ if benthic function is still distinguishable from baseline.
[2] Surveys for this type are only required once per phase (e.g., pre-construction, construction, and post-construction) and could occur during the spring of either year during construction and post-construction.
HRG = high-resolution geophysical; Q = quarter; SAV = submerged aquatic vegetation; WTG = wind turbine generator

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1.3.4.2. Benthic Monitoring Plan

Ocean Wind has developed a Benthic Monitoring Plan to document the disturbance and recovery of marine benthic habitat and communities resulting from the construction and installation of Project components, including WTG scour protection as well as the inter-array cabling and offshore export cable corridor from the Wind Farm Area to shore (Inspire 2022). The benthic survey would focus on seafloor habitat and benthic communities and make comparisons to areas unaffected by construction of the Project.

Surveys would occur based on the Project construction schedule but would begin after construction is complete and occur at roughly the same time of year in years 1, 2, 3, and 5 post-construction (Table 1-9). All survey years may not be completed if the benthic community appears to have recovered and all stakeholders agree that monitoring may cease. Ocean Wind previously collected baseline benthic and geophysical data at the Wind Farm Area and export cable corridors in surveys conducted between 2017 and 2020, and these results are provided as part of Appendix E of the Ocean Wind COP (HDR, Inc. 2021).

Ocean Wind has broken down the Benthic Monitoring Plan into five habitat categories: novel hard-bottom habitats associated with WTGs; novel hard-bottom habitats associated with cable protection; soft-bottom habitats associated with WTGs; soft-bottom habitats associated with cables; and sand ridges. Benthic habitat monitoring methods are outlined in Table 1-10 below and described in detail in the Benthic Monitoring Plan. The summary provided here is intended to characterize potential impact mechanisms that could affect ESA-listed species. For post-construction benthic surveys, all survey equipment would be deployed from contracted scientific research vessels similar to those used to conduct ecological surveys in support of the COP (Ocean Wind 2022).

Novel hard-bottom habitat monitoring at WTG/OSS foundations, scour protection layers, and cable protection layers will focus on measuring changes in percent cover, species composition and volume of macrofaunal attached communities (native and non-native species groups) and physical characteristics. These parameters will serve as proxies for resulting changes to the complex food web. Hard-bottom monitoring will utilize high-resolution video imagery at predefined depth intervals of epifaunal communities captured by a remotely operated vehicle. This high-resolution imagery will be processed and analyzed using photogrammetry methodologies that generate high-resolution, spatial models from static images, which can be used to analyze quantitative variables. Ocean Wind has identified three benthic habitat types along the export cables (sand and muddy sand; coarse sediment; and mud and sandy mud) and two benthic habitat types within the Wind Farm Area (sand and muddy sand; and coarse sediment) (Inspire 2022). As part of the Benthic Monitoring Plan, three WTG locations and three cable protection areas will be randomly selected for monitoring within each habitat type. One of the three OSS foundations will be selected for benthic monitoring.

Monitoring of soft-bottom habitat monitoring will focus on measuring physical factors and indicators of benthic function (bioturbation and utilization of organic deposits), which will serve as proxies for functional changes in the community composition. Soft-bottom habitats will be monitored using a sediment profile and plan view imagery (SPI/PV) system, which captures a multi-dimensional view of the benthic and geological conditions of seafloor segments. Monitoring of soft-bottom habitats will use the same wind structure foundations selected for the novel hard-bottom monitoring survey (triplicate WTGs randomly selected within each predefined habitat type stratum) and data on the mean currents near the Wind Farm Area will be used to establish up current and down current transects extending from each selected WTG foundation. Two 82-foot- (25-meter-) wide belt transects of SPI/PV stations will be established, one up current and the other down current of the selected turbines and OSS locations. Pre- and post-construction transects will begin at the center point of the planned/existing foundations with a sample station upstream and downstream at eight distance intervals.

Table 1-10 Proposed Benthic Monitoring Plan Approaches

Habitat Types	Survey Approach	Survey Years
Novel Hard Bottom: WTG-associated	• Methodology: ROV/video • Parameters: percent cover; key/dominant species; biomass volume; comparison across depths/habitat strata • Sample Site Selection: Stratified random selection of WTG foundations within benthic habitat (same as used for soft bottom) • Number of Replicates: 3 WTGs per stratum	• Year 0 (late summer after construction) • Year 1 • Year 2 • Year 3 • Year 5
Novel Hard Bottom: Cable Protection	• Methodology: ROV/video • Parameters: percent cover; key/dominant species; biomass volume; comparison across habitat strata • Sample Site Selection: Stratified random selection of cable protection areas within benthic habitat • Number of Replicates: 3 cable protection areas per stratum	• Year 0 (late summer after construction) • Year 1 • Year 2 • Year 3 • Year 5
Soft Bottom: WTG-associated	• Methodology: SPI/PV; BAG design • Parameters: changes in benthic function over time and with distance from WTGs • Sample Site Selection: Stratified random selection of WTG foundations within benthic habitat (same as used for hard bottom) • Number of Replicates: 3 transects WTGs per stratum	• Pre-seabed prep (6 months prior to construction) • Year 0 (late summer after construction) • Year 1 • Year 2 • Year 3 • Year 5
Soft Bottom: Cable-associated	• Methodology: SPI/PV; BAG design • Parameters: changes in benthic function over time and with distance from cables • Sample Site Selection: Stratified random selection of cable segments within benthic habitat and seafloor prep	• Year 0 (late summer after construction) • Year 1 • Year 2 • Year 3+ (TBD, if post-construction benthic functions are indistinguishable to baseline, no further monitoring required)
Soft Bottom: Sand Ridges	• Methodology: SPI/PV • Parameters: changes in sediment type and benthic functions over time • Sample Site Selection: Random selection of IAC segments that transect sand ridges	• Pre-seabed prep • Year 0 (late summer after construction) • Year 1 • Year 2 • Year 3+ (TBD, if post-construction benthic functions are indistinguishable to baseline, no further monitoring required)

Habitat Types	Survey Approach	Survey Years
SAV Monitoring	• Methodology: underwater drop camera imagery • Parameters: changes in shoot density over time and with distance from cables • Sample Site Selection: Random selection of transects across channel where cable will be installed	• Pre-seabed prep (Year 0) • Year 1 • Year 3

BAG = before-after-gradient; IAC= inter-array cable; ROV= remotely operated vehicle; SAV = submerged aquatic vegetation; SPI/PV= sediment profile and plan view imagery; TBD = to be determined; WTG = wind turbine generator

The underwater noise effects generated by the proposed multibeam echosounder and side-scan sonar methods used for habitat monitoring are similar to, but of lower magnitude than, the HRG survey methods described in the COP (Ocean Wind 2022). Noise generated by this type of equipment is unlikely to have any significant biological effect on any ESA-listed species, and they are not addressed further in this BA.

1.3.4.3. Fisheries Monitoring Plan

The proposed Fisheries Monitoring Plan submitted March 30, 2022, includes six different components to assess fisheries status in the Project area and a nearby control site throughout the pre-construction, construction, and post-construction phases (Table 1-9). Survey types include trawl surveys, environmental deoxyribonucleic acid (eDNA) surveys, structure-associated fishes surveys, clam surveys, pelagic fish surveys, and acoustic telemetry monitoring. All surveys are subject to the rules and regulations of the MMPA and ESA. Gear restrictions, closures, and other regulations set forth by take reduction plans would be adhered to as with typical scientific fishing operations to reduce the potential for interaction or injury.

1.3.4.3.1 Trawl Surveys

The trawl surveys would be conducted using same equipment and methods used by the Northeast Fisheries Science Center (NEFSC) with the Fishing Vessel (F/V) Darana R, a 90-foot commercial dragger, and occur once per season, or four times per year. The target sampling dates for the trawl survey would be as follows: the winter survey would occur in January, the spring survey would occur in April, the summer survey would occur in July, and the fall survey would occur in late September or early October. The net would be a 158- by 5-inch (400- by 12-cm), three bridle four-seam bottom trawl with Thyboron, Type IV 66-inch (168-cm) doors and a 1-inch (2.5 cm) knotless codend. The trawl survey is anticipated to begin upon receipt of the Biological Opinion for the Project, currently anticipated in February 2023. As such, Ocean Wind 1 would expect to conduct trawl surveys beginning in 2023 and 2024 during the pre-construction and construction phase and continue for 2 years post-construction in 2025 and 2026. As currently planned, this would result in 4 years of trawl surveys.

During a trawl survey event, 20 tows would be conducted in the Project area and 20 in the control site. A total of 160 tows per year would be conducted for the trawl survey and 960 over the 6-year period. All tows would be conducted during daylight hours, at a speed of 2.9 to 3.3 knots (1.5 to 1.7 m/s), and last for 20 minutes. Transits for the F/V Darana R from its homeport in Wanchese, North Carolina, to the Project area would be approximately 493 miles (428 nm, 793 km) round trip for each seasonal survey. The eDNA survey would occur concurrently with the trawl survey, aboard the F/V Darana R. Mitigation measures for ESA-listed species that would be enacted during the trawl surveys include:

1. A short tow duration of 20 minutes;
2. Sampling during daylight only;

3. Visual marine mammal monitoring by the captain or other scientific crew member before, during, and after haul back. Marine mammal watches within 1 nm will be initiated 15 minutes prior to sampling;
4. If a marine mammal is observed within 1 nm of the station within the 15-minute observation period prior to gear deployment, a delay in gear setting will be conducted until marine mammals have not been resighted for 15 minutes or a new station is chosen away from the marine mammals. If after relocating, marine mammals are still visible from the vessel, Ocean Wind may decide to move again or skip the sampling station;
5. Commencement of trawl operations as soon as possible once the vessel arrives on station and after 15-minute visual monitoring period where no marine mammals are observed;
6. During the entire period the trawl gear is in the water (throughout gear deployment, fishing, and retrieval), visual monitoring will be maintained. If a marine mammal is sighted before the gear has fully been removed from the water (i.e., prior to haul back) the vessel will slow its speed and steer away from the sighted animal to minimize potential interactions. Ocean Wind states they are open to further mitigative action upon consultation with NMFS Protected Resources Division; and
7. During haul back, the codend would be opened as quickly and carefully as possible to avoid damaging any protected species that may have been incidentally captured.

1.3.4.3.2 Structure-Associated Fishes Surveys

The multi-method survey for structure-associated fish would also be conducted concurrently with the trawl survey (four surveys per year for 6 years and a total of 24 separate survey events); however, it would occur aboard the F/V Dana Christine II. Methods employed in the multi-method survey include chevron traps, rod-and-reel fishing, and baited remote underwater video (BRUV). Target sampling dates would occur in January, April, July, and late September or early October. It is anticipated that 12 to 15 locations would be sampled over 3 days using each of the three methods. Locations would be inside the Project area, as well as at a nearby control site. At each location, chevron traps would be baited and placed in a group of six traps spaced 656 feet (200 meters) apart and soak for 90 minutes. Each chevron trap would have a vertical buoy line. The BRUV method would occur concurrently at the same location as the chevron traps after the vessel anchors. The equipment used for BRUVs would include a weighted line attached to surface and subsurface buoys that would hold a stereo-camera system in the water column and a system at the seafloor. The BRUVs would be deployed for 60 minutes at each site. Rod-and-reel sampling would be conducted at the same time as the BRUVs from the stern of the vessel using four to five rods with terminal tackle with baited hooks. Each angler would complete four to five 3-minute timed fishing “drops” at each sampling location, for a total of 16 to 25 drops at each location.

Transits for the F/V Dana Christine II from its homeport in Barnegat Light, New Jersey to the Project area would be one round trip of approximately 104 miles (90 nm, 167 km) for each seasonal survey. Mitigation measures for ESA-listed species that would be enacted during the structure-associated fishes surveys are listed in Table 1-9 and include:

1. Limited soak duration for chevron traps of <90 minutes;
2. Vessel would remain on site during equipment deployment;
3. Lines used in the multi-method survey would have a breaking strength of less than 1,700 pounds (771 kilograms [kg]) and weak links to reduce potential for moderate or significant right whale entanglement risk;
4. Labeled buoys with scientific permit numbers;
5. Immediate reports of any missing lines; and
6. If marine mammals are sighted in the area within 15 minutes prior to deployment of gear and are considered to be at risk of interaction with the research gear, then the sampling station would either

be moved or canceled or the activity suspended until there are no sightings of any marine mammal for 15 minutes within 1 nautical mile (1,852 meters) of the sampling location.

1.3.4.3.3 Clam, Oceanography, and Pelagic Fishes Surveys

The clam survey would occur once yearly in the Project area and two control sites in August over at least 6 years: two surveys before construction, two during construction, and at least 2 years post-construction. A towed modified sampling dredge would be pulled by the F/V Joey D at 10 stations within the Project area and five stations at each of the two control sites. Ocean Wind 1 estimates that up to 50 tows per year could occur, time permitting. Tows would be conducted for 2 minutes at a speed of 3 knots (1.5 m/s). It is anticipated that 40 minutes of dredging would occur for each survey trip, 20 minutes in the Project area and 10 minutes at each of the control sites. Target tow duration may be modified following the first sampling trip, dependent on the volume of catch and performance of the dredge. The clam survey would occur over a 2-day cruise. Transits for the F/V Joey D from its homeport in Atlantic City, New Jersey, would be one round trip of approximately 51 miles (44 nm, 81 km) for each yearly survey.

The pelagic fish survey would employ two methods, towed BRUVs and autonomous gliders. One glider deployment would be conducted during each of the three Project phases: pre-construction, construction, and post-construction. Glider deployment would occur in October, coinciding with one of the other vessel-based surveys, and span 3 to 4 weeks. The second survey method in the pelagic fish survey would occur during all survey vessels of opportunity (e.g., trawl survey vessel, clam survey vessel, glider deployment vessel, structure-associated habitat survey vessel) while underway. This survey would not result in additional vessel traffic.

1.3.4.3.4 Acoustic Telemetry Monitoring Survey

The acoustic telemetry survey would cover the Project Lease Area and adjacent inshore areas. Summer flounder, black sea bass, smooth dogfish, adult female horseshoe crab, and clearnose skate would be tagged. Tagging efforts would not increase vessel transits as they would occur aboard the trawl, trap, or hook and line sampling vessels. The sole increase to vessel traffic for this survey component would be the towing of the omnidirectional hydrophone during the four trips per year by the 25-foot (7.6-meter) Research Vessel (R/V) Resilience. Transits for the R/V Resilience are unclear, as it can be driven on a trailer to a nearby boat ramp. This BA assumes that a nearby boat ramp from Ocean City or Atlantic City would be chosen, resulting in one round trip of approximately 48 to 53 miles (42 to 46 nm, 78 to 85 km) transit per survey event.

1.3.4.4. Passive Acoustic Monitoring

The Applicant has stated that passive acoustic monitoring (PAM) may be implemented for the Project during construction activities to mitigate potential effects to marine mammals as well as to monitor the long-term impact of the Project on marine mammals. As outlined in Table 1-11, the Applicant is proposing to use PAM during impact pile driving, UXO detonations, and HRG surveys to limit underwater noise effects and during vessel transits to limit potential risk of strikes. Specifics regarding the type of PAM system to be used is outlined in Table 1-11 for each potential Project activity. In addition, BOEM is requiring the Applicant submit a PAM plan that describes all proposed equipment, deployment locations, detection review methodology and other procedures, and protocols related to the use of PAM for mitigation and long-term monitoring to support the Project (Table 1-12).

1.3.5 Proposed Mitigation, Monitoring, and Reporting Measures

This section outlines the mitigation, monitoring, and reporting conditions that are intended to minimize or avoid potential impacts to ESA-listed species. Mitigation measures committed to by Ocean Wind in the COP are considered a part of the Proposed Action and are binding. For marine mammals, such conditions may also be contained in the LOA from NMFS, which Ørsted will apply for under the MMPA.

Conditions would also be required under the ESA consultation process. Notably, the temporal scope of ESA consultation is broader than the LOA and covers the life of the Project, whereas the LOA regulations are valid for a duration of 5 years for construction and the initial years of O&M of the Project. Therefore, the scope of some measures such as vessel strike avoidance conditions and reporting requirements may apply beyond the scope of the LOA. Mitigation measures to which the Applicant commits as part of the MMPA process will be included as conditions of the final LOA and will be required. A requirement to follow final LOA conditions that apply to ESA-listed whales will also be included as a condition in the final record of decision.

A full description of APMs under the Proposed Action is provided in Table 1-11. During the development of the draft BA, and in coordination with cooperating agencies, BOEM considered additional mitigation measures that could further avoid, minimize, or mitigate impacts on the physical, biological, socioeconomic, and cultural resources assessed in this document. These potential additional mitigation measures are described in Table 1-12. Some or all of these BOEM proposed mitigation measures may be required as a result of consultation completed under Section 7 of the ESA, or through the Magnuson Stevens Act. Mitigation imposed through consultations will be included in the Final BA. The additional mitigation measures presented in Table 1-12 may not all be within BOEM's statutory and regulatory authority to require; however, other jurisdictional governmental agencies may potentially require them. BOEM may choose to incorporate one or more additional measures in the record of decision and adopt those measures as conditions of COP approval. As previously discussed, all Ocean Wind-committed measures are part of the Proposed Action (Table 1-11).

Table 1-11 Mitigation Monitoring, and Reporting Measures – Committed to by the Applicant

No	Measure	Description	Project Phase	Expected Effects
1	PSO/ Passive acoustic monitoring (PAM) training and requirements	• PSO and PAM operators will have completed NMFS-approved PSO training, and have team leads with experience in the northwestern Atlantic Ocean on similar projects; remaining PSOs and PAM operators will have previous experience on similar projects and the ability to work with the relevant software; PSOs and PAM operators will complete a Permits and Environmental Compliance (PECP) training and a two-day training and refresher session with the PSO provider and the Project compliance representatives before the anticipated start of Project activities.	Construction	Training of PSOs and PAM operators would minimize potential for adverse effects to ESA-listed species from vessel interactions or pile driving by increasing effectiveness of mitigation and monitoring measures.
2	General PSO Measures	• PSOs must be provided by a third-party provider. • No individual PSO will work more than 4 consecutive hours without a 2-hour break, or longer than 12 hours during a 24-hour period. • Each PSO will be provided one 8-hour break per 24-hour period to sleep. • Observations will be conducted from the best available vantage point(s) on the vessels (stable, elevated platform from which PSOs have an unobstructed 360-degree view of the water). • PSOs will systematically scan with the naked eye and a 7 x 50 reticle binocular, supplemented with night-vision equipment when needed. • When monitoring at night or in low visibility conditions, PSOs will monitor for marine mammals and other protected species using night-vision goggles with thermal clip-ons, a hand-held spotlight, and/or a mounted thermal camera system. • Activities with larger monitoring zones will use 25 x 150 mm “big eye” binoculars. • Vessel personnel will be instructed to report any sightings to the PSO team as soon as they are able, and it is safe to do so. • Members of the monitoring team will consult with NMFS’ North Atlantic right whale reporting system for the presence of North Atlantic right whales in the Project area. • If a NARW is involved in any of the above-mentioned incidents, then the vessel captain or PSO onboard should also notify the Right Whale Sighting Advisory System (RWSAS) hotline immediately and no later than within 24 hours.	Construction, O&M, decommissioning	These measures ensure that PSOs can effectively monitor for marine wildlife and that the appropriate agencies are contacted in the event of a NARW sighting. Collectively these measures minimize the potential for adverse effects to ESA-listed species.
3	Vessel Strike Avoidance Policy – General Measures	• The Project will implement a vessel strike avoidance policy for all vessels under contract to Ørsted to reduce the risk of vessel strikes, and the likelihood of death and/or serious injury to marine mammals, sea turtles, or ESA-listed fish that may result from collisions with vessels. • 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, in 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. • 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 below). • If an animal or group of animals is sighted in the vessel’s path or in 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) has moved beyond the associated separation distance (except for voluntary bow riding dolphin species). • All vessels will comply with NMFS regulations and speed restrictions and state regulations as applicable for NARW (see vessel speed restriction Standard Plan and Adaptive Plan outlines below). • All vessels will comply with the approved adaptive speed plan which will include additional measures including travel within established NARW Slow zones • Ocean Wind will submit a final NARW Vessel Strike Avoidance Plan at least 90 days prior to commencement of vessel use that details the Adaptive Plan and specific monitoring equipment to be used. The plan will, at minimum, describe how PAM, in combination with visual observations, will be conducted to ensure the transit corridor is clear of NARWs. The plan will also provide details on the vessel-based observer protocols on transiting vessels.	Construction, O&M, decommissioning	Training of crew and personnel would minimize the potential for adverse effects to ESA-listed species by increasing the effectiveness of mitigation and monitoring measures through educational and training materials and avoiding vessel interactions with ESA-listed species.
4	Vessel separation distances	Vessels will maintain, to the extent practicable, separation distances of: >500 m (546 yards) distance from any sighted North Atlantic right whale or unidentified large marine mammals; >100 m (109 yards) from all other whales; >50 m (54 yards) for dolphins, porpoises, seals, and sea turtles. Specific requirements that will be implemented should an animal enter the vessel separation distance are outlined below in, Measures #5 and 6.	Construction, O&M, decommissioning	This mitigation and monitoring measure would minimize the potential for adverse effects on marine mammals and sea turtles resulting from vessel interactions.

No	Measure	Description	Project Phase	Expected Effects
5	Vessel speed restrictions - Standard Plan	• All vessels will comply with NMFS regulations and speed restrictions and state regulations as applicable for NARW. • All vessels 65 feet (20 meters) or longer subject to the jurisdiction of the U.S. will comply with a 10-knot speed restriction when entering or departing a port or place subject to U.S. jurisdiction, and in any SMA during NARW migratory and calving periods from November 1 to April 30 (Mid-Atlantic SMAs specific to the Project area: ports of New York/New Jersey and the entrance to the Delaware Bay in the vicinity of the Project area); also, in the following feeding areas as follows: from January 1 to May 15 in Cape Cod Bay; from March 1 to April 30 off Race Point; and from April 1 to July 31 in the Great South Channel. • **Between November 1st and April 30th:** Vessels of all sizes will operate port to port (from ports in NJ, NY, MD, DE, and VA) at 10 knots or less. Vessels transiting from other ports outside those described will operate at 10 knots or less when within any active SMA or within the Offshore Wind Area, including the lease area and export cable route. • **Year Round:** Vessels of all sizes will operate at 10 knots or less in any DMAs. • **Between May 1st and October 31st:** All underway vessels (transiting or surveying) operating at greater than 10 knots will have a dedicated visual observer (or NMFS approved automated visual detection system) on duty at all times to monitor for marine mammals within a 180° direction of the forward path of the vessel (90° port to 90° starboard). Visual observers must be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, fog, etc.). The dedicated visual observer must receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. Visual observers may be third-party observers (i.e., NMFS-approved PSOs) or crew members.	Construction, O&M, decommissioning	This mitigation and monitoring measure would minimize the potential for ship strikes and impacts to marine mammals. Communication between Project vessels would further reduce potentially adverse effects by alerting vessels to the presence of marine mammals in the area.
6	Vessel speed restrictions – Adaptive Plan	• The Standard Plan outlined above will be adhered to except in cases where crew safety is at risk, and/or labor restrictions, vessel availability, costs to the Project, or other unforeseen circumstance make these measures impracticable. To address these situations, an Adaptive Plan will be developed in consultation with NMFS to allow modification of speed restrictions for vessels. Should Ocean Wind choose not to implement this Adaptive Plan, or a component of the Adaptive Plan is offline (e.g., equipment technical issues), Ocean Wind will default to the Standard Plan (described above). • The Adaptive Plan will not apply to vessel subject to speed reductions in SMAs as designated by NOAA's Vessel Strike Reduction Rule. • **Year Round**: A semi-permanent acoustic network comprising near real-time bottom mounted and/or mobile acoustic monitoring platforms will be installed such that confirmed NARW detections are regularly transmitted to a central information portal and disseminated through the situational awareness network. – The transit corridor and Offshore Wind Area will be divided into detection action zones. – Localized detections of NARWs 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. – The detection action zones size will be defined based on efficacy of PAM equipment deployed and subject to NMFS approval as part of the NARW Vessel Strike Avoidance Plan. • **Year Round**: All underway vessels (transiting or surveying) operating at greater than 10 knots will have a dedicated visual observer (or NMFS approved automated visual detection system) on duty at all times to monitor for marine mammals within a 180° direction of the forward path of the vessel (90° port to 90° starboard). Visual observers must be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, fog, etc.). The dedicated visual observer must receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. Visual observers may be third-party observers (i.e., NMFS-approved PSOs) or crew members. • **Year-round**: any DMA is established that overlaps with an area where a Project vessel would operate, that vessel, regardless of size when entering the DMA, may transit that area at a speed of >10 knots. Any active action zones within the DMA may trigger a slow down as described above. • If PAM and/or automated visual systems are offline, the Standard Plan measures will apply for the respective zone (where PAM is offline) or vessel (if automated visual systems are offline).	Construction, O&M, decommissioning	This mitigation and monitoring measure would minimize the potential for ship strikes and impacts to marine mammals during times when the standard plan cannot be followed. Communication between Project vessels would further reduce potentially adverse effects by alerting vessels to the presence of marine mammals in the area.
7	Situational Awareness System/Common Operating Picture	• Ocean Wind 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. • Ocean Wind's Marine Coordination Center will serve to coordinate and maintain a Common Operating Picture. • Systems within the Marine Coordination Center, along with field personnel, will: – monitor the NMFS North Atlantic right whale reporting systems daily; – monitor the U.S. Coast Guard VHF Channel 16 throughout the day to receive notifications of any sighting; – and monitor any existing real-time acoustic networks.	Construction, O&M, decommissioning	This monitoring and mitigation measure ensures that marine mammal detections in the area are known about as early as possible which could lead to mitigation measures if necessary.

No	Measure	Description	Project Phase	Expected Effects
8	PSO/PAM data recording	• All data will be recorded using industry-standard software. • Data recorded will include information related to ongoing operations, observation methods and effort, visibility conditions, marine mammal detections, and any mitigation actions requested and enacted. • See below for additional details on reporting requirements.	Construction, O&M	This mitigation measure would be used to evaluate impacts and potentially lead to additional mitigation measures if required.
9	Long-term Monitoring – Marine Mammals	• Pre-construction marine mammal surveys will provide a baseline set of data for comparison against the monitoring efforts during construction. • Post-construction marine mammal surveys will provide for an assessment of the potential long-term impacts of the Project. • Survey will involve a combination of visual and acoustic monitoring techniques	Pre-Construction, Construction, O&M, Decommissioning	These surveys can be used to assess the potential long-term impacts that the Project may have on marine mammal populations in the Offshore Wind Area.
10	Operational Monitoring – Marine Mammals	Visual monitoring and PAM for marine mammals will occur during vessel transits to and from the Project area as described above under vessel speed restrictions (standard and adaptive plans)	Construction, O&M, decommissioning	This mitigation and monitoring measure would minimize the potential for adverse effects on marine mammals and sea turtles resulting from vessel interactions.
11	Long-term Monitoring - Turtles	Visual monitoring will be employed to assess the potential impacts of the Project on sea turtles in the Project area. Pre-construction surveys will provide a baseline set of data for comparison against the monitoring efforts during construction. Using the same monitoring methodologies during post-construction, surveys will provide for an assessment of the potential long-term impacts of the Project. Several different methodologies will be employed to assess Project-related impacts, including vessel-based visual surveys.	Pre-Construction, Construction, O&M, Decommissioning	These surveys can be used to assess the potential long-term impacts that the Project may have on turtle populations in the Offshore Wind Area.
Sound Field Verification (SFV) Plan				
12	SFV 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 meters above the seafloor. Deployment will be made using a heavy weight as anchor - to prevent equipment drifting (typically total ballast weight exceeding 100 kg) • Deployment and retrieval 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. • 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.	Construction	This mitigation measure ensures that noise level data collected in the SFV is consistently collected at the highest possible standard using up to date methodology. In turn this allows for implemented mitigation to be optimally effective.
13	Level A harassment and level B harassment distance verification for impact pile driving	• Ocean Wind will conduct SFV under the following circumstances: – Impact driving of the first three monopiles installed over the duration of the LOA; – If Ocean Wind obtains technical information that indicates a subsequent monopile is likely to produce larger sound fields – At least three monopiles of the same size if a reduction to the clearance and/or shutdown zones is requested. • A SFV Plan will be submitted to NMFS for review and approval at least 90 days prior to planned start of pile driving. This plan will describe how Ocean Wind will ensure that the first three monopile installation sites selected for SFV are representative of the rest of the monopile installation sites and, in the case that they are not, how additional sites will be selected for SFV. • Ocean Wind will conduct a SFV to empirically determine the distances to the isopleths corresponding to Level A harassment and Level B harassment thresholds, including at the locations corresponding to the modeled distances to the Level A harassment and Level B harassment thresholds, or as agreed to in the SFV Plan. As a secondary method, Ocean Wind may also estimate distances to Level A harassment and Level B harassment thresholds by extrapolating from in situ measurements at multiple distances from the monopile, including at least one measurement location at 750 meters from the pile. • For verification of the distance to the Level B harassment threshold, Ocean Wind will report the measured or extrapolated distances where the received levels L_{rms} decay to 160 dB, as well as integration time for such L_{rms}.	Construction	These measures can be used to evaluate the potential for level A and B harassment levels to be achieved during impact pile driving as accurately as possible and to highlight potential for changes to shutdown zones if necessary
14	Modification of shutdown and monitoring zones	• For a modification request to be considered by NMFS, Ocean Wind must have conducted SFV on at least 3 piles to verify that zone sizes are consistently smaller than predicted by modeling. If a subsequent piling location is selected that was not represented by previous locations (e.g., substrate composition, water depth), SFV will be conducted. • Ocean Wind may request a modification to the size of shutdown and monitoring zones based on the results of pile measurements. The zones will be determined as follows:	Construction	These mitigation measures allow for the shutdown zones to modified to better represent actual risks to marine wildlife from noise generating activities once sufficient evidence is

No	Measure	Description	Project Phase	Expected Effects
		– The large whale pre-start clearance zone will be calculated as the radius of the maximum Level A exposure range of any mysticete. – The right whale pre-start clearance zone will be equal to the marine mammal Level B zone. – The large whale, including right whale, shutdown zone will be calculated as the radius of the maximum Level A exposure range of any mysticete. – The harbor porpoise and seal pre-start clearance zone and shutdown zone will be determined as the extent of the level A exposure range. – For all mid-frequency cetaceans other than sperm whales, no pre-clearance or shutdown zones will be implemented because the physical placement of the noise mitigation system (NMS) will preclude take (i.e., the Level A zone is smaller than the distance of the NMS from the pile)		present to permit such a change.
Impact Pile Driving				
15	Impact pile-driving time-of-year restriction	No pile installation will occur from 01 January to 30 April to avoid the times of year when NARW are present in higher densities.	Construction	Time-of-year restrictions for impact pile-driving activities would minimize and avoid potential adverse effects to ESA-listed species, such as the NARW, that are more likely to occur in the area during that time period.
16	Noise mitigation systems (NMS) during impact pile driving	The Project will use a dual NMS system for all impact piling events. The NMS will be a combination of two devices (e.g., bubble curtain, hydro-damper) to reduce noise propagation during monopile foundation pile driving. The Project is committed to achieving ranges associated with 10 dB of noise attenuation.	Construction	The reduction in SPLs would reduce the area of underwater noise effects to ESA-listed whales, sea turtles, Atlantic sturgeon, and the prey they feed upon during impact pile driving.
17	PAM for impact pile driving	• Six to eight visual PAM operators (PAM operators may be located on shore) on the pile driving vessel and four to eight visual PAM operators on any secondary marine mammal monitoring vessel. • In some cases where vessels work under 24-hour operations[2], 4-hour PAM operator rotations may be scheduled • 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. • 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. • There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods, piling, and post-piling monitoring periods • Passive acoustic monitoring will include, and extend beyond the largest shutdown zone for low and mid-frequency cetaceans • The NARW pre-clearance zone will be monitored visually out to the extent of the low-frequency cetacean clearance/shutdown zone and acoustically out to 3,800 meters in winter and 3,500 meters in summer (see Table 1-11C).	Construction	This monitoring measure would not reduce the expected adverse effects on listed species, but the data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures for impact pile driving, if required.
18	Visual monitoring for impact pile driving	• Six to eight visual PSOs on the pile driving vessel and four to eight visual PSOs on any secondary marine mammal monitoring vessel. • Two visual PSOs will hold watch on each construction and secondary vessel during pre-start clearance, throughout pile driving, and 30 minutes after piling is completed. • There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods, piling, and post-piling monitoring periods • Passive acoustic monitoring will include, and extend beyond the largest shutdown zone for low and mid-frequency cetaceans • The NARW pre-clearance zone will be monitored visually out to the extent of the low-frequency cetacean clearance/shutdown zone and acoustically out to 3,800 meters in winter and 3,500 meters in summer (see Table 1-11C).	Construction	This monitoring measure would not minimize the potential for adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for marine mammals, sea turtles, and ESA-listed fish from impact pile driving.
19	Daytime visual monitoring for impact pile driving (Daytime visual monitoring is defined by the period between nautical twilight rise and set for the region)	• There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods, piling, and post-piling monitoring periods • Passive acoustic monitoring will include, and extend beyond the largest shutdown zone for low and mid-frequency cetaceans • The NARW pre-clearance zone will be monitored visually out to the extent of the low-frequency cetacean clearance/shutdown zone and acoustically out to 3,800 meters in winter and 3,500 meters in summer (see Table 1-11C). PSOs will monitor the shutdown zone with the naked eye and reticle binoculars while one PSO periodically scans outside the shutdown zone using the mounted big eye binoculars. • The secondary vessel will be positioned and circling at the outer limit of the low-frequency and mid-frequency cetacean shutdown zones (Table 1-11B).	Construction	This monitoring measure would not minimize the potential for adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for marine mammals, sea turtles, and ESA-listed fish from impact pile driving.

[2] 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.

No	Measure	Description	Project Phase	Expected Effects
		• Monitoring equipment planned for use during standard daytime and low visibility and nighttime piling is presented in Table 1-11A.		

Table 1-11A. Monitoring equipment planned for use during standard daytime and low visibility and nighttime piling (adapted from PSMMP dated April 2022).

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

Source: HDR, Inc. 2022a
PAM = passive acoustic monitoring; NVD = night vision devices; IR = infrared; PSO = protected species observer; VHF = very high frequency; mm = millimeter
[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.

No	Measure	Description	Project Phase	Expected Effects
20	Daytime periods of reduced visibility for impact pile driving	• If the monitoring zone is obscured, the two PSOs on watch will continue to monitor the shutdown zone using thermal camera systems, handheld night-vision devices (NVD), and mounted infrared (IR) camera (as able). • All PSOs on duty will be in contact with the on-duty PAM operator who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area.	Construction	Visibility and weather restrictions would ensure that shutdown zones are effectively monitored to minimize and avoid potential adverse effects to ESA-listed species during impact pile driving.
21	Nighttime visibility for construction and secondary vessels	• Pile driving during nighttime hours could potentially occur when a pile installation is started during daylight and, due to unforeseen circumstances, would need to be finished after dark. New piles could be initiated after dark to meet schedule requirements. • Visual PSOs will rotate in pairs: one observing with a handheld NVD and one monitoring using thermal camera systems, handheld NVD and the IR thermal imaging camera system (as able) • 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 Shutdown zones and waters immediately adjacent to the vessel. • Deck lights will be extinguished or dimmed during night observations when using night-vision devices; however, if the deck lights must remain on for safety reasons, the PSO will attempt to use the NVD in areas away from potential interference by these lights. If a PSO is unable to monitor the visual clearance or shutdown zones with available NVDs piling will not commence or will be halted (as safe to do so).	Construction	Time-of-day observing requirements would ensure that shutdown zones are effectively monitored to minimize and avoid potential adverse effects to ESA-listed species.
22	Acoustic monitoring during impact pile driving	• PAM should begin at least 30-minutes prior to the start of piling. • One PAM operator on duty during both daytime and nighttime/low visibility monitoring. • Since visual observations within the applicable Shutdown zones can become impaired at night or during daylight hours due to fog, rain, or high sea states, visual monitoring with thermal and NVDs will be supplemented by PAM during these periods • PAM operator will monitor during all pre-start clearance periods, piling, and post-piling monitoring periods (daylight, reduced visibility, and	Construction	The use of PAM operators better ensures that shutdown zones are free of vocalizing marine mammals before impact pile-driving activities commence.

<table>
<tr><th>No</th><th>Measure</th><th>Description</th><th>Project Phase</th><th>Expected Effects</th></tr>
<tr><td></td><td></td><td>nighttime monitoring).
• Real-time PAM systems require at least one PAM operator 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.
• PSOs will acoustically monitor zones outlined in Table 1-11C for all marine mammals, as well as the NARW specific clearance zones.
• 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 will 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.
• 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., Mysticetus or similar system) who will be responsible for requesting the designated crewmember to implement the necessary mitigation procedures.
• Acoustic monitoring during nighttime and low visibility conditions during the day will complement visual monitoring (e.g., PSOs and thermal cameras) and will cover an area of at least the PAM Clearance Zone presented in Table 1-11C around each foundation.</td><td></td><td></td></tr>
<tr><td>23</td><td>Shutdown zones for impact pile driving</td><td>• Shutdown zones and pre-clearance zones for Project impact pile driving activities are presented in Tables 1-11B and 1-11C for winter and summer seasons separately as sound speed profiles are faster during winter conditions and therefore have larger corresponding shutdown zones. The NARW pre-start clearance zones presented in Table 1-11C are equal to the Level B zone to avoid any unnecessary takes related to behavioral disturbance.

Table 1-11B. Mitigation and Monitoring Zones[1,2,3,4] during Impact Pile Driving for Summer and Winter (adapted from PSMMP dated April 2022)
<table>
<tr><th rowspan="2">Species</th><th colspan="2">Summer (May through November)</th><th colspan="2">Winter (December only)</th></tr>
<tr><th>Pre-start Clearance Zone (m)[5]</th><th>Shutdown Zone (m)[6]</th><th>Pre-start Clearance Zone (m)[5]</th><th>Shutdown Zone (m)[6]</th></tr>
<tr><td>Low-frequency cetaceans (see Table 1-11C below for NARW)</td><td>1,650</td><td>1,650</td><td>2,490</td><td>2,490</td></tr>
<tr><td>Mid-frequency cetaceans (sperm whale only)</td><td>1,650</td><td>1,650</td><td>2,490</td><td>2,490</td></tr>
<tr><td>Sea Turtles</td><td>500</td><td>500</td><td>500</td><td>500</td></tr>
</table>
Source: HDR, Inc. 2022b
PSMMP = Protected Species Mitigation and Monitoring Plan; m = meters; NARW = North Atlantic right whale; dB = decibels
[1] Zones are based upon the following modeling assumptions:
• 8/11-m (tapered) monopile with 10 dB broadband sound attenuation.
• Either one or two monopiles driven per day, and either two or three pin piles driven per day. When modeled injury (Level A) threshold distances differed among these scenarios, the largest for each species group was chosen for conservatism.
[2] Zone monitoring will be achieved through a combined effort of passive acoustic monitoring and visual observation (but not to monitor vessel separation distance).
[3] Zones are derived from modeling that considered animal movement and aversion parameters (see more details in Section 3.2.6.2)
[4] Though zones for high-frequency cetaceans and seals were calculated, since these groups contain only non-ESA-listed species, they have been excluded from this table.
[5] The pre-start clearance zones for large whales are based upon the maximum Level A zone for each group. Turtle pre-clearance zones for impact pile driving were based on the JASCO Animal Simulation Model Including Noise Exposure (JASMINE) open-source marine mammal movement and behavior model (3MB; Houser 2006).
[6] The shutdown zones for large whales (including NARW) are based upon the maximum Level A zone for each group. 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. Turtle shutdown zones for impact pile driving were based on the same JASMINE open-source marine mammal movement and behavior model as pre-clearance zones (3MB; Houser 2006).</td><td>Construction</td><td>The establishment of shutdown zones would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from impact pile driving.</td></tr>
</table>

<table>
<tr><th>No</th><th>Measure</th><th>Description</th><th>Project Phase</th><th>Expected Effects</th></tr>
<tr><td></td><td></td><td>
Table 1-11C. NARW Clearance and Real-time PAM Monitoring Zones[1] during Impact Piling in Summer and Winter (adapted from PSMMP dated April 2022)
<table>
<tr><th>Season</th><th>Minimum Visibility Zone[2]</th><th>PAM Clearance Zone (m)[3]</th><th>Visual Clearance Delay or Shutdown Zone (m)</th><th>PAM Clearance Delay or Shutdown Zone (m)</th></tr>
<tr><td>Summer</td><td>1,650</td><td>3,500</td><td>Any Distance[4]</td><td>1,650</td></tr>
<tr><td>Winter</td><td>2,490</td><td>3,800</td><td>Any Distance</td><td>2,490</td></tr>
</table>
Source: HDR, Inc. 2022b
NARW = North Atlantic right whale; PAM = passive acoustic monitoring; PSMMP = Protected Species Mitigation and Monitoring Plan; m = meters
[1] Ocean Wind may request modification to zones based on results of sound field verification
[2] The minimum visibility zones for NARWs are based upon the maximum Level A zones for the whale group.
[3] The PAM pre-start clearance zone was set equal to the Level B zone to avoid any unnecessary take.
[4.] If a NARW is visually observed at any distance during the pre-clearance period prior to piling start, piling will be delayed. If a NARW is visually observed at any distance during piling, then piling will be shut down as described. In other words, if a NARW enters an observer's field of view at any distance, construction delay and/or shutdown will be implemented.
</td><td></td><td></td></tr>
<tr><td>24</td><td>Pre-start clearance for impact pile driving</td><td>
• Ocean Wind has proposed that piling may be initiated at any time within a 24-hour period
• Prior to the beginning of each pile driving event, PSOs and PAM operators will monitor for marine mammals and sea turtles for a minimum of 60 minutes and continue at all times during pile driving.
• All shutdown zones will be confirmed to be free of marine mammals and sea turtles prior to initiating ramp-up and the low frequency cetacean shutdown zone will be fully visible, and the NARW acoustic zone monitored for at least 30 minutes prior to commencing ramp-up.
• If a marine mammal or sea turtle is observed entering or within the relevant shutdown zones prior to the initiation of pile driving activity, pile driving activity will be delayed and will not begin until either the marine mammal(s) or sea turtle(s) has voluntarily left the respective shutdown zones and been visually or acoustically confirmed beyond that shutdown zone, or when the additional time period has elapsed with no further sighting or acoustic detection (i.e., 15 minutes for dolphins, porpoises and seals and 30 minutes for whales, 30 minutes for sea turtles).
• A PSO will observe a behavioral monitoring zone of 1,200 meters for all species of sea turtle; however the shutdown zone remains 500 meters.
</td><td>Construction</td><td>The establishment of a shutdown zone may decrease the potential for impacts to ESA-listed species during impact pile driving.</td></tr>
<tr><td>25</td><td>Ramp-up (soft start) for impact pile driving</td><td>
• Each monopile installation will begin with a minimum of 20-minute soft-start procedure.
• Soft-start procedure will not begin until the shutdown zone has been cleared by the visual PSO and PAM operators.
• If a marine mammal is detected within or about to enter the applicable shutdown zone, prior to or during the soft-start procedure, pile driving will be delayed until the animal has been observed exiting the shutdown zone or until an additional time period has elapsed with no further sighting (i.e., and 30 minutes for whales, and 30 minutes for sea turtles).
</td><td>Construction</td><td>The establishment of soft-start protocols would minimize the potential for adverse effects and warn animals of the pending impact pile-driving activity in the area and allow them to leave before full hammer power is reached.</td></tr>
<tr><td>26</td><td>Shutdowns for impact pile driving</td><td>
• If a marine mammal or sea turtle is detected entering or within the respective shutdown zones after pile driving has commenced, an immediate shutdown of pile driving will be implemented unless determined shutdown is not feasible due to an imminent risk of injury or loss of life to an individual (as described in the PSMMP dated April 2022).
• If shutdown is called for but it is determined that shutdown is not feasible due to risk of injury or loss of life, there will be a reduction of hammer energy.
• Following shutdown, pile driving will only be initiated once all shutdown zones are confirmed by PSOs to be clear of marine mammals and sea turtles for the minimum species-specific time periods.
• The shutdown zone will be continually monitored by PSOs and PAM operators during any pauses in pile driving.
• If a marine mammal or sea turtle is sighted within the shutdown zones during a pause in piling, piling will be delayed until the animal(s) has moved outside the SZ and no marine mammals are sighted for a period of 30 minutes or sea turtles for 30 minutes.
</td><td>Construction</td><td>The establishment of shutdown and power-down protocols would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from impact pile driving.</td></tr>
<tr><td>27</td><td>Post-impact piling monitoring</td><td>PSOs will continue to survey the shutdown zones throughout the duration of pile installation and for a minimum of 30 minutes after piling has been completed.</td><td>Construction</td><td>This monitoring measure would not minimize adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for impact pile driving.</td></tr>
</table>

<table>
<tr><th>No</th><th>Measure</th><th>Description</th><th>Project Phase</th><th>Expected Effects</th></tr>
<tr><td>28</td><td>Sound measurements for impact pile driving</td><td>• Received sound measurements will be collected during driving of the first three monopiles installed over the course of the Project using an NMS.
• The goals of the of field verification measurements using an NMS include verification of modeled ranges; and providing sound measurements of impact pile driving using International Organization for Standardization (ISO)-standard methodology to build data that are comparable among projects.
• Based on the sound field measurement results the Project may request a modification of the clearance and/or Shutdown zones</td><td>Construction</td><td>This monitoring measure would not reduce effects but would ensure that the deployed noise reduction technologies and shutdown zones are effective during impact pile driving.</td></tr>
<tr><td>29</td><td>Impact Pile Driving Reporting</td><td>• All data recording will be conducted using Mysticetus or similar 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.
• DMAs will be reported across all Project vessels.
• See additional details regarding reporting is provided below under "Reporting"</td><td>Construction</td><td>This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.</td></tr>
<tr><td colspan="5">Vibratory Pile Driving</td></tr>
<tr><td>30</td><td>Visual monitoring for vibratory pile driving</td><td>• All observations will take place from one of the construction vessels stationed at or near the vibratory piling location.
• Two PSOs on duty on the construction vessel.
• PSOs will continue to survey the shutdown zone using visual protocols throughout the installation of each cofferdam sheet pile and for a minimum of 30 minutes after piling has been completed.
• Monitoring Equipment shall include:
– Two sets of 7 x 50 reticle binoculars
– Two hand-held or wearable NVDs
– Two IR spotlights
– One data collection software system
– Two PSO-dedicated VHF radios
– One digital single-lens reflex camera equipped with 300-mm lens</td><td>Construction</td><td>This monitoring measure would not minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from, but would ensure the effectiveness of the required mitigation and monitoring measures for, vibratory pile driving.</td></tr>
<tr><td>31</td><td>Daytime visual monitoring for vibratory pile driving</td><td>• Two PSOs will concurrently maintain watch from the construction or support vessel during the pre-start clearance period, throughout vibratory pile driving, and 30 minutes after piling is completed.
• Two PSOs will conduct observations concurrently.
• One observer will monitor the shutdown zones with the naked eye and reticle binoculars; one PSO will monitor in the same way but will periodically scan outside the shutdown zones.</td><td>Construction</td><td>This monitoring measure would not minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from, but would ensure the effectiveness of the required mitigation and monitoring measures for, vibratory pile driving.</td></tr>
<tr><td>32</td><td>Daytime visual monitoring during periods of low visibility for vibratory pile driving</td><td>One PSO will monitor the shutdown zone with the mounted infrared camera while the other maintains visual watch with the naked eye/binoculars.</td><td>Construction</td><td>Visibility and weather restrictions would ensure that shutdown zones are effectively monitored to minimize and avoid potential adverse effects to ESA-listed species during vibratory pile driving.</td></tr>
<tr><td>33</td><td>Shutdown zones for vibratory pile driving</td><td>• Shutdown zones and pre-clearance zones for Project vibratory pile driving activities are presented in Table 1-11D.

Table 1-11D. Mitigation and Monitoring Zones during Project Vibratory Sheet Pile Driving (adapted from PSMMP dated April 2022)
<table>
<tr><th>Species</th><th>Pre-start Clearance Zone[1] (m)</th><th>Shutdown Zone[2] (m)</th></tr>
<tr><td>Low-Frequency Cetaceans including NARW and Sperm whales</td><td>150</td><td>100</td></tr>
<tr><td>Medium-Frequency Cetaceans</td><td>150</td><td>50</td></tr>
<tr><td>Turtles</td><td>500</td><td>500</td></tr>
</table>
Notes: Zones are based on modeling with no animal movement or aversions applied. m = meters
[1] The pre-start clearance zones for large whales, porpoise, and seals are based upon the maximum Level A zone (128.2 m) and rounded up for PSO clarity.</td><td>Construction</td><td>The establishment of shutdown zones would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from vibratory pile driving.</td></tr>
</table>

No	Measure	Description	Project Phase	Expected Effects
		[2] The shutdown zones for low-frequency cetaceans (including NARW) and high-frequency cetaceans are based upon the maximum Level A zone for each group and rounded up for PSO clarity. Shutdown zones for mid-frequency cetaceans (e.g., other dolphins and pilot whales) were set using precautionary distances. PTS zones for sea turtles were not modeled so the same shutdown zone as impact pile driving were applied.		
34	Pre-start clearance for vibratory pile driving	• PSOs will monitor the shutdown zone for 30 minutes prior to the start of vibratory pile driving. • If a marine mammal or sea turtle is observed entering or within the respective shutdown zones, piling cannot commence until the animal(s) has exited the shutdown zone or time has elapsed since the last sighting (15 minutes for dolphins (mid-frequency cetaceans) and porpoises (high-frequency cetaceans) and pinnipeds, 30 minutes for large whales (low-frequency cetaceans) and 30 minutes for sea turtles). • Throughout the duration of all pile driving activity (impact and vibratory), a PSO will observe a behavioral monitoring zone of 1,200 meters for all species of sea turtles and will initiate a shutdown protocol if a sea turtle encroaches or is observed within 500 meters.	Construction	The establishment of pre-clearance shutdown zones to ensure that shutdown zones are free of marine mammals before vibratory pile driving activities can commence, and to record any observations of marine mammals or sea turtles prior to commencement of pile-driving through 30 minutes post-pile driving, would minimize the potential for impacts to marine mammals, sea turtles, and ESA-listed fish during vibratory pile driving.
35	Shutdowns for vibratory pile driving	• If a marine mammal or sea turtle is observed entering or within the respective shutdown zones after sheet pile installation has commenced, a shutdown will be implemented as long as health and safety is not compromised. • The shutdown zone must be continually monitored by PSOs during any pauses in vibratory pile driving, activities will be delayed until the animal(s) has moved outside the shutdown zone and no marine mammals are sighted for a period of 30 minutes for whales or 15 minutes for dolphins, porpoises and pinnipeds, and sea turtles for 30 minutes.	Construction	The establishment of shutdown and power-down protocols may decrease the potential for impacts to ESA-listed species from vibratory pile driving.
36	Reporting	• All data recording will be conducted using Mysticetus or similar 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. • Dynamic Management Areas (DMA) will be reported across all Project vessels. • See additional details regarding reporting is provided below under "Reporting"	Construction	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
HRG Surveys				
37	General Visual monitoring for HRG surveys	• The following mitigation and monitoring measures for HRG surveys apply only to sound sources with operating frequencies below 180 kHz. There are no mitigation or monitoring protocols required for sources operating >180 kHz. • Shutdown, pre-start clearance, and ramp-up procedures will not be conducted during HRG survey operations using only non-impulsive sources (e.g., Ultra-Short BaseLine [USBL] and parametric SBPs) other than non-parametric SBPs (e.g., CHIRPs). Pre-clearance and ramp-up, but not shutdown, will be conducted when using non-impulsive, non-parametric SBPs. • Shutdowns will be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz. • Monitoring Equipment – Two pairs of 7x50 reticle binoculars – One mounted thermal/IR camera system during nighttime and low visibility conditions – Two hand-held or wearable NVDs – Two IR spotlights – One data collection software system – Two PSO-dedicated VHF radios – One digital single-lens reflex camera equipped with a 300-mm lens • The PSOs will be responsible for visually monitoring and identifying marine mammals approaching or entering the established zones during survey activities. • Visual monitoring of the established Shutdown zones and monitoring zone will be performed by PSO teams on each survey vessel: – Four to six PSOs on all 24-hour survey vessels. – Two to three PSOs on all 12-hour survey vessels. – 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.	Construction, O&M	This monitoring measure would not minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish but would ensure the effectiveness of the required mitigation and monitoring measures for HRG surveys.

<table>
<tr><th>No</th><th>Measure</th><th>Description</th><th>Project Phase</th><th>Expected Effects</th></tr>
<tr><td></td><td></td><td>

Table 1-11E provides the list of the personnel on watch and monitoring equipment available onboard each HRG 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 shutdown and monitoring zones around the respective sound sources.
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.
The PSOs will begin observation of the shutdown zones prior to initiation of HRG survey operations and will continue throughout the survey activity and/or while equipment operating below 180 kHz is in use.
PSOs will monitor the NMFS North Atlantic right whale reporting systems including WhaleAlert and SAS once every 4-hour shift during Project-related activities.
PSOs will monitor Mysticetus (or similar data system) and/or appropriate data systems for DMAs established within their survey area.
PSOs will also monitor the NMFS North Atlantic right whale reporting systems including Whale Alert and RWSAS once every 4-hour shift during Project-related activities within, or adjacent to, Seasonal Management Areas (SMA) and/or DMAs.

Table 1-11E. Personnel and Equipment Compliment for Monitoring Vessels during HRG Surveys.
<table>
<tr><th>Item</th><th>Number on Survey Vessel</th></tr>
<tr><td>PSOs on watch (Daytime)</td><td>1</td></tr>
<tr><td>PSOs on watch (Nighttime)</td><td>2</td></tr>
<tr><td>Reticle binoculars</td><td>2</td></tr>
<tr><td>Mounted thermal/IR camera system</td><td>1</td></tr>
<tr><td>Hand-held or wearable NVD</td><td>2</td></tr>
<tr><td>IR spotlights</td><td>2</td></tr>
<tr><td>Data collection software system</td><td>1</td></tr>
<tr><td>PSO-dedicated VHF radios</td><td>2</td></tr>
<tr><td>Digital single-lens reflex camera equipped with 300-mm lens</td><td>1</td></tr>
</table>
IR = infrared; NVD = night vision devices; PSO = protected species observer; VHF = very high frequency.
</td><td></td><td></td></tr>
<tr><td>38</td><td>Autonomous Surface Vehicle/ (ASV) Operations for HRG Surveys</td><td>

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.
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 shutdown and monitoring zones.
When in use, the ASV will be within 800 meters (2,625 ft) 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 in 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.

</td><td>Construction, O&M</td><td>This monitoring measure would not minimize the potential for adverse effects on marine mammals and sea turtles but would ensure the effectiveness of the required mitigation and monitoring measures for HRG surveys.</td></tr>
<tr><td>39</td><td>Daytime visual monitoring for HRG surveys (period between nautical twilight rise and set for the region)</td><td>

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

</td><td>Construction, O&M</td><td>This monitoring measure would not minimize the potential for adverse effects on marine mammals and sea turtles but would ensure the effectiveness of the required mitigation and monitoring measures for HRG surveys.</td></tr>
<tr><td>40</td><td>Nighttime and low visibility visual</td><td>

The lead PSO will determine if conditions warrant implementing reduced visibility protocols.

</td><td>Construction, O&M</td><td>Time-of-day, visibility, and weather restrictions would minimize the</td></tr>
</table>

No	Measure	Description	Project Phase	Expected Effects
	monitoring for HRG surveys	• Two PSOs on watch during all pre-clearance periods and operations. • Each PSO will use the most appropriate available technology (i.e., IR camera and NVD) and viewing locations to monitor the shutdown zones and maintain vessel separation distances.		potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from HRG surveys.
41	Shutdown zones for HRG surveys	• North Atlantic right whale: 500 meters (547 yards). • Fin whale, sei whale, blue whale, sperm whale, and all species of sea turtles: 100 meters (110 yards).	Construction, O&M	The use of PSO visual monitoring to ensure that shutdown zones are free of marine mammals before HRG survey activities can commence, and to record any observations of marine mammals prior to commencement of survey through 30 minutes post-survey would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from HRG surveys.
42	Pre-start clearance for HRG surveys	• Pre-start clearance survey will only be conducted for non-impulsive, non-parametric SBPs and impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz • Prior to the initiation of equipment ramp-up, PSOs and PAM operators will conduct a 30-minute watch of the shutdown zones to monitor for marine mammals. • The shutdown zones must be visible using the naked eye or appropriate visual technology during the entire clearance period for operations to start; if the shutdown zones are not visible, source operations <180 kHz will not commence. • If a marine mammal is observed within its respective shutdown zone during the pre-clearance period, ramp-up will not begin until the animal(s) has been observed exiting its respective shutdown zone or until an additional time period has elapsed with no further sighting (i.e., 30 minutes for large whales, and 30 minutes for sea turtles).	Construction, O&M	The establishment of a shutdown zone may decrease the potential for impacts to ESA-listed species during HRG surveys.
43	Ramp-up (soft start) for HRG surveys	• Ramp-ups will only be conducted for non-impulsive, non-parametric SBPs and impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz. • 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. • Ramp-up will not be initiated during periods of inclement conditions or if the shutdown zones cannot be adequately monitored by the PSOs, using the appropriate visual technology for a 30-minute period. • Ramp-up will begin by powering up the smallest acoustic HRG equipment at its lowest practical power output appropriate for the survey followed by a gradual increase in power and addition of other acoustic sources (as able). • If a marine mammal is detected within or about to enter its respective clearance zone, ramp-up will be delayed. • Ramp-up will continue once the animal(s) has been observed exiting its respective clearance zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes, 30 minutes for all other marine mammal species, and 30 minutes for sea turtles).	Construction, O&M	The establishment of soft-start protocols during inclement weather and poor lighting conditions would minimize the potential for adverse effects and warn animals of the pending HRG survey activity in the area, allowing them to leave before full acoustic power is reached.
44	Shutdowns for HRG surveys	• Shutdowns will only be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz if a marine mammal or sea turtle is sighted at or within its respective shutdown zone. • Shutdowns will not be implemented for dolphins that voluntarily approach the survey vessel. • An immediate shutdown of the applicable HRG survey equipment (i.e., select sources operating <180 kHz) will be required if a marine mammal is sighted at or within its respective shutdown zone. • 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 shutdown zone 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). Survey vessels may power down electromechanical equipment to lowest power output that is technically feasible for these species. • If the acoustic source is shut down for reasons other than mitigation (e.g., mechanical difficulty) for less than 30 minutes, it will be reactivated without ramp-up if PSOs have maintained constant observation and no detections of any marine mammal or sea turtle have occurred within the respective shutdown zones.	Construction, O&M	The establishment of shutdown and power-down protocols may decrease the potential for impacts to ESA-listed species for HRG surveys.

No	Measure	Description	Project Phase	Expected Effects
		• If the acoustic source is shut down for a period longer than 30 minutes or PSOs were unable to maintain constant observation, then ramp-up and pre-start clearance procedures will be initiated.		
45	Shutdown zones for HRG surveys	• Shutdowns will only be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz. • Shutdown Zones: – North Atlantic right whale: 500 meters (547 yards). – Fin whale, minke whale, sei whale, humpback whale, blue whale, sperm whale, Risso's dolphin, long & short-finned pilot whales, harbor porpoise, gray seal, harbor seal, and all species of sea turtles: 100 meters (110 yards). • Delphinids (Atlantic white sided dolphin, Atlantic spotted dolphin, short-beaked common dolphin, and bottlenose dolphin [coastal and offshore stocks]): no shutdown zone.	Construction, O&M	The establishment of shutdown and power-down protocols may decrease the potential for impacts to ESA-listed species for HRG surveys.
46	Post-construction HRG survey reporting	• All data recording will be conducted using Mysticetus or similar software. • Operations, monitoring conditions, observation effort, all marine mammal detections, and any mitigation actions will be recorded. • Post-construction, Ocean Wind will provide to BOEM and NMFS a final report annually for HRG survey activities. The final report must address any comments on the draft report provided to Ocean Wind by BOEM and NMFS. The report must include a summary of survey activities, all PSO and incident reports, and an estimate of the number of listed marine mammals observed and/or taken during these survey activities. • See additional details regarding reporting is provided below under "Reporting"	Construction	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
UXOs				
47	Visual monitoring during UXO detonations (vessel based)	• Monitoring Equipment – 2 visual PSOs and 1 PAM operator will be on watch on each PSO vessel. – There will be a team of six to eight visual and acoustic PSOs on UXO monitoring vessels. – A single vessel is anticipated to adequately cover a radius of 2000 meters. See additional details regarding reporting is provided below under "Reporting" – PAM operators may be located remotely/onshore. – 2 reticle binoculars – 1 pair of mounted "big eye" binoculars – Data collection software system – PSO-dedicated VHF radios • Digital single-lens reflex camera equipped with 300-mm lens. • Visual monitoring will be conducted from the primary monitoring vessel, and an additional vessel in cases where the monitoring zone is greater than 2,000 meters. (see Table 1-11F below). • Daytime visual monitoring is defined by the period between civil twilight rise and set for the region. • During the 60 minutes pre-start clearance period and 60 minutes after the detonation event, two PSOs will always maintain watch on the primary 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. • During daytime observations, two PSOs on each vessel will monitor the clearance zones with the naked eye and reticle binoculars. One PSO will periodically scan outside the clearance zones using the mounted big eye binoculars. • PSOs will visually monitor the maximum low frequency (Large Whale) preclearance zones. This zone encompasses the maximum Level A exposure ranges for all ESA-listed marine mammal species. • The number of vessels deployed will depend on monitoring zone size and safety set back distance from detonation. Enough vessels will be deployed to cover the clearance and shutdown zones 100% and be determined by: the detonation category and associated clearance zone size, use of NMS, and minimum distance allowed to the detonation location. • There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods and post-detonation monitoring periods. • Acoustic monitoring will include, and extend beyond, the pre-start clearance zone identified in Table 1-11E. • Fish mitigation and monitoring measures during UXO detonations will include the use of an NMS and post-detonation monitoring for injured and/or dead fish. It is not possible to maintain pre-start clearance zones or conduct visual monitoring for fish prior to UXO detonations. Any fish kills involving protected species will be reported to the appropriate agencies.	Construction	This monitoring measure would not minimize the potential for adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for marine mammals and sea turtles from UXO detonations.

No	Measure	Description	Project Phase	Expected Effects
48	Visual Monitoring during UXO detonations (Aerial Alternative)	• Aerial surveys are typically limited by low cloud ceilings, aircraft availability, survey duration, and HSE considerations and therefore are not considered feasible or practical for all detonation monitoring. However, some scenarios may necessitate the use of an aerial platform. For unmitigated detonations with clearance zones greater than 5 km, deployment of sufficient vessels may not be feasible or practical. For these events, visual monitoring will be conducted from an aerial platform. • During the 60-minute pre-start clearance period and after the detonation event as flight time allows, two PSOs will be deployed on an aerial platform. • Surveys will be conducted in a grid with 1 km line spacing, encompassing the clearance zone. • PSOs will monitor the clearance zones with the naked eye and reticle binoculars. • Aerial PSOs may exceed 4-hour watch duration but will be limited by total flight duration not likely to exceed 6 hours. • PSOs will visually monitor the maximum low-frequency cetacean pre-start clearance zones (Table 1-11F). This zone encompasses the maximum Level A exposure ranges for all marine mammal species except harbor porpoise, where Level A take has been requested due to the large zone sizes associated with high-frequency cetaceans (e.g., up to 16 km for an E12 detonation). • There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods and post-detonation monitoring periods. • Acoustic monitoring, will include, and extend beyond, the low-frequency cetaceans pre-start clearance zone.	Construction	This monitoring measure would not minimize the potential for adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for marine mammals and sea turtles from UXO detonations.
49	Time of Year/Nighttime Restrictions	• No UXO detonations are planned between January and April. • No UXO will be detonated during nighttime hours.	Construction	This monitoring measure would not minimize the potential for adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for marine mammals and sea turtles from UXO detonations.
50	Passive acoustic monitoring during UXO detonations	• Acoustic monitoring will be conducted prior to any UXO detonation event in addition to visual monitoring in order to ensure that no marine mammals are present in the designated pre-clearance zones. • PAM operators will acoustically monitor a zone that encompasses a minimum of a 10-km radius around the source. • PAM will be conducted in daylight as no UXO will be detonated during nighttime hours. • One PAM operator may be stationed on the vessel or at an alternative monitoring location • 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 will 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 detonation activity via the data collection software system (i.e., Mysticetus or similar system) who will be responsible for requesting the designated crewmember to implement the necessary mitigation procedures.	Construction	The use of PAM operators better ensures that shutdown zones are free of vocalizing marine mammals before UXO detonation activities commence.
51	Pre-start clearance for UXO detonations	• A 60-minute pre-start clearance period will be implemented prior to any UXO detonation. Visual PSOs will begin surveying the monitoring zone at least 60 minutes prior to the detonation event. PAM will also begin 60 minutes prior to the detonation event • The pre-clearance zones (Table 1-11F) must be fully visible for at least 60 minutes prior to commencing detonation. • All marine mammals must be confirmed to be out of the clearance zone prior to initiating detonation. • If a marine mammal is observed entering or within the relevant clearance zones prior to the initiation of detonation activity, the detonation must be delayed. • The detonation 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 60 minutes have elapsed without redetection for whales, including the NARW.	Construction	The establishment of pre-clearance shutdown zones to ensure that shutdown zones are free of marine mammals before UXO detonation activities can commence would minimize the potential for impacts to marine mammals and sea turtles during UXO detonations.

<table>
<tr><th>No</th><th>Measure</th><th>Description</th><th>Project Phase</th><th>Expected Effects</th></tr>
<tr><td></td><td></td><td>
Table 1-11F. Mitigation and Monitoring Zones Associated with Mitigated (10 dB attenuation) UXO Detonation of Binned Charge Weights (adapted from PSMMP dated April 2022).
<table>
<tr><th rowspan="3">Species</th><th colspan="5"></th></tr>
<tr><th>E4 (2.3 kg)</th><th>E6 (9.1 kg)</th><th>E8 (45.5 kg)</th><th>E10 (227 kg)</th><th>E12 (454 kg)</th></tr>
<tr><th>Pre-Start Clearance Zone[2] (m)</th><th>Pre-Start Clearance Zone[2] (m)</th><th>Pre-Start Clearance Zone[2] (m)</th><th>Pre-Start Clearance Zone[2] (m)</th><th>Pre-Start Clearance Zone[2] (m)</th></tr>
<tr><td>Low-Frequency Cetaceans</td><td>552</td><td>982</td><td>1,730</td><td>2,970</td><td>3,780</td></tr>
<tr><td>Mid-Frequency Cetaceans</td><td>50</td><td>75</td><td>156</td><td>337</td><td>461</td></tr>
<tr><td>Turtles</td><td><50</td><td>54</td><td>159</td><td>348</td><td>472</td></tr>
</table>
Source: Hannay and Zykov 2022
Notes: 1 UXO charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). Four project sites (S1-S4) were chosen and modeled for the detonation of each charge weight bin.
Though zones for high-frequency cetaceans and phocid pinnipeds were calculated, since these groups contain only non-ESA-listed species, they have been excluded from this table.
2 Pre-start clearance zones were calculated by selecting the largest R95% distance to the permanent threshold shift (PTS) threshold found in Tables 21 through 24 of Hannay And Zykov 2022 and based on the SEL thresholds. The chosen values were the most conservative per charge weight bin across each of the four modeled sites. All values were taken from sites 1 and 2 which had the highest R95% ranges for the onset of PTS in low frequency cetaceans, mid-frequency cetaceans, and sea turtles.
UXO = unexploded ordinance; PSMMP = Protected Species Mitigation and Monitoring Plan; m = meters; kg = kilograms; TNT = trinitrotoluene; PK = peak pressure level; SEL = sound exposure level.
</td><td></td><td></td></tr>
<tr><td>52</td><td>Noise attenuation for UXO detonations</td><td>Ocean Wind will use an NMS for all detonation events and is committed to achieving the modeled ranges associated with 10 dB of noise attenuation</td><td>Construction</td><td>The reduction in SPLs would reduce the area of underwater noise effects to ESA-listed whales, sea turtles, Atlantic sturgeon, and the prey they feed upon during UXO detonations.</td></tr>
<tr><td colspan="5">Fisheries Monitoring</td></tr>
<tr><td>53</td><td>General Measures</td><td>
• Fisheries Monitoring for the Project will consist of regular surveys carried out by academic partners from Rutgers University, Monmouth University, and Delaware State University.
• Fisheries monitoring was designed in accordance with recommendations set forth in “Guidelines for Providing Information on Fisheries for Application for Renewable Energy Development on the Atlantic Outer Continental Shelf” (BOEM 2019) and consideration to the Responsible Offshore Science Alliance (ROSA) Offshore Wind Project Monitoring Framework and Guidelines.
• All vessels will comply with the vessel speed plan as outlined above for vessel speed restrictions – standard and adaptive plans
• Marine mammal watches and monitoring will occur during daylight hours prior to deployment of gear (e.g., trawls, longline gear) and will continue until gear is brought back on board.
• If marine mammals are sighted in the area within 15 minutes prior to deployment of gear and are considered to be at risk of interaction with the research gear, then the sampling station is either moved or canceled or the activity is suspended until there are no sightings of any marine mammal for 15 minutes within 1 nautical mile (1852 meters) of sampling location.
</td><td>Pre-construction, construction, O&M, decommissioning</td><td>The mitigation measure would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from monitoring trawl surveys.</td></tr>
<tr><td>54</td><td>Trawl Surveys</td><td>
• Marine mammal monitoring will be conducted by the captain and/or a member of the scientific crew before, during, and after haul back.
• Trawl operations will commence as soon as possible once the vessel arrives on station; the target tow time will be limited to 20 minutes.
• Ocean Wind will initiate marine mammal watches (visual observation) within 1 nautical mile (1852 meters) of the site 15 minutes prior to sampling.
• If a marine mammal is sighted within 1 nautical mile (1,852 meters) of the planned sampling station in the 15 minutes before gear deployment, Ocean Wind will delay setting the trawl until marine mammals have not been resighted for 15 minutes or Ocean Wind may move the vessel away from the marine mammal to a different section of the sampling area. If, after moving on, marine mammals are still visible from the vessel, Ocean Wind may decide to move again or to skip the sampling station.
• Ocean Wind will maintain visual monitoring effort during the entire period of time that trawl gear is in the water (i.e., throughout gear deployment, fishing, and retrieval). If marine mammals are sighted before the gear is fully removed from the water, (i.e., prior to haul back) the vessel will slow its speed and steer away from the sighted animal in order to minimize potential interactions. Further mitigating actions can be
</td><td>Pre-construction, construction, O&M, decommissioning</td><td>The mitigation measure would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from monitoring trawl surveys.</td></tr>
</table>

No	Measure	Description	Project Phase	Expected Effects
		taken following consultation with and guidance from the NMFS Protected Resources Division. • Ocean Wind will open the codend of the net close to the deck/sorting area to avoid damage to animals that may be caught in gear. • Gear will be emptied as close to the deck/sorting area and as quickly as possible after retrieval. • Trawl nets will be fully cleaned and repaired (if damaged) before setting again. • Ocean Wind does not anticipate and is not requesting take of marine mammals incidental to research trawl surveys but, in the case of a marine mammal interaction, the Marine Mammal Stranding Network will be contacted immediately.		
55	Structured Habitat Surveys (Chevron traps and Baited Remote Underwater Video [BRUVs])	• The chevron traps and BRUVs will be deployed on a limited soak duration (90 minutes or less), and the vessel will remain on location with the gear while it is sampling. • Buoy/end lines with a breaking strength of <1,700 pounds (lbs) will be used. All buoy line will use weak links that are chosen from the list of NMFS approved gear. This may be accomplished by using whole buoy line that has a breaking strength of 1,700 lbs; or buoy line with weak inserts that result in line having an overall breaking strength of 1,700 lbs. • All buoys will be labeled as research gear, and the scientific permit number will be written on the buoy. All markings on the buoys and buoy lines will be compliant with the regulations, and all buoy markings will comply with any specific marking instructions received by staff at NOAA Greater Atlantic Regional Fisheries Office Protected Resources Division. • Any lines that go missing will be reported to the NOAA Greater Atlantic Regional Fisheries Office Protected Resources Division as soon as possible. • The Project Team will not deploy either the chevron traps or the BRUVs if marine mammals are sighted near the proposed sampling station. Gear will not be deployed if marine mammals are observed within the area and if a marine mammal is deemed to be at risk of interaction, all gear will be immediately removed.	Pre-construction, construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
56	Acoustic Telemetry Surveys	• No specific mitigation relevant to this type of survey • Vessel mitigation measures outlined above for all Project vessels will be employed while collecting samples.	Pre-construction, construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
57	eDNA Sampling	• Will coincide with the bottom trawl survey and associated mitigation measures. No specific mitigation relevant to this type of survey. • Vessel mitigation measures outlined above for all Project vessels will be employed while collecting samples.	Pre-construction, construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
58	Rod and reel surveys	• No specific mitigation relevant to this type of survey • Vessel mitigation measures outlined above for all Project vessels will be employed while collecting samples.	Pre-construction, construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
59	Clam Survey	• No specific mitigation relevant to this type of survey • Vessel mitigation measures outlined above for all Project vessels will be employed while collecting samples.	Pre-construction, construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
60	Glider – Oceanography	• No specific mitigation relevant to this type of survey • Vessel mitigation measures outlined above for all Project vessels will be employed while retrieving equipment	Pre-construction, construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead

No	Measure	Description	Project Phase	Expected Effects
				to additional mitigation measures, if required.
61	Pelagic Fish	• Similar mitigation will be applied as described above for Structured Habitat Surveys • Vessel mitigation measures outlined above for all Project vessels will be employed while retrieving equipment and collecting samples	Pre-construction, construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
Reporting Requirements				
62	Injured protected species reporting	• Any potential, strikes, stranded, entangled, or dead/injured protected species regardless of cause, should be reported by the vessel captain or the PSO onboard to the Greater Atlantic (Northeast) Region Marine Mammal and Sea Turtle Stranding and Entanglement Hotline (866-755-NOAA [6622]) within 24 hours of a sighting, regardless of whether the injury or death is caused by a vessel. • If the injury or death was caused by a Project activities, the vessel captain or PSO on board will ensure that NMFS is notified immediately to the NMFS Office of Protected Resources and Greater Atlantic Regional Fisheries Office and no later than within 24 hours. The notification will include date and location (latitude and longitude) of the incident, name of the vessel/platform involved, and the species identification or a description of the animal, if possible. If the Project activity is responsible for the injury or death, Ocean Wind will supply a vessel to assist in any salvage effort as requested by NMFS. • If a NARW is involved in any of the above-mentioned incidents then the vessel captain or PSO onboard should also notify the Right Whale Sighting Advisory System (RWSAS) hotline immediately and no later than within 24 hours. • PSOs/PAM operators will report any observations concerning impacts on marine mammals to NMFS within 48 hours. • BOEM and NMFS will be notified within 24 hours if any evidence of a fish kill during construction activity is observed. • Any NARW sightings will be reported as soon as possible, and no later than within 24 hours, to the NMFS RWSAS hotline or via the Whale Alert Application. Any NARW sightings will be reported as soon as possible, and no later than within 24 hours, to the NMFS RWSAS hotline or via the Whale Alert Application.	Construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
63	Report of activities and observations	Ocean Wind will provide NMFS with a report within 90 calendar days following the completion of construction and HRG surveys, including a summary of the activities and an estimate of the number of marine mammals taken.	Construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
64	Report information	• Data on all marine mammal observations will be recorded and based on standards of marine mammal observer collection data by the PSOs. This information will include dates, times, and locations of survey operations; time of observation, location and weather; details of marine mammal sightings (e.g., species, numbers, behavior); and details of any observed taking (e.g., behavioral disturbances or injury). • 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 shutdown zones, monitoring effort, environmental conditions, and Project-related activity will be provided after field operations and reporting are complete. This database will undergo thorough quality checks and include all variables required by the NMFS-issued Incidental Take Authorization (ITA) and BOEM Lease OCS-A 0498 and will be required for the Final Technical Report due to BOEM and NMFS. • During construction, weekly reports briefly summarizing sightings, detections and activities will be provided to NMFS and BOEM on the Wednesday following a Sunday-Saturday period. • Final reports will follow a standardized format for PSO reporting from activities requiring marine mammal mitigation and monitoring. • An annual report summarizing the prior year's activities will be provided to NMFS and to BOEM on April 1 every calendar year summarizing the prior year's activities.	Construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
SAV/Seabed Disturbance				
65	Siting	Site cable landfall and offshore facilities to avoid known locations of sensitive benthic habitat, to the extent practicable. Avoid SAV communities, where practicable and restore any damage to these communities.	Construction, O&M, decommissioning	This mitigation measure would ensure decreased long-term impact to important ESA-listed marine mammal, sea turtle, and marine fish prey

No	Measure	Description	Project Phase	Expected Effects
				habitat in SAV communities.
66	Port construction and vessel traffic	Use existing port and onshore operations and maintenance facilities to the extent practicable and minimize impacts to seagrass by restricting vessel traffic to established traffic routes where these resources are present.	Construction, O&M, decommissioning	This mitigation measure would ensure decreased long-term impact to important ESA-listed marine mammal, sea turtle, and marine fish prey habitat in SAV communities.
67	Monitoring	Develop and implement a site-specific monitoring program to ensure environmental conditions are monitored during construction, operation, and decommissioning phases, designed to ensure environmental conditions are monitored and reasonable actions are taken to avoid and/or minimize seabed disturbance and sediment dispersion, consistent with permit conditions. The monitoring plan will be developed during the permitting process, in consultation with resource agencies.	Construction, O&M, decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
68	Construction	• To the extent practicable, use appropriate installation technology designed to minimize disturbance to seagrass beds; avoid anchoring on sensitive habitat; and implement turbidity reduction measures to minimize impacts to sensitive habitats from construction. • Take reasonable actions (use BMPs) to minimize seabed disturbance and sediment dispersion during cable installation and construction of Project facilities	Construction	This mitigation measure would ensure decreased short- and long-term impact to important ESA-listed marine mammal, sea turtle, and marine fish prey habitat in SAV communities.
BOEM PDCs/BMPs				
69	COP PDCs/APMs	Site offshore facilities to avoid known locations of sensitive habitat or species during sensitive periods; important marine habitat; and sensitive benthic habitat to the extent practicable. Avoid hard-bottom habitats and seagrass communities, where practicable, and restore any damage to these communities.	Pre-construction	The mitigation measure would avoid adverse impacts to marine mammals, sea turtles, and ESA-listed fish by avoiding sensitive habitat and species presence to the extent practicable.
70	COP PDCs/APMs	Use standard underwater cables which have electrical shielding to control the intensity of EMF.	Construction, O&M	The mitigation measure would decrease area of EMF effects to marine mammals, sea turtles, and ESA-listed fish.
71	COP PDCs/APMs	Conduct an SAV survey of the proposed inshore export cable route.	Pre-construction	The mitigation measure would not minimize adverse effects to marine mammals, sea turtles, and ESA-listed fish prey but identifying the potential for effects.
72	COP PDCs/APMs	Evaluate geotechnical and geophysical survey results to identify sensitive habitats and avoid these during construction, to the extent practicable.	Construction	The mitigation measure would avoid adverse impacts to marine mammals, sea turtles, ESA-listed fish, and their prey by avoiding sensitive habitat and species presence to the extent practicable.
73	COP PDCs/APMs	Obtain necessary permits to address potential impacts on marine mammals from underwater noise and established appropriate and practicable mitigation and monitoring measures in coordination with regulatory agencies.	Construction, O&M	The mitigation measure would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from potential Project effects by consulting with and adhering to agency required measures.
74	COP PDCs/APMs	Lessees and grantees should evaluate marine mammal use of the proposed Project area and should design the Project to minimize and mitigate the potential for mortality or disturbance. The amount and extent of ecological baseline data required should be determined on a project basis.	Pre-Construction	The mitigation measure would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from potential Project effects.

No	Measure	Description	Project Phase	Expected Effects
75	COP PDCs/APMs	Vessels related to Project planning, construction, and operation should travel at reduced speeds when assemblages of cetaceans are observed. Vessels also should maintain a reasonable distance from whales, small cetaceans, and sea turtles, and these should be determined during site-specific consultations.	Construction, O&M, decommissioning	The mitigation measure would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from vessel interactions.
76	COP PDCs/APMs	Lessees and grantees should minimize potential vessel impacts to marine mammals and sea turtles by having Project-related vessels follow the National Marine Fisheries Service (NMFS) Regional Viewing Guidelines while in transit. Operators should undergo training on applicable vessel guidelines.	Construction, O&M, decommissioning	The mitigation measure would minimize the potential for adverse effects on marine mammals, sea turtles, and ESA-listed fish resulting from vessel interactions. Training of crew and personnel would minimize the potential for adverse effects to ESA-listed species by increasing the effectiveness of mitigation and monitoring measures through educational and training materials and avoiding vessel interactions with ESA-listed species.
77	COP PDCs/APMs	Lessees and grantees should take efforts to minimize disruption and disturbance to marine life from sound emissions, such as pile driving, during construction activities.	Construction, O&M, decommissioning	The mitigation measure would minimize the potential for disruption and disturbance effects on marine mammals, sea turtles, and ESA-listed fish resulting from vessel interactions.
78	COP PDCs/APMs	Lessees and grantees should avoid and minimize impacts to marine species and habitats in the Project area by posting a qualified observer on site during construction activities. These observers are approved by NMFS.	Construction	The mitigation and monitoring measure would not minimize adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for construction activities.
79	Dredge BMP – USACE 2022	• Utilizing closed environmental clamshell bucket equipped with sensors • Controlled lift speed • Holding times for water decanting • No barge overflow • Limited rinsing/hosing of barge to prevent runoff • Discharge of decant water into same water body from which it came • Water quality (TSS & turbidity) monitoring • Silt curtain (along shallow areas vs construction area) as feasible. For example, during the HDD exit pit excavation dredging within Barnegat Bay along the Oyster Creek export cable routes. Additionally, during ultrashallow dredging in proximity to SAV beds, the installation of silt curtains is being considered parallel to the SAV beds to reduce sediment deposition in these sensitive areas.	Construction, O&M, decommissioning	The mitigation measure would reduce effects associated with turbidity.
80	Jetting Installation BMPs – USACE 2022	• Modifying installation speed/jetting pressure to minimize sediment resuspension • Water quality (TSS & turbidity) monitoring • Silt curtain (along shallow areas vs construction area) as feasible	Construction, O&M, decommissioning	The mitigation measure would reduce effects associated with turbidity.
81	BMPs for SAV	• Use of horizontal directional drilling (HDD) will allow the Project to avoid areas of SAV during construction on the eastern and western shorelines of Barnegat Bay and in Peck Bay • The current Ocean Wind construction schedule enables the in-water work within known SAV habitat to be conducted late fall through early spring which is outside the growing season for SAV • BMPs to be implemented when construction activities are within 500 feet (152 meters) from SAV beds: – Use of silt curtains along shallow areas to the maximum extent practicable (based on hydrodynamics and water depth) – Utilization of a closed environmental clamshell bucket equipped with sensors during dredging activities – Modifying installation speed/jetting pressure during cable lay to minimize sediment resuspension and water quality (TSS and turbidity)	Construction, O&M, decommissioning	The mitigation measure would reduce effects to SAV.

No	Measure	Description	Project Phase	Expected Effects
		monitoring.		
82	SAV site-specific monitoring program	The Project will develop and implement a site-specific monitoring program to ensure that environmental conditions are monitored before and after construction to determine the amount of restoration required. The monitoring plan is in the process of being developed in consultation with resource agencies. If required based on the results of monitoring, restoration may include the following: onsite in-kind restoration which may include transplanting or seed dispersion to restore the disturbed area to its preconstruction contours and conditions, offsite in-kind restoration, onsite ecological enhancement of similar ecological function and value, other options including stakeholder mitigation to be coordinated with the NJDEP, NOAA and consulting parties or a combination of the above.	Construction, O&M, decommissioning	The mitigation measure would reduce effects to SAV.

Source: Ocean Wind 2022 HDR, Inc. 2022a, 2022b

AAR = autonomous acoustic recorder; APM = Applicant Proposed Measure; ASV = autonomous surface vehicle; BMP = best management practice; BOEM = Bureau of Ocean Energy Management; CHIRP = compressed high-intensity radar pulse, dB = decibels; DE = Delaware; DMA = Dynamic Management Area; EMF = electromagnetic field; ESA = Endangered Species Act; ft = feet; h = hour; HD = high definition; HRG = high-resolution geophysical; IR = infrared; HSE = health, safety, and environment; IR = infrared; ISO = International Organization for Standardization; ITA = Incidental Take Authorization; kg = kilograms; kHz = kilohertz; km = kilometers; lbs = pounds; LOA = Letter of Authorization; L_{rms} = root mean squared sound pressure level; m = meters; MD = Maryland; mm = millimeters; NARW = North American right whale; NJ = New Jersey; NMFS = National Marine Fisheries Service; NMS = noise mitigation system; NOAA = National Oceanic and Atmospheric Administration; NVD = night-vision device; NY = New York; O&M = operations and maintenance; OSS = offshore substation; PAM = passive acoustic monitoring; PDC = Project Design Criteria; PECP = permits and environmental compliance; PSMMP = Protected Species Mitigation and Monitoring Plan; PSO = protected species observer; PTS = permanent threshold shift; QA/QC = quality assurance/quality control; ROSA = Responsible Offshore Science Alliance; RWSAS = Right Whale Sighting Advisory System; SAS = sighting advisory system; SAV = submerged aquatic vegetation; SBP = sub-bottom profiler; SFV = sound field verification; SMA = Seasonal Management Area; SPL = sound pressure level; USBL = Ultra-Short BaseLine; USACE 2022 = Ocean Wind USACE Permit Application Package, Attachment 02 Environmental Assessment, April 27, 2022; UXO = unexploded ordnance; VHF = very high frequency

Table 1-12 Additional Proposed Mitigation Monitoring, and Reporting Measures – BOEM Proposed

No	Measure	Description	Project Phase	Expected Effects
1	Incorporate LOA requirements	The measures required by the final MMPA LOA would be incorporated into COP approval, and BOEM and/or BSEE would monitor compliance with these measures.	Years 1–5 construction and post-construction activities	Incorporation of mitigation measures designed to reduce impacts to listed and non-listed marine mammals
2	PAM Plan	BOEM and USACE would ensure that Ocean Wind prepares a PAM Plan that describes all proposed equipment, deployment locations, detection review methodology and other procedures, and protocols related to the proposed uses of PAM for mitigation and long-term monitoring. This plan would be submitted to NMFS and BOEM for review and concurrence at least 120 days prior to the planned start of activities requiring PAM.	Construction and post-construction monitoring	Ensure the efficacy of PAM placement for appropriate monitoring.
3	Pile driving monitoring plan	BOEM would ensure that Ocean Wind prepare and submit a *Pile Driving Monitoring Plan* to NMFS for review and concurrence at least 90 days before start of pile driving. The plan would detail all plans and procedures for sound attenuation as well as for monitoring ESA-listed whales and sea turtles during all impact and vibratory pile driving. The plan would also describe how BOEM and Ocean Wind would determine the number of whales exposed to noise above the Level B harassment threshold during pile driving with the vibratory hammer to install the cofferdam at the sea to shore transition. Ocean Wind would obtain NMFS' concurrence with this plan prior to starting any pile driving.	Construction	Ensure adequate monitoring and mitigation is in place during pile driving
4	PSO Coverage	BOEM and USACE would ensure that PSO coverage is sufficient to reliably detect whales and sea turtles at the surface in the identified clearance and shutdown zones to execute any pile driving delays or shutdown requirements. If, at any point prior to or during construction, the PSO coverage that is included as part of the Proposed Action is determined not to be sufficient to reliably detect ESA-listed whales and sea turtles within the clearance and shutdown zones, additional PSOs and/or platforms would be deployed. Determinations prior to construction would be based on review of the Pile Driving Monitoring Plan. Determinations during construction would be based on review of the weekly pile driving reports and other information, as appropriate.	Construction	Ensure adequate monitoring of zones
5	Sound field verification	BOEM and USACE would ensure that if the clearance and/or shutdown zones are expanded due to the verification of sound fields from Project activities, PSO coverage is sufficient to reliably monitor the expanded clearance and/or shutdown zones. Additional observers would be deployed on additional platforms for every 1,500 meters that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification.	Construction	Ensure adequate monitoring of clearance zones
6	Shut down zones	BOEM and USACE may consider reductions in the shutdown zones for sei, fin or sperm whales based upon sound field verification of a minimum of 3 piles; however, BOEM/USACE would ensure that the shutdown zone for sei whales, fin whales, blue whales, and sperm whales is not reduced to less than 1,000 meters, or 500 meters for sea turtles. No reductions in the clearance or shutdown zones for North Atlantic right whales would be considered regardless of the results of sound field verification of a minimum of three piles.	Construction	Ensures that shut down zones are sufficiently conservative
7	UXO detonations – Atlantic sturgeon	Ocean Wind would extend the APM seasonal restriction of UXO detonations (January to April) to include months of increased Atlantic sturgeon presence in the offshore wind area. No UXOs can be detonated from November to April in the offshore areas greater than 3 nautical miles (state waters). UXO surveys are expected in Fall of 2022 which defines the exact location and size of UXO.	Construction	Ensures that no mortality or serious injury to Atlantic sturgeon will occur

No	Measure	Description	Project Phase	Expected Effects
8	Monitoring zone for sea turtles	BOEM and USACE would ensure that Ocean Wind monitors the full extent of the area where noise would exceed the 175 dB rms threshold for turtles for the full duration of all pile driving activities and for 30 minutes following the cessation of pile driving activities and record all observations in order to ensure that all take that occurs is documented.	Construction	Ensures accurate monitoring of sea turtle take
9	Look out for sea turtles and reporting	a. For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, Ocean Wind would have a trained lookout posted on all vessel transits during all phases of the project to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the requirements in I below can be implemented. b. For all vessels operating south of the Virginia/North Carolina border, year-round, Ocean Wind would have a trained lookout posted on all vessel transits during all phases of the project to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the requirements I(e) below can be implemented. This requirement is in place year-round for any vessels transiting south of Virginia, as sea turtles are present year-round in those waters. c. The trained lookout would monitor https://seaturtlesightings.org/ prior to each trip and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators/captains and lookouts on duty that day. d. The trained lookout would maintain a vigilant watch and monitor a Vessel Strike Avoidance Zone (500 meters) at all times to maintain minimum separation distances from ESA-listed species. Alternative monitoring technology (e.g., night vision, thermal cameras, etc.) would be available to ensure effective watch at night and in any other low visibility conditions. If the trained lookout is a vessel crew member, this would be their designated role and primary responsibility while the vessel is transiting. Any designated crew lookouts would receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. e. If a sea turtle is sighted within 100 meters or less of the operating vessel's forward path, the vessel operator would slow down to 4 knots (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 knots or less until there is a separation distance of at least 100 meters at which time the vessel may resume normal operations. If a sea turtle is sighted within 50 meters of the forward path of the operating vessel, the vessel operator would shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots. The vessel may resume normal operations once it has passed the turtle. f. Vessel captains/operators would avoid transiting through areas of visible jellyfish aggregations or floating sargassum lines or mats. In the event that operational safety prevents avoidance of such areas, vessels would slow to 4 knots while transiting through such areas. g. All vessel crew members would be briefed in the identification of sea turtles and in regulations and best practices for avoiding vessel collisions. Reference materials would be available aboard all project vessels for identification of sea turtles. The expectation and process for reporting of sea turtles (including live, entangled, and dead individuals) would be clearly communicated and posted in highly visible locations aboard all project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to do so. h. The only exception is when the safety of the vessel or crew necessitates deviation from these requirements on an emergency basis. If any such incidents occur, they would be reported to NMFS within 24 hours. i. If a vessel is carrying a PSO or trained lookout for the purposes of maintaining watch for North Atlantic right whales, an additional lookout is not required and this PSO or trained lookout would maintain watch for whales and sea turtles. j. Vessel transits to and from the Wind Farm Area, that require PSOs will maintain a speed commensurate with weather conditions and effectively detecting sea turtles prior to reaching the 100 m avoidance measure.	All phases	Minimizes risk of vessel strikes to sea turtles
10	Sampling gear	All sampling gear would be hauled at least once every 30 days, and all gear would be removed from the water and stored on land between survey seasons to minimize risk of entanglement.	All fisheries surveys	Minimizes risk of entanglement
11	Gear identification	To facilitate identification of gear on any entangled animals, all trap/pot gear used in the surveys would be uniquely marked to distinguish it from other commercial or recreational gear. Using black and yellow striped duct tape, place a 3-foot-long mark within 2 fathoms of a buoy. In addition, using black and white paint or duct tape, place 3 additional marks on the top, middle and bottom of the line. These gear marking colors are proposed as they are not gear markings used in other fisheries and are therefore distinct. Any changes in marking would not be made without notification and approval from NMFS.	Pot/trap surveys	Distinguishes survey gear from other commercial or recreational gear
12	Lost survey gear	If any survey gear is lost, all reasonable efforts that do not compromise human safety would be undertaken to recover the gear. All lost gear would be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) within 24 hours of the documented time of missing or lost gear. This report would include information on any markings on the gear and any efforts undertaken or planned to recover the gear.	All fisheries surveys	Promotes recovery of lost gear

No	Measure	Description	Project Phase	Expected Effects
13	Marine debris awareness training	The Lessee would ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. The training consists of two parts: (1) viewing a marine trash and debris training video or slide show (described below); and (2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at https://www.bsee.gov/debris or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities would continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process would include the following elements: • Viewing of either a video or slide show by the personnel specified above; • An explanation from management personnel that emphasizes their commitment to the requirements; • Attendance measures (initial and annual); and • Recordkeeping and the availability of records for inspection by DOI. By January 31 of each year, the Lessee would submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at marinedebris@bsee.gov).	All stages	Decrease the loss of marine debris which may represent entanglement and/ or ingestions risk
14	Training	At least one of the survey staff onboard the trawl surveys and ventless trap surveys would have completed NEFOP observer training (within the last 5 years) or other training in protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon). Reference materials for identification, disentanglement, safe handling, and genetic sampling procedures would be available on board each survey vessel. BOEM would ensure that Ocean Wind prepares a training plan that addresses how this requirement would be met and that the plan is submitted to NMFS in advance of any trawl or trap surveys. This requirement is in place for any trips where gear is set or hauled.	Trawl and ventless trap surveys	Promotes safe handling and release of Atlantic sturgeon
15	Sea turtle disentanglement	Vessels deploying fixed gear (e.g., pots/traps) would have adequate disentanglement equipment (i.e., knife and boathook) onboard. Any disentanglement would occur consistent with the Northeast Atlantic Coast STDN Disentanglement Guidelines at https://www.reginfo.gov/public/do/DownloadDocument?objectID=102486501 and the procedures described in "Careful Release Protocols for Sea Turtle Release with Minimal Injury" (NOAA Technical Memorandum 580; https://repository.library.noaa.gov/view/noaa/3773).	Pot/trap surveys	Requires disentanglement of sea turtles caught in gear
16	Sea turtle/ Atlantic sturgeon identification and data collection	Any sea turtles or Atlantic sturgeon caught and/or retrieved in any fisheries survey gear would first be identified to species or species group. Each ESA-listed species caught and/or retrieved would then be properly documented using appropriate equipment and data collection forms. Biological data, samples, and tagging would occur as outlined below. Live, uninjured animals should be returned to the water as quickly as possible after completing the required handling and documentation. a. The Sturgeon and Sea Turtle Take Standard Operating Procedures would be followed (https://media.fisheries.noaa.gov/dammigration/sturgeon_&_sea_turtle_take_sops_external.pdf). b. Survey vessels would have a passive integrated transponder (PIT) tag reader onboard capable of reading 134.2 kHz and 125 kHz encrypted tags (e.g., Biomark GPR Plus Handheld PIT Tag Reader) and this reader be used to scan any captured sea turtles and sturgeon for tags. Any recorded tags would be recorded on the take reporting form (see below). c. Genetic samples would be taken from all captured Atlantic sturgeon (alive or dead) to allow for identification of the DPS of origin of captured individuals and tracking of the amount of incidental take. This would be done in accordance with the Procedures for Obtaining Sturgeon Fin Clips (https://media.fisheries.noaa.gov/dammigration/sturgeon_genetics_sampling_revised_june_2019.pdf). i. Fin clips would be sent to a NMFS approved laboratory capable of performing genetic analysis and assignment to DPS of origin. To the extent authorized by law, BOEM is responsible for the cost of the genetic analysis. Arrangements would be made for shipping and analysis in advance of submission of any samples; these arrangements would be confirmed in writing to NMFS within 60 days of the receipt of this ITS. Results of genetic analysis, including assigned DPS of origin would be submitted to NMFS within 6 months of the sample collection. ii. Subsamples of all fin clips and accompanying metadata forms would be held and submitted to a tissue repository (e.g., the Atlantic Coast Sturgeon Tissue Research Repository) on a quarterly basis. The Sturgeon Genetic Sample Submission Form is available for download at: https://www.fisheries.noaa.gov/new-england-midatlantic/consultations/section-7-take-reporting-programmaticsgreater-atlantic). d. All captured sea turtles and Atlantic sturgeon would be documented with required measurements and photographs. The animal's condition and any marks or injuries would be described. This information would be entered as part of the record for each incidental take. A NMFS Take Report Form would be filled out for each individual sturgeon and sea turtle (download at: https://media.fisheries.noaa.gov/2021-41507/Take%20Report%20Form%2007162021.pdf?null) and submitted to NMFS as described below.	All fisheries surveys	Requires standard data collection and documentation of any sea turtle/ Atlantic sturgeon caught during surveys

No	Measure	Description	Project Phase	Expected Effects
17	Sea turtle/ Atlantic sturgeon handling and resuscitation guidelines	Any sea turtles or Atlantic sturgeon caught and retrieved in gear used in fisheries surveys would be handled and resuscitated (if unresponsive) according to established protocols and whenever at-sea conditions are safe for those handling and resuscitating the animal(s) to do so. Specifically: a. Priority would be given to the handling and resuscitation of any sea turtles or sturgeon that are captured in the gear being used, if conditions at sea are safe to do so. Handling times for these species should be minimized (i.e., kept to 15 minutes or less) to limit the amount of stress placed on the animals. b. All survey vessels would have copies of the sea turtle handling and resuscitation requirements found at 50 CFR 223.206(d)(1) prior to the commencement of any on-water activity (download at: https://media.fisheries.noaa.gov/dammigration/sea_turtle_handling_and_resuscitation_measures.pdf). These handling and resuscitation procedures would be carried out any time a sea turtle is incidentally captured and brought onboard the vessel during the Proposed Actions. c. If any sea turtles that appear injured, sick, or distressed, are caught and retrieved in fisheries survey gear, survey staff would immediately contact the Greater Atlantic Region Marine Animal Hotline at 866-755-6622 for further instructions and guidance on handling the animal, and potential coordination of transfer to a rehabilitation facility. If unable to contact the hotline (e.g., due to distance from shore or lack of ability to communicate via phone), the USCG should be contacted via VHF marine radio on Channel 16. If required, hard-shelled sea turtles (i.e., non-leatherbacks) may be held on board for up to 24 hours following handling instructions provided by the Hotline, prior to transfer to a rehabilitation facility. d. Attempts would be made to resuscitate any Atlantic sturgeon that are unresponsive or comatose by providing a running source of water over the gills as described in the Sturgeon Resuscitation Guidelines (https://media.fisheries.noaa.gov/dammigration-miss/Resuscitation-Cards-120513.pdf). e. Provided that appropriate cold storage facilities are available on the survey vessel, following the report of a dead sea turtle or sturgeon to NMFS, and if NMFS requests, any dead sea turtle or Atlantic sturgeon would be retained on board the survey vessel for transfer to an appropriately permitted partner or facility on shore as safe to do so. f. Any live sea turtles or Atlantic sturgeon caught and retrieved in gear used in any fisheries survey would ultimately be released according to established protocols and whenever at-sea conditions are safe for those releasing the animal(s) to do so.	All fisheries surveys	Ensures the safe handling and resuscitation of sea turtles and Atlantic sturgeon following established protocols
18	Take notification	GARFO PRD would be notified as soon as possible of all observed takes of sea turtles, and Atlantic sturgeon occurring as a result of any fisheries survey. Specifically: a. GARFO PRD would be notified within 24 hours of any interaction with a sea turtle or sturgeon (nmfs.gar.incidental-take@noaa.gov). The report would include at a minimum: (1) survey name and applicable information (e.g., vessel name, station number); (2) GPS coordinates describing the location of the interaction (in decimal degrees); (3) gear type involved (e.g., bottom trawl, gillnet, longline); (4) soak time, gear configuration and any other pertinent gear information; (5) time and date of the interaction; and (6) identification of the animal to the species level. Additionally, the email would transmit a copy of the NMFS Take Report Form (download at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null) and a link to or acknowledgement that a clear photograph or video of the animal was taken (multiple photographs are suggested, including at least one photograph of the head scutes). If reporting within 24 hours is not possible due to distance from shore or lack of ability to communicate via phone, fax, or email, reports would be submitted as soon as possible; late reports would be submitted with an explanation for the delay. b. At the end of each survey season, a report would be sent to NMFS that compiles all information on any observations and interactions with ESA-listed species. This report would also contain information on all survey activities that took place during the season including location of gear set, duration of soak/trawl, and total effort. The report on survey activities would be comprehensive of all activities, regardless of whether ESA-listed species were observed.	All fishery surveys	Establishes procedures for immediate reporting of sea turtle/ Atlantic sturgeon take
19	Monthly/ annual reporting requirements	BOEM would ensure that Ocean Wind implements the following reporting requirements necessary to document the amount or extent of take that occurs during all phases of the Proposed Action: a. All reports would be sent to: nmfs.gar.incidental-take@noaa.gov. b. During the construction phase and for the first year of operations, Ocean Wind would compile and submit monthly reports that include a summary of all project activities carried out in the previous month, including vessel transits (number, type of vessel, and route), and piles installed, and all observations of ESA-listed species. Monthly reports are due on the 15th of the month for the previous month. c. Beginning in year 2 of operations, Ocean Wind would compile and submit annual reports that include a summary of all project activities carried out in the previous year, including vessel transits (number, type of vessel, and route), repair and maintenance activities, survey activities, and all observations of ESA-listed species. These reports are due by April 1 of each year (i.e., the 2026 report is due by April 1, 2027). Upon mutual agreement of NMFS and BOEM, the frequency of reports can be changed.	Construction and operations	Establishes reporting requirements and timing to document take and operator activities

No	Measure	Description	Project Phase	Expected Effects
20	BOEM/ NMFS meeting requirements for sea turtle take documentation	To facilitate monitoring of the incidental take exemption for sea turtles, through the first year of operations, BOEM and NMFS would meet twice annually to review sea turtle observation records. These meetings/conference calls would be held in September (to review observations through August of that year) and December (to review observations from September to November) and would use the best available information on sea turtle presence, distribution, and abundance, project vessel activity, and observations to estimate the total number of sea turtle vessel strikes in the action area that are attributable to project operations. These meetings would continue on an annual basis following year 1 of operations. Upon mutual agreement of NMFS and BOEM, the frequency of these meetings can be changed.	Construction and year 1 of operations	Establishes process for monitoring of IT exemption for sea turtles
21	Data Collection BA BMPs	BOEM would ensure that all Project Design Criteria and Best Management Practices incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (June 2021) shall be applied to activities associated with the construction, maintenance and operations of the Ocean Wind project as applicable.	All phases	Incorporates previously determined best management practices to reduce the likelihood of take of listed species during surveys, vessel operations, and maintenance in the Atlantic OCS.
22	Alternative Monitoring Plan (AMP) for Pile Driving	The Lessee must not conduct pile driving operations at any time when lighting or weather conditions (e.g., darkness, rain, fog, sea state) prevent visual monitoring of the full extent of the clearance and shutdown zones. The Lessee must submit an AMP to BOEM and NMFS for review and approval at least 6 months prior to the planned start of pile-driving. This plan may include deploying additional observers, alternative monitoring technologies such as night vision, thermal, and infrared technologies, or use of PAM and must demonstrate the ability and effectiveness to maintain all clearance and shutdown zones during daytime as outlined below in Part 1 and nighttime as outlined in Part 2 to BOEM's and NMFS's satisfaction. The AMP must include two stand-alone components as described below: • Part 1 – Daytime when lighting or weather (e.g., fog, rain, sea state) conditions prevent visual monitoring of the full extent of the clearance and shutdown zones. Daytime being defined as one hour after civil sunrise to 1.5 hours before civil sunset. • Part 2 – Nighttime inclusive of weather conditions (e.g., fog, rain, sea state). Nighttime being defined as 1.5 hours before civil sunset to one hour after civil sunrise. If a protected marine mammal or sea turtle is observed entering or found within the shutdown zones after impact pile-driving has commenced, the Lessee would follow the shutdown procedures outlined in Section 2.4.2.5.4 of the Protected Species Mitigation Monitoring Plan (PSMMP). The Lessee would notify BOEM and NMFS of any shutdown occurrence during piling driving operations with 24 hours of the occurrence unless otherwise authorized by BOEM and NMFS. The AMP should include, but is not limited to the following information: • Identification of night vision devices (e.g., mounted thermal/IR camera systems, hand-held or wearable NVDs, IR spotlights), if proposed for use to detect protected marine mammal and sea turtle species. • The AMP must demonstrate (through empirical evidence) the capability of the proposed monitoring methodology to detect marine mammals and sea turtles within the full extent of the established clearance and shutdown zones (i.e., species can be detected at the same distances and with similar confidence) with the same effectiveness as daytime visual monitoring (i.e., same detection probability). Only devices and methods demonstrated as being capable of detecting marine mammals and sea turtles to the maximum extent of the clearance and shutdown zones will be acceptable. • Evidence and discussion of the efficacy (range and accuracy) of each device proposed for low visibility monitoring must include an assessment of the results of field studies (e.g., Thayer Mahan demonstration), as well as supporting documentation regarding the efficacy of all proposed alternative monitoring methods (e.g., best scientific data available). • Procedures and timeframes for notifying NMFS and BOEM of Ocean Wind's intent to pursue nighttime pile-driving. • Reporting procedures, contacts and timeframes. BOEM may request additional information, when appropriate, to assess the efficacy of the AMP.	Construction	Establishes requirement for nighttime impact pile driving approval

No	Measure	Description	Project Phase	Expected Effects
23	Periodic Underwater Surveys, Reporting of Monofilament and Other Fishing Gear Around WTG Foundations	The Lessee must monitor indirect impacts associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least 10 of the WTGs located closest to shore in the Ocean Wind 1 Lease Area (OCS-A 0498) annually. Survey design and effort may be modified with review and concurrence by DOI. The Lessee may conduct surveys by remotely operated vehicles, divers, or other means to determine the frequency and locations of marine debris. The Lessee must report the results of the surveys to BOEM (at renewable_reporting@boem.gov) and BSEE (at marinedebris@bsee.gov) in an annual report, submitted by April 30, for the preceding calendar year. Annual reports must be submitted in Word format. Photographic and videographic materials must be provided on a portable drive in a lossless format such as TIFF or Motion JPEG 2000. Annual reports must include survey reports that include: the survey date; contact information of the operator; the location and pile identification number; photographic and/or video documentation of the survey and debris encountered; any animals sighted; and the disposition of any located debris (i.e., removed or left in place). Annual reports must also include claim data attributable to the Ocean Wind 1 project from Ørsted's corporate gear loss compensation policy and procedures. Required data and reports may be archived, analyzed, published, and disseminated by BOEM	Operations	Establishes requirement for monitoring and reporting of lost monofilament and other fishing gear around WTGs
24	PDC Minimize Vessel Interactions with Listed Species (from HRG Programmatic)	All vessels associated with survey activities (transiting [i.e., travelling between a port and the survey site] or actively surveying) must comply with the vessel strike avoidance measures specified below. The only exception is when the safety of the vessel or crew necessitates deviation from these requirements. • If any ESA-listed marine mammal is sighted within 500 meters of the forward path of a vessel, the vessel operator must steer a course away from the whale at <10 knots (18.5 km/hr) until the minimum separation distance has been established. Vessels may also shift to idle if feasible. • If any ESA-listed marine mammal is sighted within 200 meters of the forward path of a vessel, the vessel operator must reduce speed and shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 500 meters. If stationary, the vessel must not engage engines until the large whale has moved beyond 500 meters.	All phases	Establishes requirement for vessel strike avoidance measures
25	Operational Sound Field Verification Plan	BOEM would require the Lessee to develop an operational sound field verification plan to determine the operational noises emitted from the Offshore Wind Area. The plan would be reviewed and approved by BOEM and NMFS.	Operations	Establishes requirement for operational noise monitoring

AMP = Alternative Monitoring Plan; APM = Applicant Proposed Measure; BA = Biological Assessment; BMP = best management practice; BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; CFR = Code of Federal Regulations; COP = Construction and Operations Plan; dB = decibels; DOI = Department of the Interior; DPS = distinct population segment; ESA = Endangered Species Act; GARFO = Greater Atlantic Regional Fisheries Office; GPR = Global Pocket Reader; GPS = global positioning system; IR = infrared; kHz = kilohertz; km/hr = kilometers per hour; LOA = Letter of Authorization; m = meters; m/s = meters per second; MMPA = Marine Mammal Protection Act of 1972; NEFOP = Northeast Fisheries Observer Program; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NVD = night vision device; PAM = passive acoustic monitoring; PIT = passive integrated transponder; PRD = Protected Resources Division; PSMMP = Protected Species Mitigation and Monitoring Plan; PSO = protected species observer; rms = root mean squared; STDN = Sea Turtle Disentanglement Network; SZ = shutdown zone; USACE = U.S. Army Corps of Engineers; USCG = U.S. Coast Guard; UXO = unexploded ordnance; VHF = very high frequency; WTG = wind turbine generator

2. ENVIRONMENTAL BASELINE

2.1. PHYSICAL ENVIRONMENT

2.1.1 Seabed and Physical Oceanographic Conditions

2.1.1.1. Seabed Conditions

Seabed morphology in the vicinity of the Project area generally consists of a gently sloping seabed; within the Lease Area, the seafloor slopes are predominantly less than 1 degree (Guida et al. 2017). The largest slopes are associated with sand ridges that are a prominent seafloor feature of the OCS off the coast of New Jersey. They are oriented obliquely to the shoreline and are actively modified by ocean currents at depths up to 164 feet (50 meters) (Goff et al. 2005). Goff et al. (2005) report that these sand ridges range up to approximately 39 feet (12 meters) tall, are approximately 1.2 to 12.4 miles (2 to 20 km) long, and are spaced approximately 0.6 to 3.1 miles (1 to 5 km) apart. In and near portions of the Lease Area, Ocean Wind identified ridges up to 49 feet (15 meters) above the surrounding seabed (Ocean Wind COP, Volume II, Section 2.1.1.1.1; Ocean Wind 2022). Patches of ripples and mega-ripples with heights up to approximately 1.6 feet (0.5 meters) were also observed within portions of the Lease Area during Ocean Wind's geophysical survey. In contrast, the seafloor of the Lease Area overlapping the Great Egg Valley zone is smoother than the adjacent physiographic zones, with no significant bedforms (Guida et al. 2017; Ocean Wind COP, Volume II, Section 2.1.1.1.1; Ocean Wind 2022).

Ocean Wind's geophysical survey recorded water depths in the Project area. Water depths varied from -49 feet (-15 meters) MLLW in the northern part to -125 feet (-38 meters) MLLW in the southern part. Along the export cable route options, in federal waters outside the 3.5-mile (3 nm, 5.6 km) maritime limit, the water depths varied from -32.8 feet (-15 meters) MLLW to nearly -98.4 feet (-30 meters) MLLW. In the back bays, water depths are predominantly shallow except in existing channels.

Water depths within the estuary of Barnegat Bay (offshore export cable corridor to Oyster Creek substation) recorded on NOAA nautical charts range from -1.0 to -9.8 feet (-0.3 to -3.0 meters) MLLW, with a majority of the open-water area within the study corridor ranging from -1.0 to -5.9 feet (-0.3 to -1.8 meters) MLLW. The deeper areas are found along the designated intracoastal waterway, which ranges in depth from -6.9 to -9.8 feet (-2.1 to -3.0 meters) MLLW. The channels leading to Barnegat Inlet, including Oyster Creek Channel and Double Creek Channel, have the greatest depths, ranging from -7.9 to -20.0 feet (-2.4 to -6.1 meters) MLLW.

Water depths for Great Egg Harbor Bay (within the BL England study area) recorded on NOAA nautical charts are shallow, ranging from -1.0 to -3.0 feet (-0.3 to -0.9 meters) MLLW. The deepest areas, ranging from -3.3 to -41.0 feet (-1.0 to -12.5 meters) MLLW, are found at Great Egg Harbor Inlet and channels leading to the southern portions of the study corridor and up Great Egg Harbor River.

Within the Lease Area, the seafloor sediment consists predominantly of medium- to coarse-grained sand with areas of gravelly sand and gravel deposits (Alpine 2017a; Fugro 2017). Along the export cable route options, the seafloor sediment consists predominantly of sand with various amounts of gravel and patches of fine-grained sediments. Several designated sand and gravel borrow areas are mapped in the vicinity of the Offshore Project area (BOEM 2018a). Close to shore, surficial sediments of mixed fine-grained estuarine deposits and overwash of tidal-delta sands are found, as well as fine-grained estuarine clays and silts deposited by multiple rivers. Locally, gravel may be observed in the upper 9.8 feet (3 meters). In the back bays, sediment types primarily consist of sand and fine-grain sediments.

Studies in the nearshore zone near Atlantic City (depths of approximately 50 feet [15 meters]) indicate that longshore currents can be sufficiently energetic to entrain and transport sands along the seafloor, but these currents are mainly limited to high-energy storm events (Miller et al. 2014).

The Oyster Creek and BL England study areas range in elevation between sea level and approximately 60 feet (18.5 meters) above mean sea level based on the Digital Elevation Model and Light Detection and Ranging (LiDAR) data obtained by Ocean Wind. Surface soils within the Onshore Project area consist primarily of sands and silts (USDA 1978). Areas of historical anthropogenic fill were identified at the Oyster Creek and BL England Interconnection point sites (NJDEP and New Jersey Geological and Water Survey 2016).

Benthic resources include the seafloor, substrate, and communities of bottom-dwelling organisms that live within these habitats. Benthic habitats include soft-bottom (i.e., unconsolidated sediments) and hard-bottom (e.g., cobble and boulder) habitats, as well as consolidated sediment (i.e., pavement), which can occur in scour zones, and biogenic habitats (e.g., eelgrass [*Zostera marina*] and worm tubes) created by structure-forming species. Typical epibenthic invertebrates in the region include sand shrimp and sand dollars, while dominant infauna include polychaetes (primarily Spionidae), sand dollars, nemertean worms, and ascidians (sea squirts) (Guida et al. 2017). Amphipods are present but did not appear in samples as frequently as in Wind Energy Areas (WEAs) to the north (New York, Rhode Island, Massachusetts).

Benthic assemblages within the Project area include small surface-burrowing fauna, small tube-building fauna, clam beds, and sand dollar beds. These communities perform important functions, such as water filtration and nutrient cycling, and are also a valuable food source for many species. Spatial and temporal variation in benthic prey organisms can affect growth, survival, and population levels of fish and other organisms. The region experiences seasonal variations in water temperature and phytoplankton concentrations, with corresponding seasonal changes in the densities of benthic organisms. The spatial and temporal variation in benthic prey organisms can affect the growth, survival, and population levels of fish and other organisms.

Coastal and Marine Ecological Classification Standard Biotic Subclasses within the Project area were generally composed of Soft Sediment Fauna with a few isolated areas of Worm Reef Biota and Attached Fauna. Greater variability was present at the biotic group classification level, with biotic groups well suited to dynamic sandy environments, such as the prevalence of Sand Dollar Beds. Within the Lease Area, Sand Dollar Beds and Larger Tube-Building Fauna were observed most frequently. Tunicate Beds and various mobile epifauna, such as gastropods and crustaceans, were also observed. Both Small and Large Tube-Building Fauna were observed along the BL England offshore export cable route corridor. Along the Oyster Creek offshore export cable route corridor, the most frequently observed biotic group was Small Tube-Building Fauna. Other notable biotic groups were Sand Dollar Beds and Sabellariid Reefs. The Sabellariid Reef Biotic Groups documented within the Offshore Project area were patchy in nature and did not form large, continuous seafloor features (Inspire 2021).

The estuarine portion of the Oyster Creek export cable route was primarily mud and sandy mud with submerged aquatic vegetation (SAV) on the shorelines of the route and a small area of low-density boulders. A trend was identified by Taghon et al. (2017) of finer sediments near the western bank and coarser sediments toward the eastern shoreline. Total organic content ranged from 0.02% to 5.7% (Taghon et al. 2017).

Barnegat Bay is relatively shallow (average depth 3.6 feet [1.1 meters]) and poorly flushed (25 to 30 days), and, therefore, a highly eutrophic estuary (Kennish et al. 2007; Gilbert et al. 2010). Eutrophication is a result of surface-water inflows, atmospheric deposition, and direct groundwater discharges and can lead to algal growth, altered invertebrate communities, and loss of SAV (Kennish et al. 2007). From 1980 to 2010, SAV declined by as much as 25% in Barnegat Bay (Gilbert et al. 2010).

The estuarine portion of the BL England export cable route is a short (approximately 492-foot [150-meter]) crossing of Peck Bay at the Roosevelt Boulevard bridge. Peck Bay is generally shallow (1 to 2 feet [0.3 to 0.6 meters] deep) with a navigational channel along its eastern shore (NOAA 2021a; Chart

12316). A corridor through the northern end of Peck Bay/southern end of Great Egg Harbor Bay was included in the benthic habitat assessment (Inspire 2021). Sediment types along that corridor were sand and muddy sand or mud and sandy mud. The proposed crossing at the southern extent of Peck Bay is between two marinas and includes a dredged channel into Crook Horn Creek.

SAV in Barnegat Bay and Great Egg Harbor Bay was initially surveyed for the Project through aerial photography in 2019, followed by quadrat sampling in Barnegat Bay along transect lines in 2020 (HDR, Inc. 2021). The quadrat surveys documented the outer extents of SAV beds identified from the aerial survey and obtained representative information on SAV species and density. Eelgrass was the dominant type of SAV identified and widgeon grass (*Rupia maritima*) was documented in less than 0.4% of all quadrats surveyed. The distribution of seagrass described from the aerial survey is generally consistent with the New Jersey Department of Environmental Protection (NJDEP) survey results from 1986 (NJDEP 1986). Juvenile Atlantic sturgeon are known to inhabit estuarine environments for up to a year before migrating out into marine habitats (ASMFC 2012). Though Barnegat Bay is known to contain SAV, which is important to many fish species, no known strong association has been documented between juvenile Atlantic sturgeon and SAV (ASMFC 1997). Additionally, no Atlantic sturgeon were recorded during a 3-year trawl survey of Barnegat Bay that spanned all four seasons (Valenti et al. 2017).

Sparse to moderate seagrass was identified near the proposed Peck Bay crossing during the 2019 aerial survey, but additional characterization was not conducted. SAV does not appear at this location in historical imagery (NJDEP 1979).

Benthic invertebrate communities within Barnegat Bay are abundant and generally highly diverse, and have shown few changes from 1965 to 2010 (Taghon et al. 2017). Samples collected from 2012 to 2014 were numerically dominated by Polychaeta, followed by Malacostraca.

2.1.1.2. Oceanographic Conditions

The NJDEP performed ship-based surveys in 2008 and 2009 off the coast of southern New Jersey, including the Lease Area, and recorded sea surface temperatures. The minimum sea surface temperature (SST) recorded was 36 degrees Fahrenheit (°F) (2 degrees Celsius [°C]) during winter, and the maximum SST recorded was 79°F (26°C) during summer (NJDEP 2010). Average SSTs for the period ranged from approximately 39°F (4°C) in February to approximately 73°F (23°C) in August, while average bottom temperatures ranged from approximately 39°F (4°C) in February to approximately 64°F (18°C) in September (Guida et al. 2017). Stratification developed beginning around April, followed by turnover beginning in late October. This is consistent with other studies that identify the establishment of a spring/summer thermocline in the region within the upper 164 feet (50 meters) of the water column (NJDEP 2010). Since approximately 2010, sea surface and bottom temperatures in the Mid-Atlantic Bight have been subject to a warming trend (Friedland et al. 2020). Average sea temperatures have also increased since at least 1968, although there have been intermittent cooling periods and the rates of warming vary depending on the season (e.g., fall sea temperatures have been warming more than spring sea temperatures) (Dupigny-Giroux et al. 2018; Friedland et al. 2020). Sea temperatures in the region are generally expected to continue increasing for the rest of this century at rates that are faster than the global average (Saba et al. 2016).

The sea temperature stratification shown to develop in and around the Lease Area is part of an important seasonal feature identified as the “cold pool.” The cold pool is a dynamic mass of cold bottom water overlain by warmer water that seasonally extends over the middle to outer portions of the OCS from Georges Bank to Cape Hatteras, with a nearshore boundary typically at depths from 66 to 131 feet (20 to 40 meters) (Brown et al. 2015; Lentz 2017; Chen et al. 2018; Miles et al. 2020). The cold pool forms in late spring and persists through summer, gradually moving southwest, shrinking, and warming due to vertical mixing and other factors (Chen et al. 2018). During summer, occasional localized upwelling and mixing of the cold pool with surface waters provides a source of nutrients, influencing the ecosystem's primary productivity (Matte and Waldhauer 1984; Lentz 2017).

Salinity data collected during the 2008–2009 ship-based surveys were combined with historical measurements (1927 to 1989) to yield average seasonal sea surface salinity values for winter (approximately 30.0 to 31.6 practical salinity units [PSU]), spring (approximately 29.0 to 31.6 PSU), summer (approximately 30.2 to 31.5), and fall (31.5 to 31.8) (NJDEP 2010). Salinity data were also collected during the 2003 to 2016 surveys in the NJ WEA, yielding a median salinity of 32.2 PSU, with a full range spanning 29.4 to 34.4 PSU for all depths (Guida et al. 2017). These values mainly fall within the euhaline range (30 to 40 PSU), which is the typical salinity range for seawater per the Venice salinity classification system (Anonymous 1958). The lower salinity values were more common closer to shore, especially in the spring, which can be attributed to river discharge (NJDEP 2010).

The Atlantic OCS encompassing the Project area is subject to semi-diurnal (twice daily) tides, with an average tidal range of 3.9 feet (1.2 meters) (i.e., microtidal) (Miller et al. 2014). The tides drive a cross-shelf current component through the Project area with maximum near-surface speed of approximately 0.66 feet per second (ft/s) (0.20 m/s) and a maximum near-bottom speed of approximately 0.33 ft/s (0.10 m/s) (NJDEP 2010; Miller et al. 2014).

Wind-driven surface currents in the Project area are predominantly southeasterly, resulting in a net offshore direction of flow. Separate studies have noted that the highest current speeds were approximately 1.4 ft/s (0.42 m/s) for January through March, 1.3 ft/s (0.40 m/s) for April through June, 1.2 ft/s (0.37 m/s) for July through September, and 1.1 ft/s (0.35 m/s) for October through December (DHI 2018), and a mean offshore surface flow of 0.07 to 0.39 ft/s (0.02 to 0.12 m/s) over the OCS seaward of New Jersey (Miller et al. 2014). Values during winter storms and hurricanes may exceed 2.0 ft/s (0.60 m/s) (Miller et al. 2014).

The modeled bottom currents in the Project area are complex, but generally flow in a southerly direction (WHOI 2016). Surface current directions differ from the modeled bottom current directions because the top-most surface water direction is primarily driven by the prevailing westerly winds, accounting for the Coriolis effect, which causes surface currents to propagate at an angle to the wind. Currents deeper in the water column are also more influenced by local bathymetry and regional density gradients than the surface layer, and thus can differ significantly from the surface current velocities. In particular, bottom currents within a few kilometers of the coast may flow toward the shore during periods of seasonal upwelling, when winds are from the southwest (NJDEP 2010). Local bathymetric features associated with relict river deltas near present-day inlets, such as Barnegat Inlet, contribute to areas of persistent upwelling and recurrent hypoxic conditions (Townsend et al. 2004; NJDEP 2010).

The Gulf Stream is the most dominant component of ocean circulation in the northwestern Atlantic Ocean (Townsend et al. 2004). It flows northeast, seaward of the OCS near New Jersey and therefore does not cross the Project area. Eddies with warm core rings may occasionally split from the Gulf Stream and migrate over the OCS (Knauss 1996; Miller et al. 2014). A cooler "shelfbreak" current, which may be partly driven by the Labrador Current, propagates along the edge of the OCS toward the southwest (NJDEP 2010; Miller et al. 2014). The shelfbreak current limits exchange of water masses between the OCS and the deeper ocean (NJDEP 2010) and may therefore reduce the influence of Gulf Stream eddies. However, a warming trend is predicted for the remainder of this century due to a retreat of the Labrador Current and a northerly shift of the Gulf Stream (Saba et al. 2016).

2.1.1.3. Water Quality

The Wind Farm Area and a portion of the offshore export cable corridor are located in offshore marine waters where available water quality data are limited. Ambient water quality in these areas is expected to be generally representative of the regional ocean environment and subject to constant oceanic circulation that disperses, dilutes, and biodegrades anthropogenic pollutants from upland and shoreline sources (BOEM 2013).

A portion of the offshore export cable corridor is located in coastal New Jersey waters. The NJDEP conducts annual assessments of the state's waterways for water quality parameters. Five sampling sites within Barnegat Bay were in non-attainment for turbidity and considered impaired for this parameter as defined under the Clean Water Act Section 303(d) program. Water quality in Manahawkin Bay, Upper Little Egg Harbor, and Lower Little Egg Harbor Bay was designated as fully supporting recreation and shellfish but not supporting wildlife, due, in part, to increased turbidity (Ocean Wind 2022).

For the purpose of ESA Section 7 consultation, total suspended sediment (TSS) is the pertinent water quality parameter likely to be measurably affected by the proposed Project. Ocean waters beyond 3 miles (2.6 nm, 4.8 km) offshore typically have low concentrations of suspended particles and low turbidity. Waters along the Northeast Coast average 5.6 milligrams per liter (mg/L) of TSS, which is considered low. There are notable exceptions, including estuaries, that average 27.4 mg/L, although TSS sampling throughout nine assessment units in and around Barnegat Bay did not record TSS levels above 16 mg/L (EPA 2012; Ocean Wind 2022). While most ocean waters had TSS concentrations under 10 mg/L, which is the 90th percentile of all measured values, most estuarine waters (65.7% of the Northeast Coast area) had TSS concentrations above this level. Near-bottom TSS concentrations were similar to those near the water surface, averaging 6.9 mg/L. With the exception of the entrance to Delaware Bay, all other coastal ocean stations had near-bottom levels of TSS less than or equal to 16.3 mg/L (EPA 2012).

2.1.2 Electromagnetic Fields

The marine environment continuously generates additional ambient EMF effects. The motion of electrically conductive seawater through the earth's magnetic field induces voltage potential, thereby creating electrical currents. Surface and internal waves, tides, and coastal ocean currents all create weak induced EMF effects. Their magnitude at a given time and location depends on the strength of the prevailing magnetic field, site, and time-specific ocean conditions. Other external factors like electrical storms and solar events can also generate variable EMF effects. The estimated EMF level in the Project area is 505 milligauss (mG; 50.5 microteslas [µT]) (NOAA 2022). The strength of the earth's direct current (DC) magnetic field is approximately 516 mG (51.6 µT) along the southern New England Coast (CSA and Exponent 2019). As ocean currents and organisms move through this DC magnetic field, a weak DC electric field is produced. For example, the electric field generated by the movement of the ocean currents through the earth's magnetic field is reported to be approximately 0.075 millivolts per meter (mV/m) or less (CSA 2019). Other external factors like electrical storms and solar events can also generate variable EMF effects. Following the methods described by Slater et al. (2010), a uniform current of 1 m/s flowing at right angles to the natural magnetic field in the Action Area could induce a steady-state electrical field on the order of 51.5 microvolts per meter (µV/m). Wave action would also induce electrical and magnetic fields at the water surface on the order of 10 to 100 µV/m and 1 to 10 mG (0.1 to 1 µT), respectively, depending on wave height, period, and other factors. Although these effects dissipate with depth, wave action would likely produce detectable EMF effects up to 185 feet (56 meters) below the surface (Slater et al. 2010).

Though no submarine transmission or communication cables have been identified in the Project area, these can also contribute to EMF levels in an area. Electrical telecommunications cables are likely to induce a weak EMF in the immediate area along the cable path. Gill et al. (2005) observed electrical fields on the order of 1 to 6.3 µV/m within 3.3 feet (1 meter) of a typical cable of this type. The heat effects of communication cables on surrounding sediments are likely to be negligible given the limited transmission power levels involved. Fiber-optic cables with optical repeaters would not produce EMF or significant heat effects.

2.1.3 Anthropogenic Conditions

2.1.3.1. Artificial Light

Vessel traffic and navigational safety lights on buoys and meteorological towers are the only artificial lighting sources in the open-water portion of the Project area. Land-based artificial light sources become more predominant approaching the Atlantic City shoreline.

2.1.3.2. Vessel Traffic

There are several routing measures that regulate vessel traffic to help ships avoid navigational hazards in the vicinity of the Project area. Vessel traffic in and out of Delaware Bay is regulated by a Traffic Separation Scheme that is 17 miles (15 nm, 32 km) from the Project area. The Traffic Separation Scheme within the approach to Delaware Bay consists of four parts: an Eastern Approach, a Southwestern Approach, a Two-Way Traffic Route, and a Precautionary Area (33 CFR 167.170). The Inbound Five Fathom Bank to Cape Henlopen Traffic Lane, the Eastern Approach of the Traffic Separation Scheme, is 21 miles (18 nm, 33 km) south of the Lease Area and is primarily a shipping route for deep-draft vessels. The Two-Way Traffic Route (17 miles [15 nm, 28 km] from the Project area) is used primarily by tug and barge vessels entering and exiting Delaware Bay (Stahl et al. 2021).

Further to the north of the Project area (approximately 46 miles [40 nm, 74 km]) is a Traffic Separation Scheme that regulates vessel traffic in the approach to New York Harbor (NOAA 2021b, p. 361). There is a speed-restricted area for NARW seasonal management 16 miles (14 nm, 26 km) from the Project area (50 CFR 224.105).

The Lease Area is used by 377 vessel monitoring system-enabled commercial fishing vessels (BOEM 2021). The primary traffic patterns in the Project area are in the north-northeast/ south-southwest and northwest/southeast directions (COP Volume II, Section 2.3.6.1, p. 342; Ocean Wind 2022). Traffic patterns, traffic density, and statistics were developed from 1 year of automatic identification system data for the period from March 1, 2019, through February 29, 2020; data from the Mid-Atlantic Ocean Data Portal for commercial fishing transits (MARCO 2020); and ongoing dialogue with organizations representing or serving different types of waterborne traffic in the area (such as recreational boating, fishing, and towing industry organizations and pilot organizations). These data and information were analyzed in the Navigation Safety Risk Assessment (NSRA) for the proposed Project. Subsequent to the preparation of the NSRA, the USCG published the Draft *Port Access Route Study: Seacoast of New Jersey Including Offshore Approaches to the Delaware Bay, Delaware* (USCG 2021). Using 3 years (January 1, 2017, to December 31, 2019) of traffic data, this analysis offers an in-depth look at the traffic patterns and traffic composition along the New Jersey seacoast from year to year.

In June 2020, the USCG sought comments regarding the possible establishment of shipping safety fairways (“fairways”) along the Atlantic coast identified in the *Atlantic Coast Port Access Route Study* (USCG 2015) and the *Port Access Route Study: Seacoast of New Jersey Including Offshore Approaches to the Delaware Bay, Delaware* (USCG 2021). Figure 2.3.6-4 (p. 347) in the COP, Volume II (Ocean Wind 2022), shows these fairways, which avoid the Lease Area OCS-A 0498 and a significant portion of the offshore wind lease areas OCS-A 0532 and OCS-A 0499.

According to automatic identification system data, the vicinity surrounding the Action Area is heavily trafficked by vessels entering and exiting the Delaware Bay and transiting along the coast of the United States (DNV-GL 2021). Cargo/carrier, fishing, and pleasure vessels accounted for more than 61% of vessel traffic in the area in 2019 through 2020 (DNV-GL 2021). Average daily vessel transits were 18 for the entrance to Delaware Bay, 16 for Barnegat Inlet, and 11 for the east end of Delaware Bay (DNV-GL 2021). The majority of vessel transits in the vicinity of the Project area were between 197 and 262 feet (60 and 80 meters) in length (DNV-GL 2021).

2.1.4 Underwater Noise

The Ocean Wind Development Area (WDA) lies within a dynamic ambient noise environment, with natural background noise contributed by natural wind and wave action, a diverse community of vocalizing cetaceans, and other organisms. Anthropogenic noise sources, including commercial shipping traffic in high-use shipping lanes in proximity to the Action Area, also contributed ambient sound.

The Ocean Wind WDA is located in a continental shelf environment characterized by predominantly sandy seabed sediments, with some thin clay layering (Küsel et al. 2022). No ambient underwater noise measurements were collected specifically for the Project area. Kraus et al. (2016) collected passive acoustic data between 2011 and 2015 to characterize the ambient noise environment as part of the Northeast Large Pelagic Survey Collaborative in the vicinity of WEAs offshore of Massachusetts and Rhode Island, north of the Offshore Project area. In this area, depths range from approximately 98 to 197 feet (30 to 60 meters), similar to the Project area, where water depths vary from 43 to 112 feet (13 to 34 meters). The 50th percentile of the equivalent sound levels (L_{eq}) at nine locations in the study ranged from 102 to 110 decibels relative to 1 micropascal (dB re 1 µPa, root-mean-square sound pressure level [L_{rms}]) in the 20 to 477 hertz (Hz) frequency bands (Kraus et al. 2016). The acoustically surveyed study area shows it is part of a dynamic ambient noise environment, with contributions originating from a diverse biological community of vocalizing cetaceans. Some anthropogenic sound sources (not specified in the report) were also present that contributed at varying levels to the sound environment (Kraus et al. 2016).

In addition, site-specific oceanographic conditions of the Offshore Project area were included in the underwater noise modeling conducted for Project-specific activities. From June to September, the average temperature of the upper water column (shallower than 33 to 49 feet [10 to 15 meters]) is higher, which can lead to a surface layer of increased sound speeds. This creates a downward refracting environment in which propagating sound interacts with the seafloor more than in a well-mixed environment. Increased wind mixing combined with a decrease in solar energy during winter, from December through March, results in a sound speed profile that is more uniform with depth. Average summer and winter sound speed profiles were used in the Project area acoustic propagation modeling.

2.2. CLIMATE CHANGE

NMFS lists the long-term changes in climate change as a threat for almost all marine mammal species (Hayes et al. 2020, 2021). Climate change is known to increase temperatures, alter ocean acidity, raise sea levels, and increase numbers and intensity of storms. Increased temperatures can alter habitat, modify species’ use of existing habitats, change precipitation patterns, and increase storm intensity (Love et al. 2013; USEPA 2016; NASA 2019). Increase of the ocean’s acidity has numerous effects on ecosystems including reducing available calcium carbonate that organisms use to build shells and can cause impacts on prey items and result in feeding shifts within food webs (Love et al. 2013; USEPA 2016; NASA 2019). These effects have the potential to alter the distribution and abundance of marine mammal prey. For example, between 1982 and 2018 the average center of biomass for 140 marine fish and invertebrate species along U.S. coasts shifted approximately 20 miles (32 km) north. These species also migrated an average of 21 feet (6.4 meters) deeper (USEPA 2016). Shifts in abundance of zooplankton will affect baleen whales, who travel over large distances to feed (Hayes et al. 2020).

The extent of these impacts is unknown; however, it is likely that marine mammal populations already stressed by other factors (e.g., NARWs) will likely be the most affected by the repercussions of climate change. The current impacts from climate change are likely to result in long-term consequences to individuals or populations that are detectable and measurable and have the potential to result in population-level effects through detectable and measurable impacts on the individual that could compromise the viability of the species for the NARW population specifically.

2.3. SPECIES AND CRITICAL HABITAT CONSIDERED, BUT DISCOUNTED FROM FURTHER ANALYSIS

Several species and critical habitats have the potential to be affected only by interactions with vessels outside of the offshore wind farm, offshore export cable system, and supporting ports for the proposed Project. Primarily, these interactions may be associated with transits of vessels and the transport of components from Europe during construction of the Project. Potential interactions with giant manta ray, hawksbill sea turtle, Northeast Atlantic Ocean distinct population segment (DPS) of loggerhead sea turtle (the Northwest Atlantic Ocean DPS is analyzed in subsequent sections), Atlantic salmon (all DPSs), and oceanic whitetip shark are not expected in the Project area, but these species may be affected by transits from those distant port locations during construction of the proposed Project. In other cases, the occurrence of the species, as with blue whale and shortnose sturgeon, is so unlikely or rare that the potential for adverse effects is discountable. The stressors associated with the Proposed Action do not overlap with designated critical habitat for hawksbill sea turtles. Activities that overlap with critical habitat designated for the Northwest Atlantic Ocean DPS of loggerhead sea turtle and NARW are limited to vessel transits as described below BOEM has determined that the stressors associated with the Proposed Action are **not likely to adversely affect** critical habitat designated for these species.

2.3.1 Hawksbill Sea Turtle – Endangered

While hawksbill sea turtles (*Eretmochelys imbricata*) have been recorded in New England during summer months (Lazell 1980), no sightings of the species have been documented within Atlantic coastal waters off New Jersey (CWFNJ 2021), and it was not observed in the New Jersey Department of Environmental Protection’s (NJDEP’s) Ocean/Wind Power Ecological Baseline Studies (NJDEP 2010). Two sightings of one individual each occurred during the Atlantic Marine Assessment Program for Protected Species (AMAPPS) study in 2019 off central Florida, but no other sightings were recorded prior to 2019 or in 2020 (Palka et al. 2017; NEFSC and SEFSC 2020, 2021). There are also no records of them having stranded along the New Jersey coast since 1995 (Ocean Wind 2022). The species could be encountered in the Action Area associated with Project vessels moving between the WDA and ports in the Southeast United States. In the Action Area, co-occurrence of Project vessels and individual hawksbill sea turtles is expected to be extremely unlikely based on the low potential for occurrence and the probable low encounter rate by vessels in the Action Area. At-sea vessels transiting from non-local ports traveling greater than 10 knots (5.1 m/s) would employ protected species observers (PSOs) or NMFS-approved visual detecting devices. Given the low density of hawksbill sea turtles and the low number of vessel transits from non-local ports, the likelihood of an encounter resulting in a ship strike is very low. Additionally, the general mitigation and monitoring measures proposed for all Project vessels to watch out for and avoid all sea turtles (Table 1-11) would further reduce the chance of any adverse effects to the species from the Proposed Action. Therefore, due to its rarity in the Action Area, this species is not considered further in this BA.

2.3.2 Northeast Atlantic Distinct Population Segment of Loggerhead Sea Turtle

The Northeast Atlantic DPS of loggerhead sea turtle occurs in the northeast Atlantic Ocean north of the equator, south of 60°N latitude, and east of 40°W longitude except in the vicinity of the Strait of Gibraltar, where the eastern boundary is 5°36′ W longitude. The only portion of the Action Area where Northeast Atlantic DPS loggerheads occur is along the portion of any vessel transit routes from Europe that are east of 40°W longitude. In the Action Area, co-occurrence of Project vessels and individual sea turtles is expected to be extremely unlikely; this is because of the dispersed nature of sea turtles in the open ocean and because of the intermittent presence of Project vessels. Together, these factors make it extremely unlikely that any Northeast Atlantic DPS loggerhead individuals would be struck by a Project vessel. No other effects to sea turtles from this DPS are anticipated. Therefore, this DPS is not considered further in this BA.

2.3.3 Shortnose Sturgeon – Endangered

The shortnose sturgeon (*Acipenser brevirostrum*) is anadromous, spawning and growing in freshwater and foraging in both the estuary of its natal river and shallow marine habitats close to the estuary (Bain 1997; Fernandes et al. 2010). Shortnose sturgeon occur in the Northwest Atlantic but are typically found in freshwater or estuarine environments. Historically, the species was found in coastal rivers along the entire east coast of North America. Because of threats such as habitat degradation, water pollution, dredging, water withdrawals, fishery bycatch, and habitat impediments (e.g., dams), the species is now listed as endangered throughout the entire population range. Within the Mid-Atlantic region, shortnose sturgeon are found in the Delaware and Hudson River estuaries (NOAA Fisheries 2018). Movement of shortnose sturgeon between rivers is rare, and their presence in the marine environment is uncommon (BOEM 2018b); therefore, the species is not expected to be found in the Offshore Project area and is unlikely to be found in the estuaries of Barnegat Bay and Great Egg Harbor (offshore export cable corridors) (NOAA Fisheries 2018). Shortnose sturgeon may be encountered by vessels transiting from the potential foundation fabrication facility in Paulsboro, New Jersey, which is located on the Delaware River just south of Philadelphia, Pennsylvania, or the WTG pre-assembly site in Hope Creek, New Jersey, or Norfolk, Virginia. It is estimated that 99 trips would take place to the Paulsboro port facility and 99 trips to the Hope Creek or Norfolk site. Over an 8-year span from 2008 to 2016, 11 of 53 (21%) salvaged shortnose sturgeon carcasses that stranded were found in the Delaware River (NMFS 2021a). However, only 6 of 11 (55%) of that subset indicated interaction with a vessel. Of two salvaged shortnose sturgeon from 2019 to 2020, none were discovered in the Delaware River (NMFS 2021a). Given the amount of traffic in the Delaware River and the small increase in traffic due to the Project, the likelihood of a vessel strike of a shortnose sturgeon is extremely low. When considering vessel transits to and from the Norfolk site, the potential for interaction with shortnose sturgeon could occur if the Chesapeake and Delaware canal (C and D canal) route were taken. Data on shortnose sturgeon in this waterbody are limited, but tagged individuals have been recorded in the C and D canal and one was recorded outside the river in which it was tagged (Welsh et al. 2002). Salvage data for the C and D canal are even more rare than acoustic data. No shortnose sturgeon carcasses have been salvaged in recent years; however, it is assumed that three Atlantic sturgeon carcasses were discovered over a 7-year period (NMFS 2021a). Shortnose sturgeon vessel interactions were shown to be considerably fewer than Atlantic sturgeon vessel interactions in the Delaware River (NMFS 2021a). Given the amount of traffic in the C and D canal and the small increase in traffic due to the Project, the effect of vessel strikes on shortnose sturgeon is extremely low in this area. Lastly, if a vessel were to transit between the Project and Charleston, South Carolina, the intracoastal waterway route would have to be taken in order to impact shortnose sturgeon. This is extremely unlikely given the inefficiencies of the route. Therefore, potential impacts on shortnose sturgeon from the Project are expected to be insignificant, and this species is not considered further in this BA.

2.3.4 Giant Manta Ray – Threatened

The giant manta ray (*Manta birostris*) is the world's largest ray and can be found worldwide in tropical, subtropical, and temperate waters between 35°N and 35°S latitudes. In the western Atlantic Ocean, this includes South Carolina south to Brazil and Bermuda. Sighting records of giant manta rays in the Mid-Atlantic and New England are rare, but individuals have been observed as far north as New Jersey (Miller and Klimovich 2017) and Block Island (Gudger 1922). The species is unlikely to occur within the Project area as water temperatures are likely at the lower range of its tolerance. Additionally, these rays frequently feed in waters at depths of 656 to 1,312 feet (200 to 400 meters) (NOAA Fisheries 2019a), depths much greater than waters found within the Project area. However, giant manta rays travel long distances during seasonal migrations and may be found in upwelling waters at the shelf break south or east of the Project area. There is a small chance that the transport of foundation and WTG components from Europe could traverse some upwelling areas. The species could also be encountered in the Action Area associated with Project vessels moving between the WDA and ports in the Southeast United States.

In the Action Area, co-occurrence of Project vessels and individual giant manta rays is expected to be extremely unlikely based on the low potential for occurrence and the probable low encounter rate by vessels in the Action Area. At-sea vessels transiting from non-local ports are not anticipated to employ PSOs or travel at reduced speeds. Given the low density of giant manta rays and the low number of vessel transits from non-local ports, the likelihood of an encounter resulting in a ship strike is very low. Additionally, the general mitigation and monitoring measures proposed for all Project vessels to watch out for and avoid all giant manta rays would further reduce the chance of any adverse effects to the species from the Proposed Action. The likelihood of any potential impacts resulting from the Project would be discountable; therefore, giant manta rays are not considered further in this BA.

2.3.5 Atlantic Salmon – Endangered - Gulf of Maine Distinct Population Segment

The endangered Gulf of Maine DPS (Androscoggin River, Maine north to the Dennys River, Maine) of Atlantic salmon (*Salmo salar*) does not occur in the Project area (BOEM 2018b). Smolts migrate from their natal river to foraging grounds in the Western North Atlantic off Canada and Greenland, and after one or more winters at sea, adults return to their natal river to spawn (Fay et al. 2006). Additionally, the vessel transit routes from the mid- and southeast Atlantic and Europe do not overlap with Atlantic salmon presence. It is noted that even if Atlantic salmon presence overlapped with vessel transit routes, vessel strikes are not an identified threat to the species (74 Federal Register [FR] 29344) or their recovery (USFWS and NMFS 2019). Therefore, the Project is not expected to result in detectable effects to salmon, and this species is not considered further in this BA.

2.3.6 Oceanic Whitetip Shark – Threatened

The oceanic whitetip shark (*Carcharhinus longimanus*) is typically found offshore in the open ocean, on the OCS, or around oceanic islands in water deeper than 604 feet (184 meters). The species has a clear preference for open ocean waters between latitudes of 10°N and 10°S but can be found in decreasing numbers out to 30°N and 35°S, with abundance decreasing with greater proximity to continental shelves (Young et al. 2017). In the western Atlantic Ocean, oceanic whitetip sharks occur from Maine to Argentina, including the Caribbean and Gulf of Mexico. In the central and eastern Atlantic Ocean, the species occurs from Madeira, Portugal, south to the Gulf of Guinea, and possibly in the Mediterranean Sea. There is a small chance that the transport of foundation and WTG components from Europe would interact with oceanic whitetip sharks. At-sea vessels transiting from non-local ports are not anticipated to travel at reduced speeds. However, given the low density of oceanic whitetip sharks and the low number of vessel transits from non-local ports, the likelihood of an encounter resulting in a ship strike is very low. Vessel strikes are not identified as a threat in the status review (Young et al. 2017), listing determination (83 FR 4153), or the recovery outline (NMFS 2018a). There is no information to suggest that vessels in the ocean have any effects on oceanic whitetip sharks. Therefore, effects on the oceanic whitetip shark are not expected even if migrating individuals co-occur with Project vessels, and this species is not considered further in this BA.

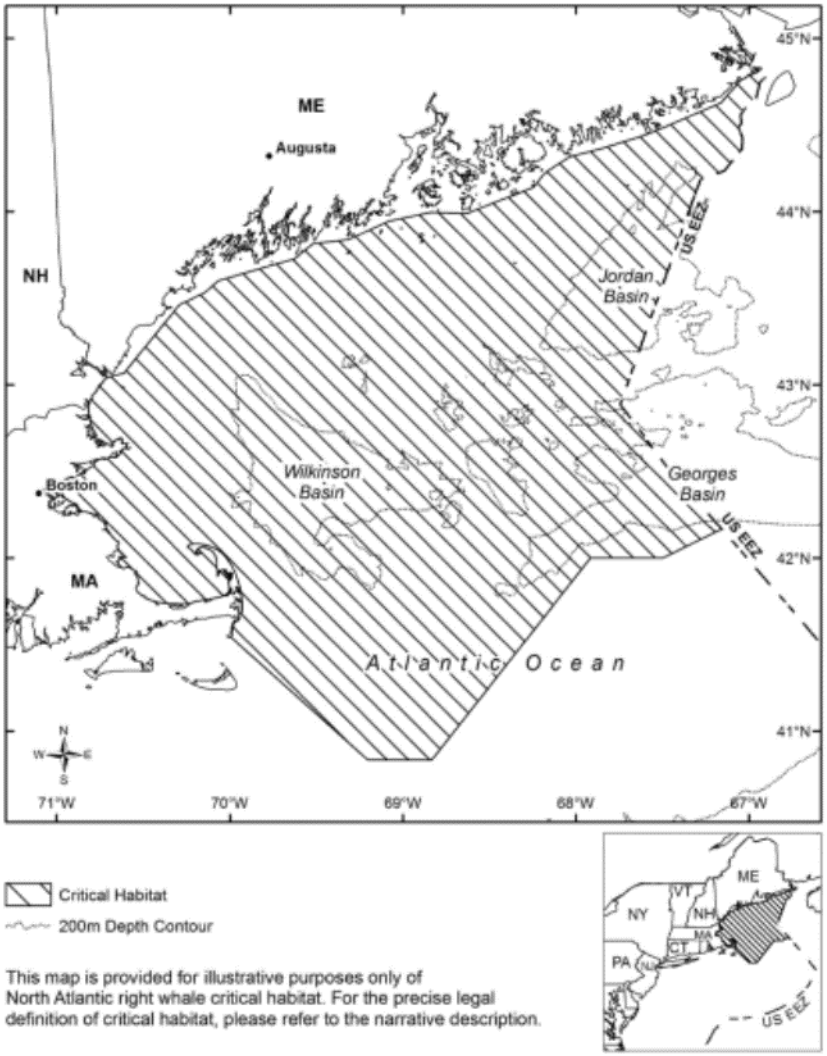
2.3.7 Critical Habitat Designated for the North Atlantic Right Whale

In 1994, NMFS designated critical habitat for the NARW population in the North Atlantic Ocean (59 FR 28805). This critical habitat designation included portions of Cape Cod Bay and Stellwagen Bank, the Great South Channel (each off the coast of Massachusetts), and waters adjacent to the coasts of South Carolina, Georgia, and the east coast of Florida. These areas were determined to provide critical feeding, nursery, and calving habitat for the North Atlantic population of NARWs.

In 2016, NMFS revised designated critical habitat for the NARW with two new expanded areas. The areas designated as critical habitat contains approximately 29,763 square nautical miles (nm2) (102,084.2 km2) of marine habitat in the Gulf of Maine and Georges Bank region (Unit 1) (Figure 2-1) and off the Southeast U.S. coast (Unit 2) (Figure 2-2). Units 1 and 2 are both outside of the Project area; however, Project vessels may transit through Unit 2 if Charleston, South Carolina, is used for cable staging instead of Port Elizabeth, New Jersey, Europe, or transported directly from the cable supplier (Ocean Wind 2022). Unit 1, which contains the physical and biological features essential to NARW foraging habitat, occurs outside of the Project area and is not discussed below.

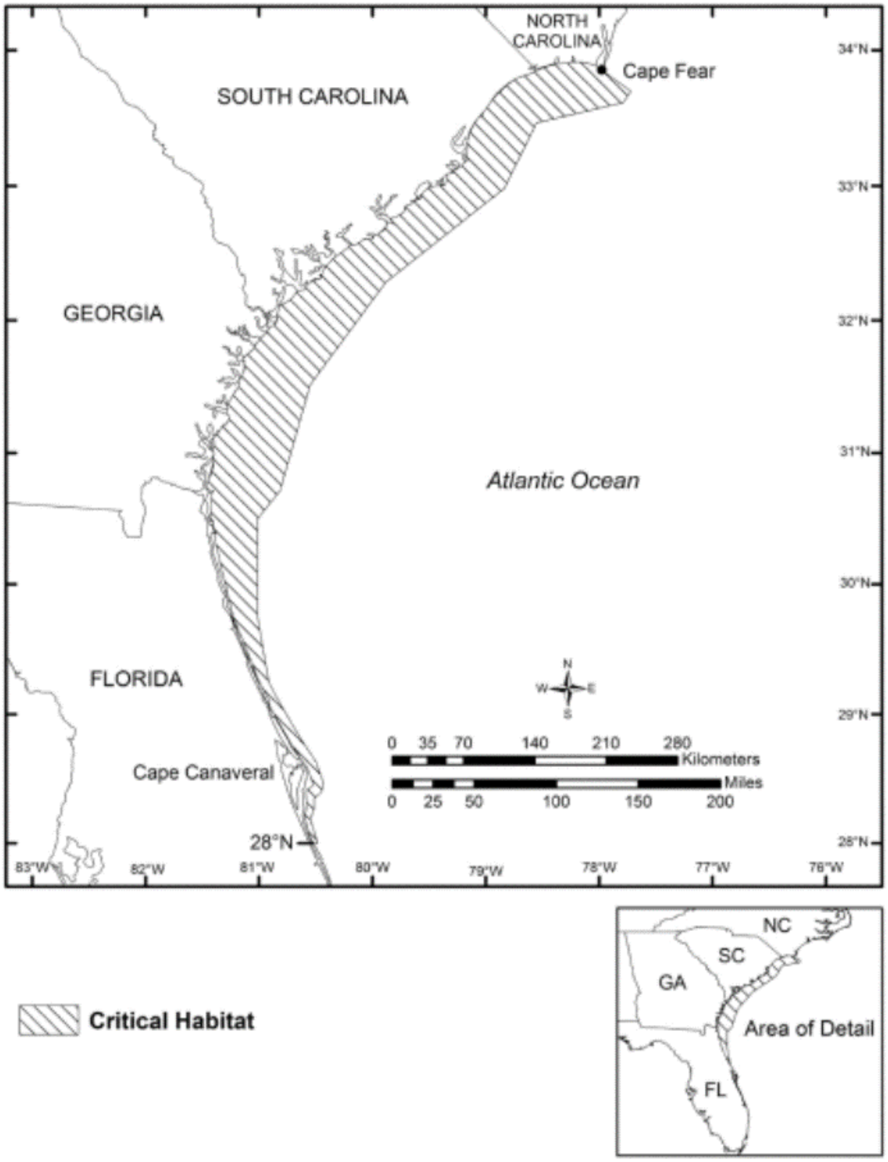
The physical and biological features (PBFs) essential to the conservation of NARW calving habitat, which provide calving area functions in Unit 2 are: (1) calm sea surface conditions of Force 4 or less on the Beaufort wind scale; (2) sea surface temperatures from a minimum of 44.6°F (7°C), and never more than 62.6°F (17°C); and (3) water depths of 19.7 to 91.9 feet (6 to 28 meters) where these features co-occur over contiguous areas of at least 231 nm2 (792.3 km^2) of ocean waters during the months of November through April. When these features are available, they are selected by North Atlantic right whale cows and calves in dynamic combinations that are suitable for calving nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves (81 FR 4838).

Both areas (Unit 1 and Unit 2) are outside of the Action Area, but vessel transits through Unit 2 may occur. However, vessel transits through Unit 2 as a result of the Proposed Action will not affect the physical oceanographic conditions or modify the oceanographic features associated with calving area functions (calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale, sea surface temperatures, or water depths) when they occur from November through April. No effects of the Proposed Action were identified that would affect that ability of NARW cows and calves to select an area with these features, when they co-occur, within the ranges specified. The presence of a small number of vessels is not expected to affect the selection of these critically important features by NARWs. As a precaution, and required by federal regulations, all vessels must maintain 1,640 feet (500 meters) or greater from any sighted NARW. Compliance with this regulation aids in ensuring no adverse effects on the ability of whales to select an area with the co-occurrence of these features. Therefore, it was determined that the Project will have no effect on Unit 2 of NARW critical habitat and is not considered further.



Source: 81 FR 4838

Figure 2-1 Map Identifying Designated Critical Habitat in the Northeastern Foraging Area for the Endangered North Atlantic Right Whale



Source: 81 FR 4838

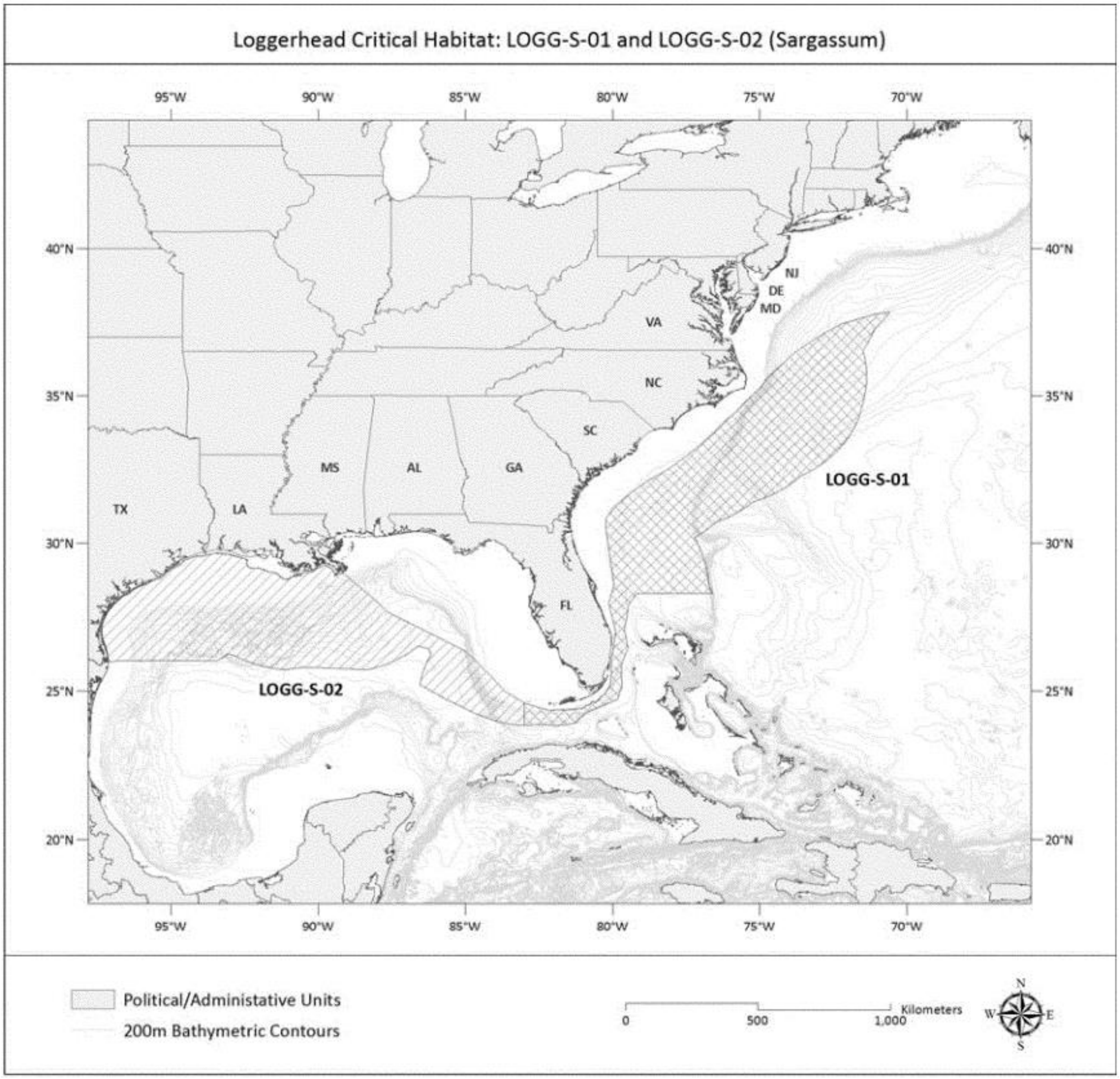
Figure 2-2 Map Identifying Designated Critical Habitat (Unit 2) in the Southeastern Calving Area for the Endangered North Atlantic Right Whale

2.3.8 Critical Habitat Designated for the Northwest Atlantic Ocean Distinct Population Segment of Loggerhead Sea Turtle

Designated critical habitat for the Northwest Atlantic Ocean DPS of the loggerhead sea turtle includes 38 occupied marine areas in the Atlantic Ocean and Gulf of Mexico that contain nearshore reproductive habitat, winter area, breeding areas, constricted migratory corridors, and/or *Sargassum* habitat (79 FR 39856). There is no designated critical habitat for this DPS located within the Project area. However, there is potential overlap of the loggerhead overwintering, *Sargassum* (Figure 2-3), and migratory (Figure 2-4 critical habitat designated off North Carolina and vessels in the Action Area transiting to southeastern U.S. ports if Charleston, South Carolina, is used for cable staging instead of Port Elizabeth, New Jersey, Europe, or transported directly from the cable supplier (Ocean Wind 2022).

The *Sargassum* critical habitat (LOGG-S-01) designated at the outer boundary of the U.S. exclusive economic zone (EEZ), along the southeastern United States until the EEZ coincides with the Gulf Stream (Figure 2-3; 79 FR 39892). This area encompasses approximately 150,496 square miles (mi^2) (389,784 km^2) that begins its northern latitude roughly even with the Maryland Eastern Shore and extends south through the Straits of Florida until it reaches the Dry Tortugas. Though it is unlikely, potential exists for Project vessels to enter LOGG-S-01 if transiting between Charleston, South Carolina, and the Project area. The PBFs for *Sargassum* critical habitat are: (1) convergence zones, surface-water down-welling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads; (2) *Sargassum* concentrations that support adequate prey abundance and cover; (3) available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods; and (4) sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads (i.e., <33-foot [>10-meter] depth). When these features are available, they support the development and foraging of young loggerheads.

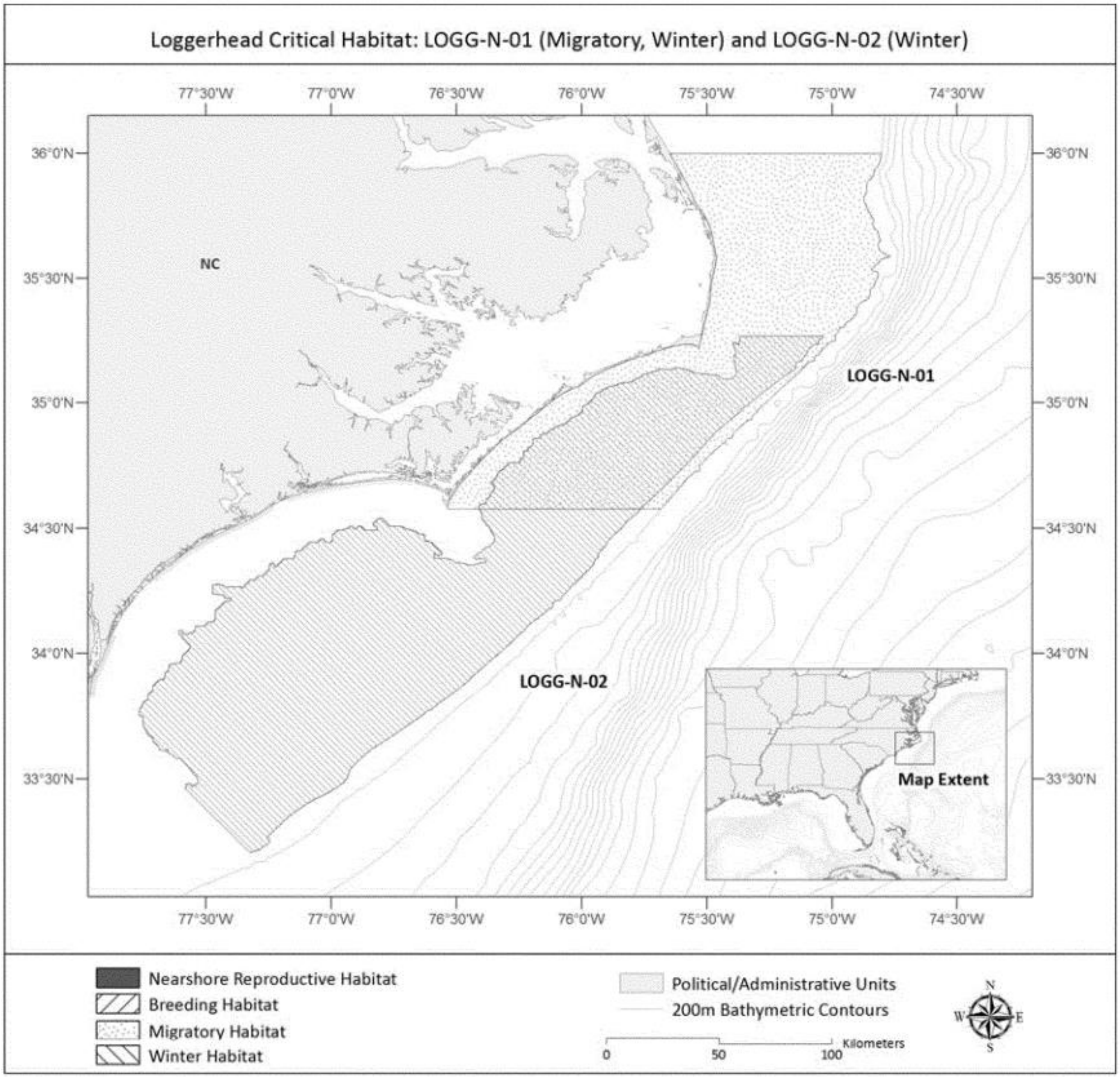
The North Carolina Constricted Migratory Corridor critical habitat (LOGG-N-01) designated from the shoreline to the 656-foot (200-meter) depth contour (continental shelf) surrounds the coastal waters of Cape Hatteras, North Carolina, approximately 60 miles (46 nm, 85 km) north and southwest (79 FR 39890). It spans approximately 4,135 mi^2 (10,709 km^2). Due to its proximity to shore, the likelihood of Project vessels entering migratory LOGG-N-01 habitat if transiting between Charleston, South Carolina, and the Project area is greater than the *Sargassum* habitat. The PBFs for loggerhead migratory critical habitat are: (1) constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and (2) passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas. When these features are available, they create a narrow pinch point through which migrating loggerheads must pass.



Source: 79 FR 39912

Figure 2-3 Map Identifying Designated Sargassum Critical Habitat in the Southeastern Calving Area for the Threatened loggerhead Sea Turtle

The North Carolina winter concentration area consists of a northern portion contained within LOGG-N-01 and a southern portion designated the LOGG-N-02 winter habitat (Figure 2-4; 79 FR 39890). The winter concentration area is bounded by the 65.6- and 328-foot (20- and 100-meter) depth contours, with the northern extent beginning at Cape Hatteras, North Carolina, and stretching to Cape Fear, North Carolina. The northern portion of the North Carolina winter concentration area encompasses 1,571 mi^2 (4,069 km^2), and the southern portion is composed of 5,007 mi^2 (12,967 km^2). Like the migratory critical habitat, the proximity of the winter concentration area to shore increases the likelihood of Project vessels entering migratory LOGG-N-01 and LOGG-N-02 habitat if transiting between Charleston, South Carolina, and the Project area. The PBFs for loggerhead winter critical habitat are: (1) water temperatures above 50°F (10°C) from November through April; (2) continental shelf waters in proximity to the western boundary of the Gulf Stream; and (3) water depths between 65.6 and 328 feet (20 and 100 meters). When these features are available, they create suitable habitat for a high concentration of juveniles and adults during the winter months.



Source: 79 FR 39893

Figure 2-4 Map Identifying Designated Migratory and Winter Concentration Critical Habitat in the Southeastern Calving area for the Threatened Loggerhead Sea Turtle

All Northwest Atlantic loggerhead critical habitat areas (LOGG-S-01, LOGG-N-01, and LOGG-N-02) are outside of the Action Area, but vessel transits through designated areas may occur. However, vessel transits through LOGG-S-01, LOGG-N-01, and LOGG-N-02 due to the Proposed Action will not affect the physical oceanographic conditions or modify the oceanographic features associated with growth, migratory, and wintering area functions. No effects of the Proposed Action were identified to foraging habitat, the seafloor, or prey items. Further, no effects to sufficient prey availability or prey quality were identified because of the Proposed Action. Vessel transits due to the Proposed Action would not decrease water temperatures below 50°F (10°C) from November through April, alter habitat in continental shelf waters near the western boundary of the Gulf Stream, or change water depths between 65.6 and 328 feet (20 and 100 meters). Though the Project Action Area may overlap with the designated areas mentioned previously, the physical and oceanographic features of the habitat would not be affected in a manner that adversely impacts the critical habitat.

Therefore, we have determined that the Project will have no effect on LOGG-S-01, LOGG-N-01, and LOGG-N-02 of northwest Atlantic loggerhead critical habitat and is not considered further in this BA.

2.3.9 Critical Habitat for All Listed Distinct Population Segments of Atlantic Sturgeon

Five DPSs of Atlantic sturgeon were listed under the ESA in 2012 (77 FR 5880, 77 FR 5914): Chesapeake Bay (endangered), Carolina (endangered), New York Bight (endangered), South Atlantic (endangered), and Gulf of Maine (threatened). The final rule for Atlantic sturgeon critical habitat (all listed DPSs) was issued on August 17, 2017 (82 FR 39160). This rule includes 31 units, all rivers, occurring from Maine to Florida. No marine habitats were identified as critical habitat because the PBFs in these habitats essential for the conservation of Atlantic sturgeon could not be identified.

Critical habitat designations for the Atlantic sturgeon Gulf of Maine DPS encompasses seven rivers of Maine, New Hampshire, and Massachusetts. Chesapeake Bay Atlantic sturgeon DPS critical habitat includes five main tributaries to the bay: the Potomac, Rappahannock, York, James, and Nanticoke Rivers. The South Atlantic DPS Atlantic sturgeon critical habitat is composed of nine rivers of South Carolina, Georgia, and Florida. The Project area is a significant distance from the tributaries of the Gulf of Maine, Chesapeake Bay, and South Atlantic DPSs. The only Project activity that may affect Atlantic sturgeon critical habitat are Project vessel transits within the Action Area. Project vessel transits throughout the Action Area do not include the rivers identified for the Gulf of Maine or South Atlantic critical habitats and are not discussed further. Project vessels transiting between the WDA and Europe, Atlantic City, New Jersey, and Port Elizabeth, New Jersey would not travel through critical habitat of any Atlantic sturgeon DPS. Although the Project Action Area may include Norfolk, Virginia, for WTG pre-assembly and load-out if Hope Creek, New Jersey, is not chosen, the ports in Norfolk, Virginia are east of and outside the James River Unit 5 critical habitat boundary, therefore, the Chesapeake Bay critical habitat is not discussed further (82 FR 39253; Ocean Wind 2022). Project vessels would transit through critical habitat of the Atlantic sturgeon New York Bight DPS and may transit through the critical habitat of the Atlantic sturgeon Carolina DPS. Both transits are discussed below.

Critical habitat designations for the New York Bight DPS covering 340 miles (527 km) include the Hudson, Connecticut, and Housatonic Rivers to where the mainstem discharges into either New York Harbor or Long Island Sound; however, the Action Area does not overlap with these rivers. The final river within the New York Bight Atlantic sturgeon critical habitat, New York Bight Unit 4 (Figure 2-5), does overlap with the Action Area. The downstream boundary of New York Bight Unit 4 are the markers that separate the Delaware River from Delaware Bay at river mile 48.5 (river km 78), while the upstream boundary is the Trenton-Morrisville Route 1 Toll Bridge at river mile 132.5 (river km 213.5; 89 FR 39248). Project vessels would transit through New York Bight Unit 4 from the Paulsboro Marine Terminal in Paulsboro, New Jersey (approximately river mile 86.3 [river km 139]) and the New Jersey Wind Port in Hope Creek, New Jersey (approximately river mile 51 [river km 82]) to the Wind Farm Area.

The Carolina Atlantic sturgeon critical habitat includes approximately 1,205 miles (1,939 km) of riverine habitat in 12 rivers between the two Carolinian states. The Roanoke, Tar-Pamlico, Neuse, Cape Fear, Northeast Cape Fear, Waccamaw, Pee Dee, Black, Santee, North Santee, and South Santee rivers all contain critical habitat for the Carolina DPS of Atlantic sturgeon and are outside the Project and Action areas. However, Carolina Unit 7 critical habitat (Figure 2-6) contains lower portions of the Cooper River/Port of Charleston, South Carolina that could include Project vessel ports of call if cable staging is not conducted in Port Elizabeth, New Jersey, Europe, or transported directly from the cable supplier (Ocean Wind 2022).

The PBFs vital to conservation of the New York Bight DPS of Atlantic sturgeon contained within these designated critical habitats, but may be ephemeral or vary spatially across time, include:

1. Hard bottom substrate (e.g., rock, cobble, gravel, limestone, and boulder) in low salinity waters (i.e., 0.0 to 0.5 parts per trillion [ppt] range) for settlement of fertilized eggs, refuge, growth, and development of early life stages;
2. Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;
3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, and gear) between the river mouth and spawning sites necessary to support:
   - Unimpeded movements of adults to and from spawning sites;
   - Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and
   - Staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (e.g., at least 3.9 feet [1.2 meters]) to ensure continuous flow in the main channel at all times when any sturgeon in any life stage would be in the river; and
4. Water between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:
   - Spawning;
   - Annual and interannual adult, subadult, larval, and juvenile survival; and
   - Larval, juvenile, and subadult growth, development, and recruitment (e.g., 55°F [13°C] to 78.8°F [26°C] for spawning habitat and no more than 86°F [30°C] for juvenile rearing habitat, and 6 mg/L or greater dissolved oxygen for juvenile rearing habitat). 82 FR 39160.

For the Carolina DPS of Atlantic sturgeon, PBFs 1 through 3 are the same as the New York Bight DPS of Atlantic sturgeon; however, PBF 4 specifies that the water temperature, salinity, and oxygen values vary slightly, "…Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6.0 mg/L DO [dissolved oxygen] or greater likely supports juvenile rearing habitat, whereas DO less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 77°F (25°C). In temperatures greater than 78°F (26°C), DO greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 55 to 78°F (13 to 26°C) likely support spawning habitat." 82 FR 39160. Vessels transiting from the Project area to Hope Creek, New Jersey; Paulsboro, New Jersey; or Charleston, South Carolina, would travel through the New York Bight and Carolina DPSs.

PBF 1: Hard-bottom substrate (e.g., rock, cobble, gravel, limestone, and boulder) in low salinity waters (i.e., 0.0 to 0.5 parts per trillion [ppt] range) for settlement of fertilized eggs, refuge, growth, and development of early life stages

The components of PBF 1 are the preservation of hard substrate and their presence in low salinity waters. Project vessels would not interact with the bottom or alter the substrate of the rivers. The Delaware River Basin Commission identifies river mile 67 (river km 107.8) as the lower part of the long-term median range for the salt front (defined as 0.25 ppt) in April and river mile 76 (river km 122.3) as the upper part of the long-term median range in September (DRBC 2021). Historically, the salt front is reported at approximately river mile 57.4 (river km 92.3). The location of the salt front varies depending on conditions of freshwater input, tidal currents, storms, and weather conditions, etc. These variations can cause a specific salinity value or range to move upstream or downstream by as much as 10 river miles (~16 river km) in a day due to semi-diurnal tides, and by more than 20 river miles (~32 river km) over periods ranging from a day to weeks or months due to storm and seasonal effects on freshwater inflows (NMFS 2021a). Given variability of the location of the salt front, salinity values surrounding the salt front, and lack of evidence that transiting vessels have an impact on salinity levels, Project vessels would not affect PBF 1 for the Delaware River.

The salinity profile of the Cooper River system has undergone major changes throughout the end of the 20th century resulting from diversion and rediversion projects (Althausen Jr. and Kjerfve 1992). Documented suitable spawning locations have only been found north of the Pinopolis Dam where Atlantic sturgeon have been unsuccessful at passage (81 FR 36086). The location of the salt front in the Cooper River is reported at the confluence of the Black and Cooper rivers, which is approximately 14.7 river miles (23.7 river km) north of the northern extent of the Port of Charleston and approximately 6.4 river miles (10.3 river km) north of the northern extent of Port of Charleston-North where Project vessels have the potential to transit (SCDNR 2020). Therefore, PBF 1 for the Carolina Unit 7 does not occur within the Action Area, and Project activities would have no effect on PBF 1.

PBF 2: Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development

The components of PBF 2 are a gradual salinity gradient and presence of soft substrate between river mouth and spawning locations. Habitat containing this PBF in the Delaware River is found from river mile 48 (river km 77) to river mile 67 (river km 107.8). As mentioned in the previous section, salinity levels in the Delaware River vary on short- and long-term scales. Soft substrates make up a majority of the bottom type throughout this stretch of the Delaware River (Anderson et al. 2014). Habitat containing PBF 2 in the Cooper River can be found between river mile 0 (river km 0) and river mile 16.4 (river km 26.4). As mentioned above, given that vessels would not affect salinity or bottom substrate, Project vessels would not affect PBF 2 in either the New York Bight or Carolina DPSs.

PBF 3: Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, and gear) between the river mouth and spawning sites

The components of PBF 3 are adequate depth and lack of physical barriers that allow for sturgeon movement of various life stages between the river mouth and spawning sites. Water of appropriate depth and absent physical barriers to passage between the river mouth and spawning sites necessary to support: (i) Unimpeded movement of adults to and from spawning sites; (ii) Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and, (iii) Staging, resting, or holding of subadults or spawning condition adults, is present throughout the extent of critical habitat designated in the Delaware River. Water depths in the main river channels is also deep enough (e.g., at least 3.9 feet [1.2 meters]) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. Project vessels would neither alter the water depth or flow of the Delaware River or Cooper River, nor present a barrier to passage of any Atlantic sturgeon life stage. Therefore, Project vessels would not affect PBF 3.

New York Bight DPS PBF 4:

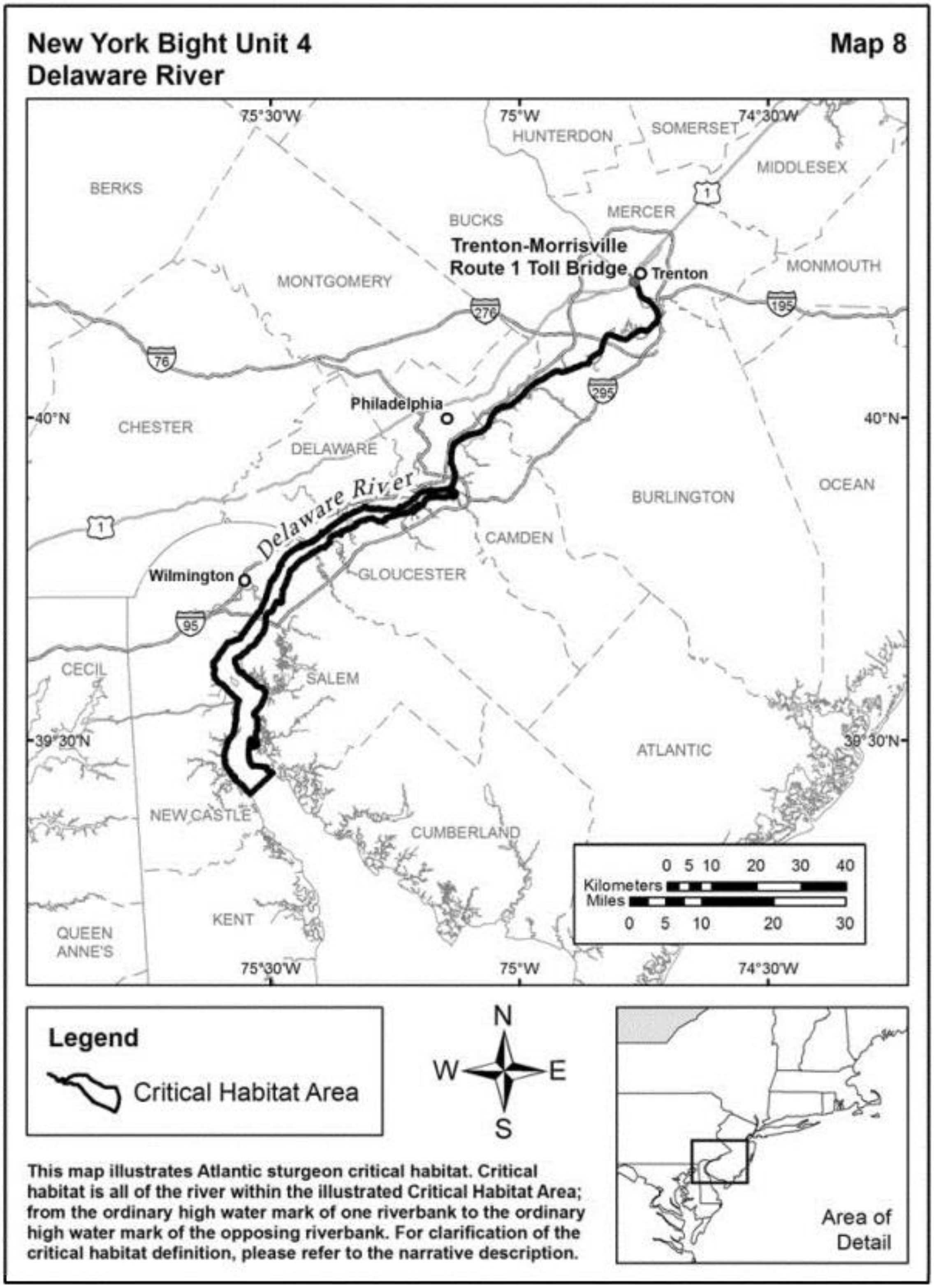
Components of PBF 4 for the New York Bight DPS are dissolved oxygen and temperatures that support reproduction and recruitment within the habitat range, especially near the bottom meter of the water column. These water quality conditions are interactive and both temperature and salinity influence the dissolved oxygen saturation for a particular area. Project vessels would transit through habitat containing PBF 4 of the New York Bight DPS. However, vessels would not affect temperature, salinity, or dissolved oxygen of the water column.

Carolina DPS PBF 4:

The main components of PBF for the Carolina DPS are the same as for New York Bight DPS, however the additional caveat of variability is introduced: "…Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6.0 mg/L DO or greater likely supports juvenile rearing habitat, whereas DO less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 77°F (25°C). In temperatures greater than 78°F (26°C), DO greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 55 to 78°F (13 to 26°C) likely support spawning habitat." As mentioned above, these water quality conditions are interactive and both temperature and salinity influence the dissolved oxygen saturation for a particular area. Project vessels would transit through habitat containing PBF 4 of the Carolina DPS. However, vessels would not affect temperature, salinity, or dissolved oxygen of the water column.

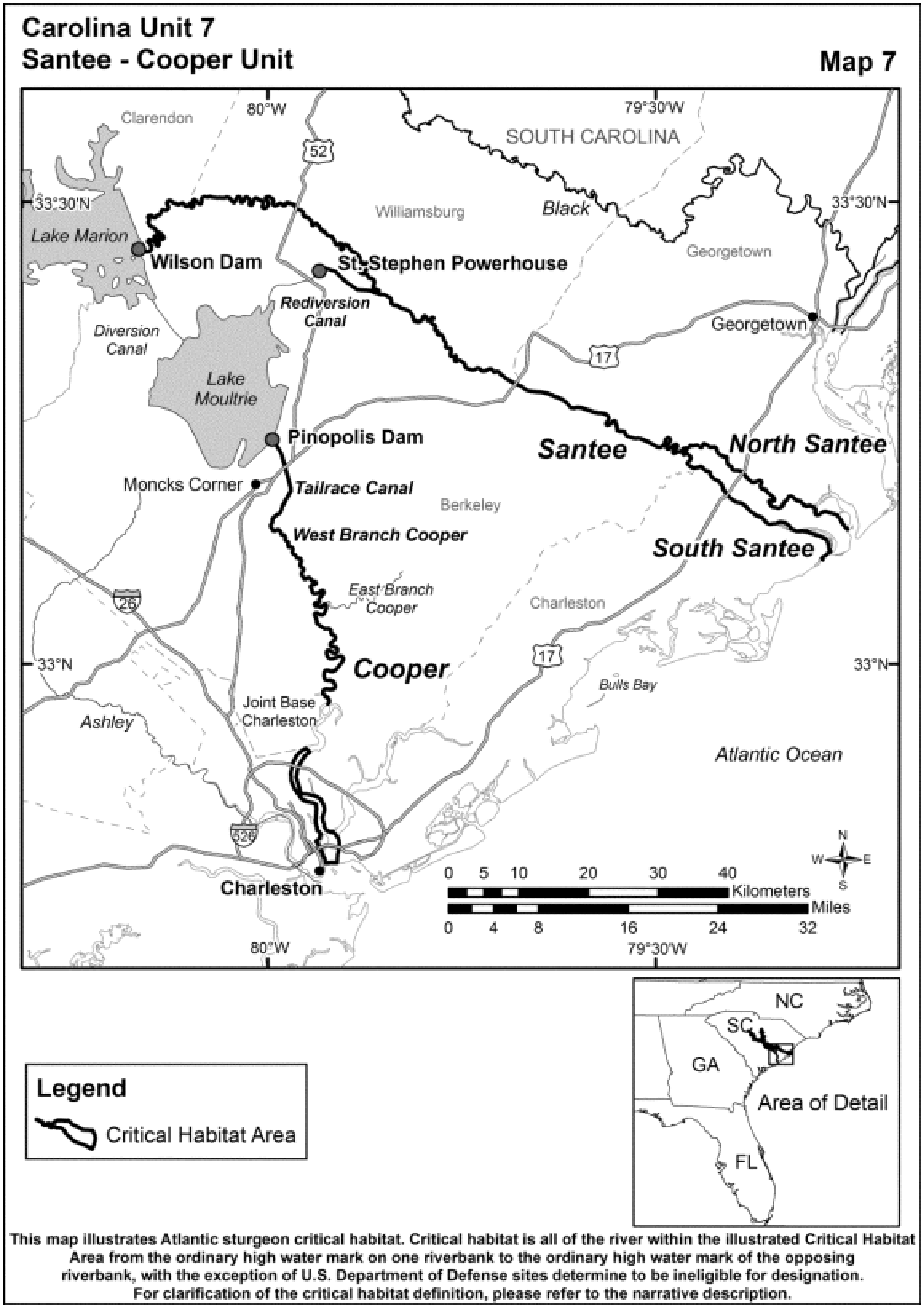
Summary of Effects on Atlantic Sturgeon Critical Habitat

Given the lack of vessel impacts on the essential features of the critical habitat, it is determined that Project activities will have no effect on PBFs 1, 2, 3, and 4. Based on this conclusion and the analysis laid out above, the Project will have **no effect** on the critical habitat designated for the New York Bight, Chesapeake Bay, and Carolina DPSs of Atlantic sturgeon and this habitat is not considered further in this BA.



Source: 82 FR 39248

Figure 2-5 Map Identifying Designated Critical Habitat in the New York Bight Distinct Population Segment for the Endangered Atlantic Sturgeon within the Action Area



Source: 82 FR 39248

Figure 2-6 Map Identifying Designated Critical Habitat in the Carolina Distinct Population Segment for the Endangered Atlantic Sturgeon Potentially within the Action Area

2.4. THREATENED AND ENDANGERED SPECIES CONSIDERED FOR FURTHER ANALYSIS

Ten ESA-listed species under NMFS jurisdiction are considered for further analysis: five large whale species, four sea turtle species, and one fish species. These species and their potential occurrence in the Action Area are summarized in Table 2-1. Information about species occurrence was drawn from several available sources. These include state ecological baseline studies of marine species known or likely to occur in New Jersey coastal and offshore waters (NJDEP 2010); the AMAPPS, which coordinates data collection and analysis to assess the abundance, distribution, ecology, and behavior of marine mammals in the U.S. Atlantic (NJDEP 2006, 2010; NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2018, 2019, 2020, 2021); habitat-based cetacean density models for the U.S. EEZ of the East Coast (eastern United States) and Gulf of Mexico developed by the Duke University Marine Geospatial Ecology Lab in 2016 (Roberts et al. 2016); the most current marine mammal stock assessments (Hayes et al. 2020); and other specific research (e.g., Davis et al. 2020). Additional species-specific sources of information are cited below where appropriate.

Table 2-1 Federal Register References for ESA Species Considered for Further Analysis

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Blue Whale (Balaenoptera musculus)	E – 35 FR 18319		07/1998 10/2018
Fin Whale (Balaenoptera physalus)	E – 35 FR 18319	-- --	75 FR 47538 07/2010
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	81 FR 4837	70 FR 32293 08/2004
Sei Whale (Balaenoptera borealis)	E – 35 FR 18319	-- --	12/2011
Sperm Whale (Physeter macrocephalus)	E – 35 FR 18319	-- --	75 FR 81584 12/2010
Marine Reptiles			
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693	FR Not Available 10/1991 – U.S. Atlantic
Kemp’s Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	09/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 and 77 FR 4170	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39856	74 FR 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 01/2009 – Northwest Atlantic

Species	ESA Status	Critical Habitat	Recovery Plan
Fishes			
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus)* – Carolina, Chesapeake, Gulf of Maine, New York Bight, South Atlantic DPSs	E – 77 FR 5913	82 FR 39160	-- --

DPS=Distinct Population Segment; E=Endangered; ESA = Endangered Species Act; FR = Federal Register; T=Threatened

General information about these species, status, threats, use of the Action Area, and additional information about habitat use that is pertinent to this consultation are summarized in Table 2-2 and described in the following sections.

Table 2-2 Summary of Status, Occurrence in Project Area, and Critical Habitat for Species Considered for Further Analysis

Common Name	Scientific Name	ESA Status	Occurrence within Project Area[a]	Critical Habitat Occurs in Area of Direct Effects	Stock (NMFS) or Distinct Population Segment
Marine Mammals					
Blue whale	*Balaenoptera musculus*	Endangered	Rare	Not yet designated	Western North Atlantic
Fin whale	*Balaenoptera physalus*	Endangered	Regular	Not yet designated	Western North Atlantic
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Regular	No. Critical habitat areas is 250 miles (217 nm, 402 km) from the Project area.	Western North Atlantic
Sei whale	*Balaenoptera borealis*	Endangered	Rare	Not yet designated	Nova Scotia
Sperm whale	*Physeter macrocephalus*	Endangered	Uncommon	Not yet designated	North Atlantic
Sea Turtles					
Green sea turtle	*Chelonia mydas*	Threatened	Uncommon	No. Critical habitat areas is 1,500 miles (1,303 nm; 2,414 km) from the Project area.	North Atlantic DPS
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Common	No. Nearest critical habitat is 1,553 miles (2,500 km; 1,349 nm) from the Project Area.	Not applicable
Loggerhead sea turtle	*Caretta*	Threatened	Common	No. Critical habitat areas is 250 miles (217 nm, 402 km) from the Project area.	Northwest Atlantic Ocean DPS

Common Name	Scientific Name	ESA Status	Occurrence within Project Area[a]	Critical Habitat Occurs in Area of Direct Effects	Stock (NMFS) or Distinct Population Segment
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	Uncommon	Not yet designated	Not applicable
Marine Fish					
Atlantic Sturgeon	*Acipenser oxyrinchus*	Endangered	Common	Yes, Action Area overlaps with critical habitat from vessel transits in the Delaware River	Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs

Notes:
[a] Occurrence in the Offshore Survey Corridor was derived from sightings and information in NJDEP (2006, 2010); (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2018, 2019, 2020, 2021); Roberts et al. (2016); Palka et al. (2017); Hayes et al. (2021); and NMFS (2021). The species known to occur in the Project area and vicinity, and expected to occur in the survey area, are addressed based on their reported occurrence of rare to regular (i.e., common).
DPS = distinct population segment; ESA = Endangered Species Act; km = kilometers; NEFSC = Northeast Fisheries Science Center; NJDEP = New Jersey Department of Environmental Protection; nm = nautical miles; NMFS = National Marine Fisheries Service; SEFSC = Southeast Fisheries Science Center

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3. EFFECTS OF THE PROPOSED ACTION

Effects of the Proposed Action are evaluated for the potential to result in harm to listed species. If a Project-related activity may affect a listed species, the exposure level and duration of effects are evaluated further for the potential for those effects to harass or injure listed species. The following sections present the potential Project-related effects on listed species of marine mammals, sea turtles, and Atlantic sturgeon from the construction/installation, O&M, and decommissioning stages over the lifetime of the Project. This effects discussion is organized by stressor responsible for impacts to each ESA-animal group (e.g., marine mammals, sea turtles, and marine fish). Each subsection addresses potential impacts applicable to Project phases: pre-construction (pre-C), construction (C), operations and maintenance (O&M), and decommissioning (D). The applicable Project phase is identified at the end of the subsection header in brackets.

3.1. DETERMINATION OF EFFECTS

The term "consequences," was introduced to the ESA to replace "direct" and "indirect" effects in 2019. Consequences are a result or effect of an action on ESA species. NMFS uses two criteria to identify the ESA-listed species and designated critical habitat that are **not likely to be adversely affected** by the Proposed Action.

The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If NMFS concludes that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, they must also conclude that the species or designated critical habitat is **not likely to be adversely affected** by those activities.

The second criterion is the probability of a response given exposure. An ESA-listed species or designated critical habitat that co-occurs with a stressor of the action but is not likely to respond to the stressor is also **not likely to be adversely affected** by the Proposed Action.

Section 7(a)(2) of the ESA requires federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of an ESA-listed species as a whole (50 CFR §402.02).

Based on an analysis of potential consequences, we provide a determination for each species and designated critical habitat. One of the following three determinations, as defined by the ESA, has been applied for listed species and critical habitat that have potential to be affected by the Project: No effect; may affect, not likely to adversely affect; may affect, likely to adversely affect.

The probability of an effect on a species or designated critical habitat is a function of exposure intensity and susceptibility of a species to a stressor's effects (i.e., probability of response).

No effect – This determination indicates that the proposed Project would have no impacts, positive or negative, on species or designated critical habitat. Generally, this means that the species or critical habitat would not be exposed to the proposed Project and its environmental consequences.

A **may affect, not likely to adversely affect** determination would be given if the Project's effects are wholly beneficial, insignificant, or discountable.

1. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat.
2. *Insignificant* effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen but will not rise to the level of constituting an adverse effect.
3. *Discountable*[3] effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is extremely unlikely to occur (USFWS and NMFS 1998).

A *may affect, likely to adversely affect* determination occurs when the proposed Project may result in any adverse effect on a species or its designated critical habitat. In the event that the Project may have beneficial effects on listed species or critical habitat, but is also likely to cause some adverse effects, then the proposed Project **may affect, likely to adversely affect**, the listed species.

Table 3-1 depicts the effects determinations for each ESA-listed species analyzed in this assessment by stressor. Following is a description of the existing conditions for each species of ESA-listed marine mammals in the Project area, accompanied by the detailed effects assessment for each stressor on ESA-listed marine mammals. Then existing conditions for ESA-listed sea turtles in the Project area are described, accompanied by the detailed effects assessment for each stressor on ESA-listed sea turtles. Lastly, details of existing conditions for ESA-listed marine fish in the Project area are given, accompanied by the detailed effects assessment for each stressor on ESA-listed marine fish.

[3] When the terms "discountable" or "discountable effects" appear in this document, they refer to potential effects that are found to support a "not likely to adversely affect" conclusion because they are extremely unlikely to occur. The use of these terms should not be interpreted as having any meaning inconsistent with the ESA regulatory definition of "effects of the action."

Table 3-1 Effects Determinations by Stressor

Stressor		Marine Mammals					Sea Turtles				Marine Fish
		Blue Whale	Fin Whale	North Atlantic Right Whale	Sei Whale	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic DPS)	Kemp's Ridley Sea Turtle	Atlantic Sturgeon
Underwater Noise	Impact Pile-Driving	NLAA for PTS LAA for BD	LAA	NLAA for PTS LAA for BD	NLAA for PTS LAA for BD	NLAA for PTS LAA for BD	NLAA	NLAA for PTS LAA for BD	LAA	NLAA for PTS LAA for BD	NLAA
	Vibratory Pile-Driving	NLAA	NLAA for PTS LAA for BD	NLAA for PTS LAA for BD	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	HRG Surveys	NLAA	NLAA for PTS LAA for BD	NLAA for PTS LAA for BD	NLAA for PTS LAA for BD	NLAA for PTS LAA for BD	NLAA	NLAA	NLAA	NLAA	NLAA
	Vessel Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	WTG Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Aircraft Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Cable Laying or Trenching Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Dredging Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
UXO		NLAA	NLAA for mortality/ slight lung injury/ gastrointestinal injury LAA for PTS and TTS/BD	NLAA for PTS/ mortality/slight lung injury/ gastrointestinal injury LAA for TTS/BD	NLAA	NLAA	NLAA	NLAA	NLAA for PTS/ mortality/slight lung/ gastrointestinal injury LAA for TTS/BD	NLAA	NLAA
Habitat Disturbance		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Secondary Entanglement from Increased Recreational Fishing Due to Reef Effect		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	LAA	LAA	NLAA	NLAA
Turbidity		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Vessel Traffic		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Monitoring Surveys		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA for all except for trawl surveys which are LAA for capture/potential injury	NLAA for all except for trawl surveys which are LAA for capture/potential injury	NLAA for all except for trawl surveys which are LAA for capture/ potential injury
EMF		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Air Emissions		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Dredging		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Lighting/ Marking of Structures		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Oil Spills/ Chemical Release		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Unanticipated Events		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Overall Effects Determination		LAA	LAA	LAA	LAA	LAA	NLAA	LAA	LAA	LAA	LAA

BD = behavioral disturbance; DPS = distinct population segment; EMF = electromagnetic field; HRG = high-resolution geophysical; LAA = likely to adversely affect; NLAA = not likely to adversely affect; TTS = temporary threshold shift; PTS = permanent threshold shift; TBD = to be determined following additional analysis; UXO = unexploded ordnance; WTG = wind turbine generator;

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3.2. MARINE MAMMALS

Five marine mammal species listed under the ESA are known to occur in the Action Area, all of which are large whales: blue whale, fin whale, NARW, sei whale, and sperm whale. Species descriptions, status, likelihood, and timing of occurrence in the Action Area, and information about feeding habits and hearing ability relevant to this effects analysis, are provided in the following sections.

3.2.1 Blue Whale

In the North Atlantic Ocean, the range of blue whales (*Balaenoptera musculus*) extends from the subtropics to the Greenland Sea. As described in the most recent stock assessment report, blue whales have been detected and tracked acoustically in much of the North Atlantic, with most of the acoustic detections around the Grand Banks area of Newfoundland and west of the British Isles (Hayes et al. 2020). Photo-identification in eastern Canadian waters indicates that blue whales from the St. Lawrence River, Newfoundland; Nova Scotia; New England; and Greenland all belong to the same stock, whereas blue whales photographed off Iceland and the Azores appear to be part of a separate population (CETAP 1982; Wenzel et al. 1988; Sears and Calambokidis 2002; Sears and Larsen 2002). The largest concentrations of blue whales are found in the lower St. Lawrence Estuary (Lesage et al. 2007; Comtois et al. 2010), which is outside of the Project area. Blue whales do not regularly occur within the U.S. EEZ and typically occur farther offshore in areas with depths of 328 feet (100 meters) or more (Waring et al. 2011).

Migration patterns for blue whales in the eastern North Atlantic Ocean are poorly understood. However, blue whales have been documented in winter months off Mauritania in northwest Africa (Baines and Reichelt 2014); in the Azores, where their arrival is linked to secondary production generated by the North Atlantic spring phytoplankton bloom (Visser et al. 2011); and traveling through deepwater areas near the shelf break west of the British Isles (Charif and Clark 2009). Blue whale calls have been detected in winter on hydrophones along the mid-Atlantic ridge south of the Azores (Nieukirk et al. 2004).

3.2.1.1. Current Status

Blue whales have been listed as endangered under the ESA Endangered Species Conservation Act of 1969, with a recovery plan published under 63 FR 56911. No critical habitat has been designated for the blue whale. Blue whales are separated into two major populations (the north Pacific and north Atlantic population) and further subdivided in stocks. The North Atlantic Stock includes mid-latitude (North Carolina coastal and open ocean) to Arctic waters (Newfoundland and Labrador). However, historical observations indicate that the blue whale has a wide range of distribution from warm temperate latitudes typically in the winter months and northerly distribution in the summer months. Blue whales are known to be an occasional visitor to U.S. Atlantic EEZ waters, with limited sightings. Whale-watchers off of Montauk Point, New York, were observed in August 1990. In the year of 2008, vocalization detections of blue whales were also observed 28 out of 258 days of recordings in the offshore areas of New York Bight. Population size of blue whales off the eastern coast of the United States is not known; however, a catalog count of 402 individuals from the Gulf of St. Lawrence is the minimum population estimate (NOAA Fisheries 2020).

3.2.1.2. Potential Habitat Surrounding and within Project Area

Blue whales are thought to occur seasonally within the Project area in the spring and summer (Ocean Wind 2022), but, because of their rarity, overlap with vessel transits within the Project area is not anticipated. Furthermore, the use of speed restrictions and lookouts during transit reduces the potential for impacts on blue whales. Vessels transiting from non-local ports (Europe) may also encounter blue whales within the Action Area. At-sea vessels on cross-ocean transits are not anticipated to employ PSOs or travel at reduced speeds. Given the low density of blue whales and the low number of vessel transits from non-local ports, the likelihood of an encounter resulting in a ship strike is very low. Therefore, potential impacts on blue whales from the Project are not expected to occur, and this species is not considered further in this BA. Sightings data are available at: http://seamap.env.duke.edu/species/180528.

3.2.2 Fin Whale

Fin whales are a globally distributed baleen whale species found in the Atlantic Ocean, Pacific Ocean, and southern hemisphere (NMFS 2010a). The western North Atlantic stock is concentrated in the U.S. and Canadian Atlantic EEZs from Cape Hatteras to Nova Scotia (Hayes et al. 2020) and is therefore the most likely source of individuals occurring in the Action Area. Fin whales are the most commonly sighted large whale species in this region, accounting for 46% of all sightings in aerial surveys conducted from 1978 to 1982 (CETAP 1982; Hayes et al. 2018), and constitute the majority of large whale sightings in recent aerial and shipboard surveys (Kraus et al. 2016; NEFSC and SEFSC 2018). They are present throughout this region year-round, but abundance in specific locations varies by season (Hayes et al. 2017). While they prefer the deeper waters of the continental shelf (300 to 600 feet [91 to 183 meters]), they are regularly observed anywhere from coastal to abyssal areas (Hayes et al. 2020).

Fin whales are fast swimmers typically found in social groups of two to seven, often congregating with other whales in large feeding groups (Hayes et al. 2017). The species returns annually to established feeding areas and fasts during migration between feeding and calving grounds. Fin whales in the North Atlantic feed on krill (*Meganyctiphanes norvegica* and *Thysanoessa inermis*) and schooling fish such as capelin (*Mallotus villosus*), herring (*Clupea harengus*), and sand lance (*Ammodytes* spp.), captured by skimming or lunge feeding (Borobia et al. 1995). Several studies suggest that distribution and movements of fin whales along the east coast of the United States are influenced by the availability of sand lance (Kenney and Winn 1986; Payne et al. 1990).

Fin whales and other baleen whales belong to the low-frequency cetacean (LFC) marine mammal hearing group, which has a generalized hearing range of 7 Hz to 35 kHz (NMFS 2018a). Peak hearing sensitivity of fin whales is believed to range from 20 to 150 Hz (Erbe 2002).

3.2.2.1. Current Status

Fin whales have been listed as endangered under the ESA since the act's passage in 1973 (35 FR 8491), and critical habitat has not been designated. The best available abundance estimate for the western North Atlantic stock is 6,802, with a minimum population estimate of 5,573 based on shipboard and aerial surveys conducted in 2016 and on the 2016 NEFSC and Department of Fisheries and Oceans Canada surveys (Hayes et al. 2021). The extents of these two surveys do not overlap; therefore, the survey estimates were added together. NMFS has not conducted a population trend analysis due to insufficient data and irregular survey design (Hayes et al. 2021). The best available information indicates that the gross annual reproduction rate is 8%, with a mean calving interval of 2.7 years (Hayes et al. 2021).

3.2.2.2. Potential Habitat Surrounding and within Project Area

Fin whales were observed during all seasons of the Environmental Baseline Study (EBS) (NJDEP 2010). The EBS results indicate that the nearshore waters off New Jersey serve as nursery habitat, based on the occurrence of a cow-calf pair. The EBS estimated a year-round abundance of two individuals offshore of New Jersey (NJDEP 2010). AMAPPS surveys detected fin whales in the WEAs in the fall 2012 aerial, spring 2013 aerial, spring 2014 aerial, spring and summer 2017 aerial, winter 2018 aerial, and summer 2016 shipboard surveys (NEFSC and SEFSC 2012, 2013, 2014, 2016, 2018, 2019). Fin whales were also recorded in the Project area during the summer 2017 HRG survey (Alpine 2017b) and during the Geotechnical 1A Survey in winter 2017–2018 (Smultea Environmental Sciences 2018). For the NJ WEA, seasonal estimates calculated for fin whales showed low numbers during the spring, summer and fall, with peaks in cooler months (Palka et al. 2017).

In addition, 10 fin whales are reported to have stranded along the New Jersey coast from 2008 to 2017 (Hayes et al. 2020; Henry et al. 2020). Of these, nine were determined to be the result of vessel strikes and one ruled an entanglement.

3.2.3 North Atlantic Right Whale

The NARW is a large baleen whale, ranging from 45 to 55 feet (13.7 to 16.8 meters) in length and weighing up to 70 tons at maturity, with females being larger than males. The NARW is recognized as a separate species from the southern right whale (*Eubalaena australis*). These two species are separated into distinct populations in the northern Atlantic and Pacific Oceans. The North Atlantic population, referred to as the NARW, ranges from calving grounds in coastal waters of the southeastern United States to primary feeding grounds off New England, the Canadian Bay of Fundy, the Scotian Shelf, and the Gulf of St. Lawrence.

The NARW is primarily planktivorous, preferentially targeting certain calanoid copepod species, primarily the late juvenile developmental stage of *Calanus finmarchicus*. This species occurs in dense patches and demonstrates both diel and seasonal vertical migration patterns (Baumgartner et al. 2011). Baumgartner et al. (2017) investigated NARW foraging ecology in the Gulf of Maine and southwestern Scotian Shelf using archival tags. Diving behavior was variable but followed distinct patterns correlated with the vertical distribution of forage species in the water column. Importantly, Baumgartner et al. (2017) found that NARWs spent 72% of their time within 33 feet (10 meters) of the surface. Although NARWs are always at risk of ship strike when breathing, the tendency to forage near but below the surface for extended periods substantially increases this risk (Baumgartner et al. 2017). NARW feeding behavior varies by region in response to different seasonal and prey availability conditions. For example, NARWs may rely more frequently on skim-feeding when in transit between core habitats or when dense concentrations of prey are less available (Whitt et al. 2013).

During spring and summer months, right whales migrate north to the productive waters of the northeast region to feed and nurse their young. Within the northeast region, feeding habitats have been observed off the coast of Massachusetts, at Georges Bank, in the Great South Channel, in the Gulf of Maine, over the Scotian Shelf, and in the Bay of Fundy (Brilliant et al. 2015; Hayes et al. 2020). These feeding and calving habitats are considered high-use areas for the species. Although high-use areas have been established for the right whale, frequent travel along the east coast of the United States is common. Satellite tags have shown NARWs making round trip migrations to an area off the southeastern United States and back to Cape Cod Bay at least twice during the winter (Hayes et al. 2020). Although these historical high-use areas are well known, NARW distribution during winter is uncertain and may include the Northwest Atlantic OCS to a greater extent than previously understood (Davis et al. 2017; Hayes et al. 2020).

The Mid-Atlantic Bight is an important migratory corridor for NARWs traveling between summer feeding and winter calving grounds on the northern and southern Atlantic coast. LaBrecque et al. (2015) defined five biologically important areas in Atlantic waters of New England, all of which were located outside of the Action Area. The LaBrecque et al. (2015) delineations reflect NARW observations prior to 2010 that are not representative of recent shifts in species distribution. NARW occurrence in the Northwest Atlantic OCS has been far more prevalent since 2011 (Davis et al. 2017), indicating an increasingly likelihood of species occurrence in the Action Area. In 2017, an unusual mortality event began for NARWs, totaling 34 dead stranded whales: 21 in Canada and 13 in the United States (NOAA Fisheries 2021). Entanglement in fishing gear and ship strikes were the cause of mortality during the unusual mortality events.

The total hearing range of NARWs, based on inner ear anatomy is between 10 Hz and 22 kHz (Parks et al. 2007). Within this range, the peak hearing sensitivity of NARWs is most likely between 100 and 400 Hz, based on recorded vocalization patterns (Erbe 2002).

3.2.3.1. Current Status

NARWs have been listed as endangered under the ESA since the act's passage in 1973 (35 FR 8491). The species was nearly driven to extinction by commercial whaling efforts over more than three centuries. The historical size of the western Atlantic population is uncertain but likely numbers in the tens of thousands (Reeves et al. 2007; Monsarrat et al. 2016). The population has modestly rebounded after the cessation of commercial whaling, increasing from an estimated low of approximately 270 individuals in 1990 to a recent peak of approximately 483 in 2010 (Pace et al. 2017). The population has since exhibited a significant downward trend in abundance, as well as changes in distribution that have increased exposure to vessel strikes, fishing gear entanglement, and other anthropogenic stressors (Corkeron et al. 2018; Kenney 2018). A 2008 study reported that between 2002 and 2006, NARWs in the western Atlantic were subject to the highest proportion of entanglements (25 of 145 confirmed events) and vessel strikes (16 of 43 confirmed occurrences) of any marine mammal studied (Glass et al. 2008). Bycatch of NARWs has also been reported in pelagic drift gillnet operations by the Northeast Fisheries Observer Program; however, no mortalities have been reported (Glass et al. 2008). From 2013 through 2017, the minimum rate of annual human-caused mortality and serious injury to this species from fishing entanglements averaged 6.85 per year, while vessel strikes averaged 1.3 whales per year (Hayes et al. 2020). Environmental fluctuations and anthropogenic disturbance may be contributing to the decline in overall health of individual NARWs that has been occurring for the last three decades (Rolland et al. 2016).

By 2015, total abundance declined to an estimated 458 individuals when the rate of unusual mortalities began to accelerate. By 2017, the population had declined to the most recent estimate of just 428 individuals, which does not include several additional mortalities recorded during and after that year (Pace et al. 2017; Hayes et al. 2020). This is a concerning trend given the low reproductive productivity demonstrated by this population (Hayes et al. 2020). The draft 2021 NMFS stock assessment report gives a population estimate of 368 (Hayes et al. 2021).

To mitigate the potential for vessel strikes, in 2008 NMFS designated certain nearshore waters of the Mid-Atlantic Bight (within a 23-mile [20 nm, 1.9 km] radius of ports and bays) as Mid-Atlantic U.S. Seasonal Management Areas (SMAs) for NARWs (73 FR 60173). NMFS requires that all vessels 65 feet (19.8 meters) or longer must travel at 11.5 miles per hour (10 nm per hour, 1.9 km per hour) or less within the SMAs from November 1 through April 30, when NARWs are most likely to pass through these waters. An SMA is in place for this species at the entrance of the Delaware Bay between November 1 and April 30.

3.2.3.2. Potential Habitat Surrounding and within Project Area

NARWs were observed during the EBS surveys (i.e., detected visually or acoustically) in every season and are considered regular visitors to the Project area (NJDEP 2010). During these surveys, foraging was observed, and the presence of a cow-calf pair was documented, suggesting that nearshore waters off New Jersey serve as feeding and nursery habitat (Ocean Wind 2022). Initial sightings of females, and subsequent confirmations of these same individuals in calving grounds, illustrate that these waters are part of the species' migratory corridor (Whitt et al. 2013). NARWs were also observed in spring 2014, winter/spring 2015, and spring 2019 AMAPPS aerial surveys (NEFSC and SEFSC 2014, 2015, 2020). A single NARW occurred in the Project area during the Geotechnical 1A Survey in winter 2017–2018 (Smultea Environmental Sciences 2018), but no NARWs were observed during the Ocean Wind Offshore Wind Farm Survey in summer 2017 in the Project vicinity (Alpine 2017b). Three NARW sightings within the Project area were reported between December 13 and 14, 2018 (NOAA Fisheries 2019b). When observed, NARWs were mostly seen near the 328-foot (100-meter) contour line (NEFSC and SEFSC 2020). Depths within the WTG array range from 49 to 118 feet (15 to 36 meters) MLLW (Ocean Wind 2022). The Offshore Wind Area overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a northward migration during March to April and a southward migration during November to December.

3.2.4 Sei Whale

The sei whale is a large baleen whale species found in subtropical, temperate, and subpolar waters around the globe, most commonly observed in temperate waters at mid-latitudes. Sei whales are often associated with deeper waters and areas along the continental shelf edge (Hain et al. 1985); however, this general offshore pattern of sei whale distribution is disrupted during occasional incursions into more shallow and inshore waters (Waring et al. 2004). Sightings in U.S. Atlantic waters are typically centered on mid-shelf and the shelf edge and slope (Olsen et al. 2009). The species is notable for its unpredictable distribution, concentrating in specific areas in large numbers for a period and then abandoning those habitats for years or even decades. The breeding and calving areas used by this species are unknown (Hayes et al. 2020).

Sei whales usually travel alone or in small groups of two to five animals, occasionally in groups as large as 10 (Hayes et al. 2020). Potential species occurrence in the Action Area is likely to be closely tied to feeding behavior and seasonal availability of preferred prey resources. Sei whales in the North Atlantic preferentially prey on calanoid copepods, particularly *Calanus finmarchicus*, over all other zooplankton species (NMFS 2011; Prieto et al. 2014), demonstrating a clear preference for copepods between June and October, with euphausiids constituting a larger part of the diet in May and November (NMFS 2011; Prieto et al. 2014). The prey preferences of sei whales closely resemble those of NARW (Hayes et al. 2020), particularly where the two species overlap.

Sei whales are occasionally killed in collisions with vessels. Of three sei whales that stranded along the U.S. Atlantic coast between 1975 and 1996, two showed evidence of collisions with ships (Laist et al. 2001). Between 1999 and 2005, there were three reports of sei whales being struck by vessels along the Atlantic coast of the United States and the maritime provinces of Canada (Cole et al. 2005; Nelson et al. 2007). Two of these vessel strikes were reported as having resulted in the death of the sei whale.

There have been no recorded strandings of sei whales in New Jersey since 2008 (Henry et al. 2020); however, in the summer of 2017, a sei whale carcass was found on the bow of a ship in the Hudson River, Newark, New Jersey (Hayes et al. 2020).

Sei whales and other baleen whales belong to the LFC hearing group of marine mammals, which has a generalized hearing range of 7 Hz to 35 kHz (NMFS 2018a). Peak hearing sensitivity of sei whales is believed to range from 1.5 to 3.5 kHz based on recorded vocalization patterns (Erbe 2002).

3.2.4.1. Current Status

Sei whales have been ESA-listed as endangered at the species level since the passage of the act in 1973 (35 FR 8491). Critical habitat for this species has not been designated. This species was subjected to intense commercial whaling pressure in the 19th and 20th centuries, with an estimated 300,000 animals killed for their meat and oil during this time. Commercial whaling ended for this species in 1980, but limited scientific whaling continues in Iceland and Japan. Vessel strikes and fishing gear entanglement pose the greatest risk to the species currently (Hayes et al. 2020). The most recent abundance estimate for the Nova Scotia stock of sei whales is 6,292 adults, based on aerial surveys conducted from 2010 through 2013 (Hayes et al. 2020). The majority of sightings were concentrated in offshore waters between 328 and 3,280 feet (100 and 1,000 meters) deep.

3.2.4.2. Potential Habitat Surrounding and within Project Area

Sei whales are unlikely to be encountered in the Project area, although small numbers have been documented there during the spring and summer months (Hayes et al. 2020). No sei whales were recorded during EBS surveys, but a fin or sei whale (could not be identified to species) was documented in the waters off New Jersey during the summer 2016 and 2017 AMAPPS surveys (NJDEP 2010; NEFSC and SEFSC 2016, 2018). This species is encountered closer to shore during years when oceanographic conditions force planktonic prey, such as copepods and euphausiids, to shelf and inshore waters (Payne et al. 1990).

3.2.5 Sperm Whale

The sperm whale is the largest member of the order Odontocetes, or toothed whales, and the largest predator on earth. The species is found in tropical, subtropical, and ice-free temperate ocean regions around the globe. It is most commonly observed in association with continental shelf margins and marine canyons with depths greater than 2,000 feet (609 meters) and is rarely observed in waters less than 1,000 feet (305 meters) deep (NMFS 2010b). While deep water is their typical habitat, sperm whales have been observed near Long Island, New York, in water between 135 and 180 feet (41 and 55 meters; Scott and Sadove 1997). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956).

Geographic distribution of sperm whales appears to be linked to social structure. Females and juveniles tend to congregate in matrilineal social groups in subtropical waters, whereas males range widely from the tropics to high latitudes and breed across social groups (Hayes et al. 2020). Sperm whales in the North Atlantic display sufficient genetic isolation from other Atlantic groupings to justify their identification as a breeding stock, but insufficient data are available to determine a definitive population structure (Waring et al. 2015). In the western Atlantic Ocean, sperm whales are distributed in a distinct seasonal cycle, concentrated east-northeast of Cape Hatteras in winter and shifting northward in spring, when they are found throughout the Mid-Atlantic Bight. Their distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight.

Sperm whales are predatory specialists known for hunting prey in deep water. The species is among the deepest diving of all marine mammals. Males have been known to dive 3,936 feet (1,200 meters), whereas females dive to at least 3,280 feet (1,000 meters); both can continuously dive for more than 1 hour. Sperm whales are also relatively fast swimmers, capable of swimming at speeds of up to 20 miles per hour (9 m/s) (Aoki et al. 2007). The species preferentially targets squid, which make up at least 70% of the whale's typical diet (Kawakami 1980; Pauly et al. 1998). Sperm whale are also known to prey on bottom-oriented organisms such as octopus, fish, shrimp, crab, and sharks (Leatherwood et al. 1988; Pauly et al. 1998).

Sperm whales belong to the mid-frequency cetacean (MFC) marine mammal hearing group, which has a generalized hearing range of 150 Hz to 160 kHz (NMFS 2018a). Peak hearing sensitivity of sperm whales ranges from 5 to 20 kHz based on auditory brainstem response to recorded stimuli completed on a stranded neonate (Ridgway and Carder 2001). Sperm whales communicate and search for prey using broadband transient signals between 500 and 24 kHz, with most sound energy focused in the 2- and 9-kHz range (Lohrasbipeydeh et al. 2012).

3.2.5.1. Current Status

Sperm whales have been listed as endangered under the ESA since the initial passage of the act (35 FR 8491). Critical habitat has not been designated. The species was subjected to intense commercial whaling pressure in the 18th, 19th, and early 20th centuries, resulting in a prolonged and severe decline in abundance. Sperm whale populations are rebuilding after the cessation of commercial whaling on the species; the primary threats today are ship collisions and fishing gear entanglement (Hayes et al. 2020). The most recent abundance estimate for the North Atlantic stock is 4,349; between 1,000 to 3,400 Of these individuals occur in U.S. (Hayes et al. 2020). However, this group is likely part of a larger western North Atlantic population, and that population may or may not be distinct from the eastern North Atlantic population (Hayes et al. 2020).

3.2.5.2. Potential Habitat Surrounding and within Project Area

Sperm whales could potentially occur in the Project area. During the summer 2017 AMAPPS aerial survey, a sperm whale was documented in the waters off New Jersey, in the deeper portion of the shelf edge (NEFSC and SEFSC 2018). There have been no recorded strandings of sperm whales in New Jersey since 2008 (Henry et al. 2020).

3.2.6 Effects Analysis for Marine Mammals

3.2.6.1. Definition of Take, Harm and Harass

Section 3 of the ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. NMFS categorizes two forms of take, lethal and sublethal take. Lethal take is expected to result in immediate, imminent, or delayed but likely mortality. Sublethal take is when effects of the action are below the level expected to cause death, but are still expected to cause injury, harm, or harassment. Harm, as defined by regulation (50 CFR §222.102), includes acts that actually kill or injure wildlife and acts that may cause significant habitat modification or degradation that actually kill or injure fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering. Thus, for sublethal take NMFS is concerned with harm that does not result in mortality but is still likely to injure an animal.

NMFS has not defined “harass” under the ESA by regulation. However, on October 21, 2016, NMFS issued interim guidance on the term “harass,” defining it as to “create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.” (NMFS 2016a) For this consultation, we rely on this definition of “harass” when assessing effects to all ESA-listed species except marine mammals.

For marine mammal species, prior to the issuance of the October 21, 2016, guidance, consultations that involved NMFS Permits and Conservation Division’s authorization under the MMPA relied on the MMPA definition of harassment. Under the MMPA, harassment is defined as any act of pursuit, torment, or annoyance that:

1. *has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or*
2. *has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B Harassment). Under NMFS regulation, Level B harassment does not include an act that has the potential to injure a marine mammal or marine mammal stock in the wild.*

NMFS October 21, 2016, guidance states that the “interim ESA harass interpretation does not specifically equate to MMPA Level A or Level B harassment but shares some similarities with both levels in the use of the terms ‘injury/injure’ and a focus on a disruption of behavior patterns. NMFS has not defined ‘injure’ for purposes of interpreting Level A and Level B harassment but in practice has applied a physical test for Level A harassment.” (NMFS 2016a) In this assessment, available data and models that provide estimates of MMPA Level B harassment have been used in estimating the number of instances of harassment of ESA-listed marine mammals, whereas available data and models that provide estimates of MMPA Level A harassment have been considered for our analysis to be instances of harm and/or injury under the ESA, depending on the nature of the effects.

Level B harassment as applied in this consultation may involve a wide range of behavioral responses, including, but not limited to, avoidance, changes in vocalizations or dive patterns, or disruption of feeding, migrating, or reproductive behaviors.

3.2.6.2. Underwater Noise

BOEM recognizes that underwater noise can result in the exposure of ESA-listed marine mammal species leading to ESA-level takes of harm and/or harass. The Proposed Action would produce temporary construction-related underwater noise and long-term operational underwater noise above levels that may impact listed species. Underwater noise generated by Project construction and operations include impact pile driving for the installation WTGs and OSS, detonations of UXOs, HRG surveys, vibratory installation, and removal of sheet piles for the cofferdam, vessel activity, aircraft operations, cable laying and trenching, dredging, and WTG operations. These activities would increase sound levels in the marine receiving environment and may affect ESA-listed marine mammals in the Project area and Action Area.

3.2.6.2.1 Overview of Underwater Noise

Underwater sound can be described through a source-path-receiver model. An acoustic source emits sound energy that radiates outward and travels through the water and the seafloor as pressure waves. The sound level decreases with increasing distance from the acoustic source as the sound pressure waves spread out under the influence of the surrounding receiving environment. The amount by which the sound levels decrease between a source and a receiver is called transmission loss. The amount of transmission loss that occurs depends on the source-receiver separation, the frequency of the sound, the properties of the water column, and the properties of the seafloor. Underwater sound levels are expressed in decibels (dB), which is a logarithmic ratio relative to a fixed reference pressure of 1 micropascal (μPa) (equal to 10^{-6} pascals [Pa] or 10^{-11} bar).

The efficiency of underwater sound propagation allows marine mammals to use underwater sound as a method of communication, navigation, and prey detection and predator avoidance (Richardson et al. 1995; Southall et al. 2007). Anthropogenic (i.e., human-introduced) noise has gained recognition as a potential stressor for marine mammals because of their reliance on underwater hearing for maintenance of these critical biological functions (Richardson et al. 1995; Ketten 1998). Underwater noise generated by human activities can often be detected by marine animals many kilometers from the source. With increasing distance from a noise source, potential acoustic impacts can range from physiological injury to permanent or temporary hearing loss, behavioral changes, and acoustic masking (i.e., communication interference). All the above impacts have the potential to induce stress on marine animals in their receiving environment (OSPAR Commission 2009; Erbe 2013).

Anthropogenic noise sources can be categorized generally as impulsive (e.g., impact pile driving, explosions) or non-impulsive (e.g., vibratory pile-driving, vessel noise). Sounds from moving sources such as ships are continuous noise sources, although transient relative to the receivers. Impulsive noises are characterized by broad frequencies, fast rise time, short durations, and a high peak sound pressure (Finneran 2016). Non-impulsive (i.e., continuous) noise is better described as a steady-state noise source.

For auditory effects underwater noise is less likely to disturb or injure an animal if it occurs at frequencies at which the animal cannot hear well. The importance of sound components at particular frequencies can be scaled by frequency weighting relative to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998; Nedwell et al. 2007). Regulatory thresholds used for the purpose of predicting the extent of potential noise impacts on marine mammal hearing (permanent threshold shift [PTS]/temporary threshold shift [TTS]) and subsequent management of these impacts have recently been revised to account for the duration of exposure, incorporation of new hearing and TTS data and the differences in hearing acuity in various marine mammal species (Finneran 2016; NMFS 2018b).

Shock waves associated with underwater detonations (e.g., UXOs) can induce both auditory effects (PTS and TTS) and non-auditory physiological effects, including mortality and direct tissue damage known as primary blast injury. The magnitude of the acoustic impulse (which is the integral of the instantaneous sound pressure) of the underwater blast causes the most common injuries, and therefore its value is used to determine if mortality or non-auditory injury occurs (U.S. Navy 2017).

The auditory and non-auditory thresholds used in this BA are:

1. Auditory thresholds for marine mammals (all activities): NMFS (2018b). Marine Mammal Acoustic Technical Guidance (2018) Revision to Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing, Office of Protected Resources, NOAA Technical Memorandum NMFS-OPR-59, April 2018.
2. Non-auditory thresholds for marine mammals and sea turtles (UXO detonations): U.S. Department of the Navy (U.S. Navy) (2017). Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III), June 2017. Thresholds for gastrointestinal and lung injury, and mortality for marine mammals and sea turtles due to explosive pressure based on impulse and peak pressure.
3. Thresholds for fish (impact pile driving): Fisheries Hydroacoustic Working Group (FHWG) (2008). Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities.
4. Thresholds for fish (quantitative and qualitative; all activities): Popper et al. (2014). Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014.

Potential adverse auditory effects to marine mammals from Project-generated underwater noise includes PTS, TTS, behavioral disruption, and masking; potential non-auditory effects to marine mammals from Project-generated underwater noise (UXO detonations only) includes mortality, lung injury, and gastrointestinal injury.

The extent and severity of auditory and non-auditory effects from Project-generated underwater noise is dependent on the timing of activities relative to species occurrence, the type of noise impact, and species-specific sensitivity. To support the underwater noise assessment for the Project, the Applicant conducted Project-specific underwater noise modeling for the following Project activities: impact pile driving, vibratory sheet pile driving, UXO detonations, and HRG surveys. The assessment of underwater noise in this BA uses modeling and take numbers (Level A and Level B harassment as per the MMPA) presented in Ocean Wind's application for an LOA February 2022. A summary of the reports used in the BA are provided below:

1. UXO underwater modeling report for marine mammals, sea turtles and fish. Hannay, D.E. and M. Zykov. 2022. Underwater Acoustic Modeling of Detonations of Unexploded Ordnance (UXO) for Ørsted Wind Farm Construction, US East Coast. Document 02604, Version 3.0. Report by JASCO Applied Sciences for Ørsted.
2. Impact pile driving underwater modeling report for marine mammals sea turtles and fish. Küsel, E. T., M. J. Weirathmueller, K. E. Zammit, S. J. Welch, K. E. Limpert, and D. G. Zeddies. 2022. Underwater Acoustic and Exposure Modeling. Document 02109, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Ocean Wind LLC.
3. Vibratory pile driving underwater modeling for marine mammals. JASCO Applied Sciences Inc. (JASCO). 2022. Distance to behavioral threshold for vibratory pile driving of sheet piles. Technical Memorandum by JASCO Applied Sciences for Ocean Wind LLC, Dated 21 March 2022.
4. HRG Survey underwater modeling for marine mammals. HDR. 2022. Ocean Wind Offshore Wind Farm. Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization Application. Prepared for: Ocean Wind LLC, Prepared by: HDR. Dated February, 2022.

For sound sources or for species where no Project-specific modeling was completed, information available in the literature regarding source levels was used to develop the effects analysis.

The sections below provide an overview of the available information on marine mammal hearing, the thresholds applied, the results of the underwater noise modeling conducted, and the impact consequences for each potential underwater noise generating activity for the Project.

3.2.6.2.2 Auditory Criteria for Injury and Disturbance

Assessment of the potential effects of underwater noise on marine mammals requires acoustic thresholds against which received sound levels can be compared. Auditory thresholds from underwater noise are expressed using three common metrics: root-mean-square sound pressure level (SPL or L_{rms}) and peak sound pressure level (L_{pk}), both measured in decibels relative to 1 micropascal (dB re 1 μPa), and sound exposure level (SEL), a measure of energy in decibels relative to 1 micropascal squared second (dB re 1 $\mu Pa^2 s$). L_{pk} is an instantaneous value, whereas SEL (L_E) is the total noise energy over a given time period or event. As such, the SEL accumulated over 24 hours, ($L_{E,24h}$) is appropriate when assessing effects to marine mammals from cumulative exposure to multiple pulses or durations of exposure. L_{rms} is an root mean squared (rms) average over a period of time and is equal to the SEL divided (linearly) by the time period of exposure. Therefore, if the time period is 1 second, the SEL and the L_{rms} are equal.

For marine mammals, established acoustic criteria for hearing injury and behavioral disturbance recognized by NMFS have recently been updated in terms of auditory injury thresholds (NMFS 2018b). The revised auditory injury thresholds apply dual criteria based on L_{pk} and SEL accumulated over 24 hours (L_{E24hr}) and are based on updated frequency weighting functions for five marine mammal hearing groups described by NMFS 2018b, Southall et al. (2007), and Finneran and Jenkins (2012) as summarized in Table 3-2. Behavioral disturbance thresholds for marine mammals are based on L_{rms} of 160 dB re 1 μPa for non-explosive impulsive or intermittent sounds and 120 dB re 1 μPa for continuous sounds for all marine mammal species (NOAA 2005). It is worth noting that non-impulsive HRG survey equipment that have signals that sweep through a range of frequencies (i.e., CHIRPs) were assessed against the 160 dB re 1 μPa threshold. Although these disturbance thresholds remain current (in the sense that they have not been formally superseded by newer directives), they are not frequency weighted to account for different hearing abilities by the five marine mammal hearing groups.

The potential for underwater noise exposures to result in adverse impacts on a marine animal depends on the received sound level, the frequency content of the sound relative to the hearing ability of the animal, the duration, and the level of natural background noise. Potential effects range from subtle changes in behavior at low received levels to strong disturbance effects or potential injury at high received levels.

Table 3-2 Marine Mammal Hearing Groups

Hearing Groups	Taxonomic Group	Generalized Hearing Range[a]
Low-frequency cetaceans (LFC)	Baleen whales (e.g., humpback whale, blue whale)	7 Hz to 35 kHz
Mid-frequency cetaceans (MFC)	Most dolphin species, beaked whales, sperm whale	150 Hz to 160 kHz

Sources: Southall et al. 2007; Finneran and Jenkins 2012; NMFS 2018b
Note:
[a] The generalized hearing range is for all species within a group. Individual hearing may vary. Generalized hearing range based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LFC (Southall et al. 2007)
dB = decibels; Hz = hertz; kHz = kilohertz

Sound reaching the receiver with ample duration and SPL can result in a loss of hearing sensitivity in marine animals termed a noise-induced threshold shift. This may consist of TTS or PTS. TTS is a relatively short-term, reversible loss of hearing following exposure (Southall et al. 2007; Le Prell 2012), often resulting from cellular fatigue and metabolic changes (Saunders et al. 1985; Yost 2000). While experiencing TTS, the hearing threshold rises, and subsequent sounds must be louder to be detected. PTS is an irreversible loss of hearing (permanent damage; not fully recoverable) following exposure that commonly results from inner ear hair cell loss or structural damage to auditory tissues (Saunders et al. 1985; Henderson et al. 2008). PTS has been demonstrated in harbor seals (Kastak et al. 2008; Reichmuth et al. 2019). TTS has been demonstrated in some odontocete and pinniped species in response to exposure to impulsive and non-impulsive noise sources in a laboratory setting (a full review is provided in Southall et al. 2007; NOAA 2013; U.S. Navy 2017). Prolonged or repeated exposures to sound levels sufficient to induce TTS without recovery time can lead to PTS (Southall et al. 2007).

Table 3-3 outlines the acoustic thresholds for onset of acoustic impacts (PTS, TTS, and/or significant behavioral disruption) for marine mammals for both impulsive and non-impulsive noise sources. Impulsive noise sources for the Project include impact pile driving, some HRG equipment and explosion of UXOs. Non-impulsive noise sources associated with the Project include vibratory pile driving associated with installation and removal of the cofferdam, some HRG equipment, vessel activities, and dredging.

Table 3-3 Acoustic Marine Mammal Thresholds (TTS and PTS) based on NMFS (2018a) for ESA-listed Cetaceans

Marine Mammal Hearing Group	Effect	Impulsive Source		Continuous Source
		Unweighted L_{pk} (dB re 1 µPa)	Weighted $L_{E,24h}$ (dB re 1 µPa²s)	Weighted $L_{E,24h}$ (dB re 1 µPa²s)
LFC	PTS	219	183	199
	TTS	213	168	179
MFC	PTS	230	185	198
	TTS	224	170	178

Source: NMFS 2018a
Note: Values presented for SEL ($L_{E,24h}$) use a 24-hour cumulative analysis unless stated otherwise.
dB re 1 µPa = decibels relative to 1 micropascal; dB re 1 µPa^{2}s = decibels relative to 1 micropascal squared second; L_{E24hr} = sound exposure level accumulated over 24 hours; L_{pk} = instantaneous peak sound pressure level; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; PTS = permanent threshold shift; rms = root mean squared; TTS = temporary threshold shift

Marine mammals show varying levels of disturbance in response to underwater noise sources. Observed behavioral responses include displacement and avoidance, decreases in vocal activity, and habituation. Behavioral responses can consist of disruption in foraging patterns, increases in physiological stress, and reduced breeding opportunities, among other responses. To better understand and categorize the potential effects of behavioral responses, Southall et al. (2007) developed a behavioral response severity scale of low, moderate, or high (Southall et al. 2007; U.S. Navy 2017). This scale was recently updated in Southall et al. (2021). The revised report updated the single severity response criteria defined in Southall et al. (2007) into three parallel severity tracks that score behavioral responses from 0 to 9. The three severity tracks are (1) survival, (2) reproduction, and (3) foraging. This approach is acknowledged as being relevant to vital rates, defining behaviors that may affect individual fitness, which may ultimately affect population parameters. It is noted that not all the responses within a given category need to be observed but that a score is assigned for a severity category if any of the responses in that category are displayed. To be conservative, the highest (or most severe) score is to be assigned for instances when several responses are observed from different categories. In addition, the authors acknowledge that it is no longer appropriate to relate "simple all-or-nothing thresholds" to specific received sound levels and behavioral responses across broad taxonomic groupings and sound types due to the high degree of variability within and between species and noise types. The new criteria also move away from distinguishing noise impacts from impulsive vs. non-impulsive sound types into considering the specific type of noise (e.g., pile driving, seismic, vessels, etc.).

For the purposes of this BA, the NMFS behavioral thresholds along with the updated Southall et al. (2021) severity scale and information available in the literature will be used to assess the potential effects and consequences of behavioral effects from underwater noise on marine mammals.

Auditory masking occurs when sound signals used by marine mammals overlap in time, space, and frequency with another sound source (Richardson et al. 1995). Masking can reduce communication space, limit the detection of relevant biological cues, and reduce communication or echolocation effectiveness. A growing body of literature is focused on improving the framework for assessing the potential for masking of animal communication by anthropogenic noise and understanding the resulting effects. More research is needed to understand the process of masking, the risk of masking by anthropogenic activities such as sonar emissions, the ecological significance of masking, and what anti-masking strategies are used by marine animals and their degree of effectiveness before masking can be incorporated into regulation strategies or mitigation approaches (Erbe et al. 2016). For the current assessment, masking was considered possible if the frequency of the sound source overlaps with the hearing range of the marine mammal (Table 3-2).

3.2.6.2.3 Non-auditory Injury Criteria for Explosives (Unexploded Ordnance)

NMFS has adopted criteria used by the U.S. Navy to assess the potential for non-auditory injury from underwater explosive sources as presented in U.S. Navy (2017). These criteria include thresholds for the following non-auditory effects: mortality, lung injury and gastrointestinal injury. Unlike auditory thresholds, these depend upon an animal's mass and depth. Table 3-4 provides mass estimates for the marine mammal species considered and Table 3-5 and Table 3-6 present the equations used to calculate thresholds. For the BA, the more conservative 1% thresholds have been applied when determining the consequence of the effects and the number of marine mammals potentially exposed.

Single blast events within a 24-hour period are not presently considered by NMFS to produce behavioral effects if they are below the onset of TTS thresholds for frequency-weighted SEL and peak pressure levels. As only one charge detonation per day is planned for the Project, the effective disturbance threshold for single events in each 24-hour period is the TTS onset (Table 3-3).

Table 3-4 Representative Calf/Pup and Adult Mass Estimates Used for Assessing Impulse-based Onset of Lung Injury and Mortality Threshold Exceedance Distances

Impulse Animal Group	Representative Species	Calf/Pup Mass (kg)	Adult Mass (kg)
Baleen whales and Sperm whale	Sei whale (Balaenoptera borealis) Sperm whale (Physeter macrocephalus)	650	16,000

Source: Hannay and Zykov 2022
Note: These values are based on the smallest expected animals for the species that might be present within Project areas. Masses listed here are used for assessing impulse-based onset of lung injury and mortality threshold exceedance distances. kg = kilograms.

Table 3-5 Thresholds for Onset of Non-auditory Injury Based on Observed Effects on 1 Percent of Exposed Animals

Non-auditory Effect	Threshold
Onset of Mortality: Impulse (severe lung injury)	$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa·s
Onset Non-auditory Injury: Impulse (slight lung injury)	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa·s
Onset Non-auditory Injury: Peak Pressure (L_{pk}) (slight lung injury)	237 dB re 1 µPa

Source: U.S. Navy 2017

Note: Thresholds based on impulse depend on the animal's mass, M, in kilograms and depth, D, in meters.
dB re 1 μPa = decibels relative to 1 micropascal; Pa·s = pascal second

Table 3-6 Thresholds for Onset of Non-auditory Injury Based on Observed Effects on 50 Percent of Exposed Animals

Non-auditory Effect	Threshold
Onset of Mortality: Impulse (severe lung injury)	$144M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa·s
Onset Non-auditory Injury: Impulse (slight lung injury)	$65.8M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa·s
Onset Non-auditory Injury: Peak Pressure (L_{pk}) (slight lung injury)	243 dB re 1 μPa

Source: U.S. Navy 2017
Note: Thresholds based on impulse depend on the animal's mass, M, in kilograms and depth, D, in meters.
dB re 1 μPa = decibels relative to 1 micropascal; Pa·s = pascal second

3.2.6.2.4 Assessment of Effects

3.2.6.2.4.1 Impulsive Underwater Noise

Project-generated impulsive underwater noise includes impact pile driving associated with the installation of the WTGs and OSS, some HRG surveys[4] (described below), and the potential detonation of UXOs. Acoustic propagation modeling of these sources was undertaken by JASCO Applied Sciences to determine distances to the established PTS and disturbance thresholds for marine mammals (Hannay and Zykov 2022; HDR 2022; Küsel et al. 2022). Potential effects associated with impulsive underwater noise sources include exposure to noise above the MMPA Level A and Level B harassment thresholds, inclusive of PTS, non-auditory injury from explosions, TTS, and behavioral disruptions, as well as masking effects.

<u>Impact Pile Driving (C)</u>

Noise from impact pile driving for the installation of WTGs and OSS foundations would occur intermittently during the installation of offshore structures. To support the Project, acoustic propagation modeling of impact pile-driving activities was undertaken by JASCO Applied Sciences (Küsel et al. 2022). The modeling assuming the Project design information presented herein.

Pile driving for the Project involves two pile types: monopiles and pin piles. For the WTGs, a single vertical hollow steel monopile (26.2 feet [8 meters] in diameter at top, 36.1 feet [11 meters] in diameter at seafloor) with a 4-inch (10.3 cm) wall thickness will be installed for each location using an impact hammer (IHC-4000 or IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 164 feet (50 meters. Installation of a single monopile is expected to take 9 hours (1 hour pre-clearance period, 4 hours piling, and 4 hours moving to the next location). Up to two piles are expected to be installed per 24-hour period. For the OSS, a piled jacket foundation is being considered. This would involve installing 52.5- by 8.0-foot (16 by 2.44-meter) diameter piles as a foundation for each OSS foundation using an impact hammer (IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 230 feet (70 meters). Alternatively, a single monopile like the ones used for WTGs may be used for each OSS (each option was modeled). Each pin pile takes approximately 4 hours to install and a single OSS foundation is expected to take 6 days. A total of 98 monopiles would be installed for WTGs, and 48 pin piles (or three monopiles) would be installed for OSS, constituting about 584 hours of active pile driving (404 if monopiles are used, assuming OSS monopile installation is identical to that for WTGs). For installation of both the WTG and OSS monopile foundations, installation of more than

[4] HRG surveys are discussed together below under continuous sounds, although some HRG surveys are impulsive.

one pile at one time is not expected to occur; however, the Applicant is requesting 24-hour-per-day pile driving. Sound fields were modeled at one representative location in the Offshore Wind Area.

The amount of sound generated during pile driving varies with the energy required to drive piles to a desired depth and depends on the sediment resistance encountered. Sediment types with greater resistance require hammers that deliver higher energy strikes and/or an increased number of strikes relative to installations in softer sediment. General monopile installation parameters assumed for the modeling, including total number of strikes, are listed in Table 3-7.

Table 3-7 Key Assumptions About the Piles Used in the Underwater Acoustic Modeling

Foundation Type	Modeled Maximum Impact Hammer Energy (kJ)	Number of Strikes	Strike Rate (min-1)	Pile Diameter (m)	Pile wall thickness (mm)	Seabed Penetration (m)	Piles per Day
Monopile	4,000	10,846	50	8 to 11 (tapered)	80	50	2
Jacket	1,500	13,191	50	2.44	75	70	2 to 3

Source: Küsel et al. 2022.
kJ = kilojoule; m = meter; min-1 = per minute; mm = millimeter

Ocean Wind has committed to using a noise mitigation system (also termed noise abatement system) during installation of both monopiles and pin piles (Table 1-11). The noise mitigation system would be a combination of two devices that function together as a system to reduce noise propagation. The same or a different noise mitigation system would be used during UXO detonations. The noise mitigation system ultimately selected for the Project would be tailored to and optimized for site-specific conditions, but the exact system to be used is not specified at this time. Bellmann et al. (2020) found three noise abatement systems to have proven effectiveness and offshore suitable: 1) the near-to-pile noise abatement systems - noise mitigation screen (IHC-NMS); 2) the near-to-pile hydro sound damper (HSD); and 3) for a far-from-pile noise abatement system, the single and double big bubble curtain (BBC and DBBC). With the IHC-NMS or the BBC, noise reductions of approximately 15 to 17 dB in depths of 82 to 131 feet (25 to 40 meters) could be achieved. The HSD system, independent of the water depth, demonstrated noise reductions of 10 dB with an optimum system design. The achieved broadband noise reduction with a BBC or DBBC was dependent on the technical-constructive system configuration. Based on Bellmann et al. (2020), the noise mitigation system performance of 10 dB broadband attenuation assumed for the Project is considered achievable with currently available technologies for pile-driving activities. Ocean Wind has committed to achieving a minimum 10 dB broadband noise reduction during impact pile-driving operations (Table 1-11).

The modeling incorporated the use of the 10-dB-per-hammer-strike noise attenuation for the predicted received sound fields used to estimate potential marine mammal exposures. Traditional acoustic modeling assumes that marine mammals remain stationary for the duration of the sound event. However, the pathway a marine mammal takes through the sound field determines the received sound level; therefore, treating marine mammals as stationary may not produce realistic estimates for the monitoring zones. For the Project, animal movement modeling was used to estimate exposure ranges.

The distance to the closest point of approach (CPA) for each of the species-specific animats (simulated animals) during a simulation is recorded, and then the CPA distance that accounts for a specified percentage of the animats that exceed an acoustic impact threshold is determined. The 95th percentile exposure range (ER95%) is the horizontal distance that includes 95% of the CPAs of animats exceeding a given impact threshold.

Exposure ranges for each species are the distances at which an exposure is unlikely to occur for animals of that species that remain further away and is based on animal movement modeling rather than a static animal at a specified distance. ER95% distances are species-specific rather than categorized only by hearing group because they incorporate species-specific biological parameters such as movement habits and species distribution.

The modeling considered a conservative construction schedule that maximized pile-driving activities during the highest-density months for each species as outlined in Appendix A. Sixty WTG monopiles (two per day for 30 days) were assumed to be installed in the highest-density month for each species and an additional 38 WTG monopiles (two per day for 19 days) were assumed to be installed during the month with the second highest animal density. The two OSS installation options: either three monopiles (two per day for 1 day and one on a third day) or 48 pin piles (three per day for 16 days) were assumed to occur in the highest-density marine mammal month. Both options were modeled, and the worst-case scenario from and underwater noise perspective (e.g., 48 pin piles—three per day for 16 days) is evaluated in this BA.

Table 3-8 summarizes the maximum exposure ranges to PTS and behavioral thresholds for the worst-case impact pile driving scenario for each ESA-listed marine mammal hearing group. Maximum PTS exposure ranges for LFC were 5,413.4 feet (1,650 meters) during the summer months and 8,169.3 feet (2,490 meters) during the winter months. Based on the animal movement modeling and application of the noise mitigation system, PTS effects to MFC (sperm whales) are not anticipated (e.g., exposure ranges were 0 meters) (Hannay and Zykov 2022).

The Applicant-proposed mitigation for impact pile driving includes seasonal pre-clearance and shutdown zones and specific monitoring requirements for NARW (see Table 1-11). As outlined in Table 3-8 below, the pre-clearance zones and shutdown zones are based on the maximum PTS zones modeled for each species group and specific to seasonal variation (e.g., one for summer and one for winter months). This is particularly important due to the larger exposure ranges expected during the winter months.

Visual detections of large whales by PSOs using standard visual aids (7x50 reticle binoculars, rangefinder sticks, and the unaided eye) demonstrate the ability of trained PSOs to be capable of monitoring clearance zones out to 4 km. Data from January 2020 to July 2022 for Revolution Wind G&G surveys reported over 45 sightings of large whales that included minke, humpback, and fin whales at distance of 2-5 km–19 of which exceeded 3.8 km. For the Proposed Action, PSOs will be equipped with binoculars and other equipment as listed in Table 10 of the PSMMP. Ocean Wind expects any secondary vessels to maneuver within the monitoring zone to ensure effective and consistent coverage to the necessary distances.

Furthermore, passive acoustic monitoring as described in the Applicant-proposed mitigation in Table 1-6 will be used to assist in detections. In addition, Real-time, 24-hour PAM is also being proposed by the Applicant during daytime and nighttime impact pile driving activities and will be located at the Level B monitoring zone for NARW (12,467 feet [3,800 meters] in winter and 11,483 feet (3,500 meters) in summer; Table 3-9) to avoid any unnecessary exposures particularly to NARWs. Ramp-up procedures are proposed in Table 1-11 and would occur over a 20-minute period. Ramp-ups can be an effective mechanism to reduce the potential for PTS exposures in certain species by deterring species from the area; however, the efficacy of deterring ESA-listed baleen whales and sperm whales through pile driving ramp-up procedures is unknown.

Table 3-8 ER95% Ranges to PTS, Behavioral, and Applicable Pre-clearance and Shutdown Zones[a,b] to Be Applied during Impact Pile Driving (with 10-dB attenuation)

Hearing Group[c]	Max ER95% Range to PTS Thresholds (m)		Pre-clearance/Shutdown Zone[d] (m)		Max ER95% Range to Behavioral Thresholds[f] (m)	
	Summer	Winter	Summer	Winter	Summer	Winter
LFC (Blue, Fin, and Sei Whales)[e]	1,650	2,490	1,650	2,490	3,130	3,450
NARW	1,650	2,490	3,500	3,800	3,130	3,450
MFC (Sperm Whale)	0	0	1,650	2,490	3,090	3,410

Sources: Maximum PTS and behavioral zones taken from Küsel et al. 2022. Pre-clearance/shutdown zones taken from the PSMMP dated April 2022 (Table 7 and 8).
Source: HDR, Inc. 2022b
Notes:
[a] Zones are based upon the following modeling assumptions:
- 8/11-meter (tapered) monopile with 10 dB broadband sound attenuation.
- Either one or two monopiles driven per day, and either two or three pin piles driven per day. When modeled injury (Level A) threshold distances differed among these scenarios, the largest for each species group was chosen for conservatism.

[b] Zones are derived from modeling that considered animal movement and aversion parameters (see more details in Section 3.3.5)
[c] Though zones for high-frequency cetaceans and seals were calculated, since these groups contain only non-ESA-listed species, they have been excluded from this table.
[d] Zone monitoring will be achieved through a combined effort of passive acoustic monitoring and visual observation (but not to monitor vessel separation distance).
[e] The shutdown zones for large whales (including NARW) are based upon the maximum Level A zone for each group. 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. Turtle shutdown zones for impact pile driving were based on the same JASMINE open-source marine mammal movement and behavior model as pre-clearance zones (3MB; Houser 2006).
[f] Behavioral ranges based on SPL threshold of 160 dB re 1 µPa
dB = decibels; ER95% = 95th percentile exposure range; ESA = Endangered Species Act; m = meters; NARW = North Atlantic right whale; PSMMP = Protected Species Mitigation and Monitoring Plan

Table 3-9 NARW Clearance and Real-time PAM Monitoring Zones[a] during Impact Piling in Summer and Winter

Season	Minimum Visibility Zone[b]	PAM Clearance Zone (m)[c]	Visual Clearance Delay or Shutdown Zone (m)	PAM Clearance Delay or Shutdown Zone (m)
Summer	1,650	3,500	Any Distance	1,650
Winter	2,490	3,800	Any Distance	2,490

Sources: HDR, Inc. 2022b, PSMMP dated April 2022 (Table 9)
Notes:
[a] Ocean Wind may request modification to zones based on results of sound field verification.
[b] The minimum visibility zones for NARWs are based upon the maximum Level A zones for the whale group.
[c] The PAM pre-start clearance zone was set equal to the Level B zone to avoid any unnecessary take.
NARW = North Atlantic right whale; m = meters; PAM = passive acoustic monitoring; PSMMP = Protected Species Mitigation and Monitoring Plan

Ocean Wind has also stated that pile driving during nighttime hours could occur when a pile installation is started during daylight and, due to unforeseen circumstances, would need to be finished after dark and that new piles could be initiated after dark to meet schedule requirements. Therefore, in addition to PAM, the Applicant is proposing to use other visual monitoring techniques would be implemented during nighttime installation or during periods of daytime low visibility. These include thermal or infrared cameras, night vision devices, and infrared spotlight. The efficacy of these other monitoring devices is relatively unknown; however, in support of the request for nighttime piling, Ocean Wind is conducting a marine mammal monitoring field demonstration project in spring 2022 to demonstrate the efficacy of its nighttime monitoring methods. In response to this request, BOEM will require Ocean Wind to develop an Alternative Monitoring Plan (AMP) for Pile Driving (see BOEM proposed measure in Table 1-11, #21) that incorporates the field demonstration results (e.g., based on Thayer-Mahan results) and proves the efficacy of the night vision devices proposed by Ocean Wind (e.g., mounted thermal/IR camera systems, hand-held or wearable night vision devices [NVDs], infrared (IR) spotlights) in detecting protected marine mammal and turtle species to the full extent of the established shutdown and clearance zones. The plan will be reviewed and approved by NMFS and BOEM. If the efficacy of the technology is not proven through the field demonstration project and the AMP for Pile Driving, then nighttime impact pile driving would not occur. Specifically, no new piles could be initiated after dark if BOEM and NMFS do not approve the nighttime monitoring plan and the technology proposed. In addition, the Applicant is proposing that, if during nighttime pile driving, a PSO is unable to monitor the visual clearance or shutdown zones with available NVDs (due to light pollution from the platform) nighttime pile driving will not commence or will be halted (as safe to do so).

As the pre-clearance and shutdown zones are based on the maximum PTS zones modeled for each hearing group and separated by season, the potential for PTS effects is reduced. The extended NARW clearance zones to be implemented during all impact pile-driving operations, which extend beyond the NARW behavioral zones, would further reduce the potential for PTS and behavioral effects on NARWs. In addition, no pile installation would occur from January 1 to April 30 during the time of year when NARWs are present in the region in higher numbers, further reducing effects to this species. As outlined in the LOA, pile driving during the night would reduce the total duration of construction activities, limit crew transfers and vessel trips and allow impact pile driving to be conducted during low NARW density months in the summer, which would reduce the overall potential impact to this species.

Effects of Exposure to Noise Above the PTS Thresholds

No PTS exposures are expected for blue whales, NARWs, sei whales, or sperm whales for any Project activity; thus, the potential for PTS exposure to these ESA-listed species is considered extremely unlikely to occur and **discountable**. Therefore, the effects of noise exposure from Project impact pile driving leading to PTS **may affect**, **not likely to adversely affect** blue whales, NARWs, sei whales, or sperm whales**.**

Modeling indicates that up to seven individual fin whales may be exposed to underwater noise levels above PTS thresholds from impact pile driving noise. The potential for serious injury is minimized by the implementation of pre-clearance, shutdown zones, and ramp-ups for impact pile driving operations that would facilitate a delay of pile driving if marine mammals were observed approaching or within areas that could be ensonified above sound levels that could result in auditory injury. These measures also make it unlikely that any ESA-listed cetacean will be exposed to pile driving that would result in severe hearing impairment or serious injury and would more likely have the potential to result in slight PTS (i.e., minor degradation of hearing capabilities at some hearing thresholds). In addition, ramp-ups could be effective in deterring marine mammals from impact pile driving activities prior to exposure resulting in a serious injury. The potential for serious injury is also minimized through using a noise mitigation system during all impact pile driving operations. The proposed requirement that impact pile driving can only commence when the pre-clearance zones (Table 3-8) are fully visible to PSOs allows a high marine mammal detection capability, and enables a high rate of success in implementing these zones to avoid serious injury. However, exposures leading to PTS are still possible, therefore, the effects of noise exposure from Project impact pile driving leading to PTS **may affect, likely to adversely affect** fin whales.

Effects of Exposure to Noise Above the Behavioral Thresholds and Masking

Considering impact pile driving activities, up to 15 fin whales, 15 NARWs, two sei whales, four blue whales, and six sperm whales may be exposed to noise levels that exceed behavioral thresholds (Table 3-10 and Table 3-11). Although behavioral thresholds may be reached, how species react and the subsequence consequence of these reactions are relatively unknown. This is due to the lack of species-specific studies that outline the behavioral responses of ESA-listed marine mammal species likely to be present in the Action Area to Project activities (i.e., impact pile driving activities, vibratory pile driving activities, HRG surveys, or UXO detonations). Some avoidance and displacement of LFCs has been documented during other impulsive noise activities (seismic exploration), which may be used as a proxy to determine the potential behavioral reactions of LFC to other impulsive activities such as impact pile driving or UXO detonations. However, recent reports assessing the severity of behavioral reactions to underwater noise sources indicates that applying behavioral responses across broad sound categories (e.g., impact pile driving and seismic exploration are both impulsive) can lead to significant errors in predicting effects (Southall et al. 2021). Hearing-specific analyses are presented below.

Table 3-10 Number of ESA-Listed Marine Mammal Exposed to Sound Levels Above PTS and Behavioral Thresholds for Impact Pile Driving – WTG Installation – 10 dB Attenuation

Marine Mammal Species		PTS	Behavioral
LFC	NARW	0[a]	12
	Blue whale	0	4[b]
	Fin whale	6	13
	Sei whale	0	1
MFC	Sperm whale	0	3

Source: Küsel et al. 2022.
Notes: Worst-case scenario presented, included modeling of two monopiles per 24-hour period and the results for the $L_{E,24h}$ threshold. Monopile foundation assumed tapered 8- to 11-meter-diameter piles, 50-meter penetration depth, and 4,000-kilojoule hammer energy. Exposure values ≥0.5 were rounded up to the nearest integer, values <0.5 rounded down to 0.
[a] 3.25 PTS exposures were estimated for this species, but due to mitigation measures proposed by the Applicant, no PTS (Level A takes) exposures are expected and no Level A takes have been requested for these species.
[b] No Level B exposures were estimated for blue whale, but up to 4 Level B takes not calculated through density estimates are
requested in the unlikely event that 4 individuals, or two cow and calf pairs, approach monopile installation.
PTS and behavioral exposures are based on the number of MMPA Level A and Level B takes requested in the Letter of Authorization.
dB = decibels; ESA = Endangered Species Act; LFC = low-frequency cetaceans; $L_{E,24h}$ = cumulative sound exposure level; MFC = mid-frequency cetaceans; NARW = North Atlantic Right Whale; PTS = permanent threshold shift; WTG = wind turbine generator

Table 3-11 Number of ESA-Listed Marine Mammal Exposed to Sound Levels Above PTS and Behavioral Thresholds for Impact Pile Driving – OSS Installation – 10 dB attenuation

Marine Mammal Species		Option 1: Three Monopiles		Option 2: 48 Pin Piles	
		PTS	Behavioral	PTS	Behavioral
LFC	NARW	0	0	0	3
	Blue whale	0	0	0	0
	Fin whale	0	0	1	2
	Sei whale	0	0	0	1
MFC	Sperm whale	0	0	0	3

Source: Küsel et al. 2022.

Note: Worst-case scenario presented, included modeling of two monopiles per 24-hour period and the results for the $L_{E,24h}$ threshold. Monopile foundation assumed tapered 8- to 11-meter-diameter piles, 50-meter penetration depth, and 4,000-kilojoule hammer energy.
Exposure values ≥0.5 were rounded up to the nearest integer, values <0.5 rounded down to 0.
dB = decibels; ESA = Endangered Species Act; LFC = low-frequency cetaceans; MFC = mid-frequency cetaceans; NARW = North Atlantic Right Whale; OSS = offshore substation; PTS = permanent threshold shift.
PTS and behavioral exposures are based on the number of MMPA Level A and Level B takes requested in the Letter of Authorization.

Low-frequency Cetaceans (LFC)

Behavioral and masking effects are more difficult to mitigate and are, therefore, still considered likely for activities with large acoustic disturbance areas such as impact pile driving. Pile-driving activities have been shown to cause avoidance behaviors in most marine mammal species, although studies that examine the behavioral responses of baleen whales to pile driving are absent from the literature. Behavioral avoidance of other impulsive noise sources has been documented and can be used as a proxy for impact pile driving. Malme et al. (1986) observed the responses of migrating gray whales to seismic exploration. At received levels of about 173 dB re 1 μPa, feeding gray whales had a 50% probability of stopping feeding and leaving the area. Some whales ceased to feed but remained in the area at received levels of 163 dB re 1 μPa. Individual responses were highly variable. Most whales resumed foraging activities once the air gun activities stopped. Dunlop et al. (2017) observed that migrating humpback whales would avoid air gun arrays up to 1.8 miles (3 km) away when received levels were over 140 dB re 1 μPa (Dunlop et al. 2017). Baleen whales showed varying levels of sensitivity to other mid-frequency impulsive noise sources (i.e., active sonar), with observed responses ranging from displacement (Maybaum 1993) to avoidance behavior (animals moving rapidly away from the source) (Hatakeyama et al. 1995; Watkins et al. 1993), decreased vocal activity, and disruption in foraging patterns (Goldbogen et al. 2013).

The Offshore Wind Area, where impact pile driving will occur, overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a northward migration during March to April and a southward migration during November to December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route (Hayes et al. 2020). Fin, sei, and blue whales generally prefer the deeper waters of the continental slope and more often can be found in water > 295 feet (90 meters) deep (Hain et al. 1985; Hayes et al. 2020; Waring et al. 2011). Based on the literature outlined above, behavioral responses of LFCs to impact pile driving could include ceasing feeding and avoiding the ensonified area. To limit potential effects to NARWs, impact pile driving will not occur during January 1 through April 30, avoiding the times of year when NARWs are present in higher densities (see Appendix A). In addition, the NARW pre-start PAM clearance zones presented in Table 3-9 are equal to the Level B zone to avoid any unnecessary takes related to behavioral disturbance, which will limit the potential for behavioral disturbance to all ESA-listed marine mammal species. If animals are exposed to underwater noise above behavioral thresholds, it could result in displacement of mother and calf pairs from a localized area around a pile (e.g., 1.9 miles [3.5 km] in the summer; Table 3-8). However, this displacement would be temporary for the duration of activity, which would be a maximum of 4 hours per pile with a 4-hour break before another pile would be driven. NARWs (and any LFCs) could be expected to resume their previous behavior (e.g., pre-construction activities) following an unknown period of time (e.g., active pile driving only expected for 8 hours per 24-hour period). In addition, the behavioral disturbance area (1.9 miles [3.5 km] in the summer and (2.3 miles [3.8 km] in the winter) would not impede the migration of NARWs to critical habitats located to the north and south of the Offshore Wind Area as animals would still be able to pass along coastal areas. The energetic consequences of any avoidance behavior and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Acoustic masking can occur if the frequencies of the activity overlap with the communication frequencies used by marine mammals. Modeling results indicate that dominant frequencies of impact pile-driving activities for the Proposed Action were concentrated below 1 kHz (Küsel et al. 2022). The short-term consequences of masking from Project activities range from temporary changes in vocalizations to avoidance (as outlined above). Longer-term consequences include permanent changes to vocal patterns; reductions in fitness, survivorship, and recruitment; and abandonment of important habitat areas. Most marine mammal species use a range of frequencies to communicate. Project activities would not overlap with the vocalization of all LFC communications. As a result, a complete masking of LFC marine mammal communications would not be expected during active pile driving. In addition, the duty cycle of sound sources is also important when considering masking effects. Low-duty cycle sound sources such as impact pile driving are less likely to mask LFC communications, as the sound transmits less frequently with pauses or breaks between impacts, providing opportunities for communications to be heard.

Mid-frequency Cetaceans (MFC)

MFCs also show varying levels of sensitivity to mid-frequency impulsive noise sources (i.e., active sonar, pile driving), with observed responses ranging from displacement (Maybaum 1993) to avoidance behavior (animals moving rapidly away from the source) (Watkins et al. 1993; Hatakeyama et al. 1995), decreased vocal activity, and disruption in foraging patterns (Goldbogen et al. 2013). Würsig et al. 2000 studied the response of Indo-Pacific hump-backed dolphins (*Sousa chinensis*) to impact pile driving in the seabed in water depths of 19.7 to 26.2 feet (6 to 8 meters). No overt behavioral changes were observed in response to the pile-driving activities, but the animals' speed of travel increased, and some dolphins remained in the vicinity while others temporarily abandoned the area. Once pile driving had ceased, dolphin abundance and behavioral activities returned to pre-pile driving numbers and behaviors. Sperm whales are rarely seen in shallower waters of the continental shelf (less than 1,000 feet [305 meters]) deep and frequent the continental slope in water depths greater than 2,000 feet (609 meters) (NMFS 2010b). They prefer deeper waters to hunt for squid and are generally found in the mid-Atlantic Bight during the spring. Near the Offshore Wind Area, the density of sperm whales is expected to be low (see Appendix A). Based on the available literature, behavioral responses of sperm whales to impact pile driving could include ceasing feeding and avoiding the ensonified area. However, due to the expected low density of sperm whales in the Offshore Wind Area the potential for exposure to underwater noises above behavioral thresholds is considered rare. In addition, pre-start PAM clearance zones presented in Table 3-9 for NARW will also limit the potential for behavioral disturbance to sperm whales. If animals are exposed to underwater noise above behavioral thresholds, it would likely result temporary localized displacement (e.g., 1.9 miles [3 km] in the summer; Table 3-8). This displacement would be temporary for the duration of activity, which would be a maximum of 4 hours per pile with a 4-hour break before another pile would be driven. MFCs (specifically sperm whale) would be expected to resume pre-construction activities following the 4-hour installation or once they move out of the disturbance zone. The energetic consequences of any avoidance behavior and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

As outlined above for LFCs, modeling results indicate that dominant frequencies of impact pile-driving activities for the Proposed Action will be concentrated below 1 kHz (Küsel et al. 2022). This does not overlap with the majority of vocalization made by sperm whales and would not impede their ability to echolocate prey or navigate. If any masking were to occur, it could be intermittent as the pauses or breaks between impacts provides opportunities for lower frequency communications to be heard.

Impact Pile Driving - Behavioral Impact Summary

Based on the mitigation and monitoring measures presented and discussed (Table 1-11) and the animal's ability to move away from the noise, the potential for exposure of these ESA-listed species to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. However, as discussed above up to 15 fin whales, 15 NARWs, two sei whales, four blue whales, and six sperm whales may be exposed to noise above the behavioral thresholds (Table 3-10 and Table 3-11). Therefore, the effects of noise exposure to Project impact pile driving leading to behavioral disruption **may affect, likely to adversely affect** fin whales, NARWs, sei, blue and sperm whales.

Detonation of UXOs (C)

During construction, Ocean Wind may encounter UXOs on the seabed in the Lease Area and along export cable routes. While non-explosive methods may be employed to lift and move these objects, some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could kill, injure, or disturb marine mammals. Ocean Wind conducted modeling of acoustic fields for UXO detonations, which included three sound pressure metrics (peak pressure level, SEL, and acoustic impulse), four different depths at four different sites, and five charge weight bins ranging from 5 pounds (2.3 kg) (bin E4) up to 1,000 pounds (454 kg) (bin E12). The depths were selected to be representative[5] of the Offshore Wind Area and cable route (like the 50- to 125-foot [15- to 38-meter] depths in this project [Section 2.1.1.1]) and ranged from 39 to 148 feet (12 to 45 meters). The modeling of acoustic fields was performed using a combination of semi-empirical and physics-based computational models. The modeling assumed that the full weights of UXO explosive charges are detonated together with their donor charges (listed in Table 3-12) and that no shielding by sediments occur. It also assumed that only one UXO would be detonated within a 24-hour period. Modeling of mitigated (10 dB attenuation) and unmitigated scenarios were conducted. As Ocean Wind has committed to attaining a 10 dB attenuation for all UXO detonation events, mitigated values are presented herein (Table 3-12).

Ocean Wind is committing to the use of a dual noise-mitigation system during all detonations as described in Table 1-11. Based on previous experience, 10 dB minimum of attenuation is possible with the use of a noise mitigation system (review provided in Hannay and Zykov 2022), and Ocean Wind has committed to attaining a 10 dB attenuation for all UXO detonation events (Table 3-12).

Table 3-12 UXO Charge Sizes Used for Underwater Acoustic Modeling

Navy Bin	Maximum net equivalent weight TNT	
	kg	Pounds
E4	2.3	5
E6	9.1	20
E8	45.5	100
E10	227	500
E12	454	1,000

Source: Hannay and Zykov 2022.
kg = kilograms; TNT = trinitrotoluene; UXO = unexploded ordnance

[5] The locations for the modeling presented in Hannay and Zykov (2022) were selected to be representative of three projects The specific locations modeled were chosen inside the Revolution Wind project area off the coast of Massachusetts. The key influencing parameter for these results is water depth; however, small variances of water depth (<33 feet [10 meters]) are not expected to generate significant differences to the sound fields, so the propagation results will be relevant for each project area at sites with similar water depth as the sites modeled.

Table 3-13 summarizes the maximum distances to PTS and behavioral thresholds per charge weight bin for each ESA-listed marine mammal hearing group. The ranges to PTS thresholds were larger than ranges to mortality and non-auditory injury criteria per charge bin. See Table 3-14 for charge size E12 (1,000 pounds [454 kg]) (Hannay and Zykov 2022). Therefore, the pre-clearance UXO zones for marine mammals were based on the ranges to PTS threshold.

Table 3-13 Maximum PTS Zones and Applicable Pre-clearance Zones to Be Applied during UXO Detonations – Mitigated

Hearing Group	Charge Size									
	E4 (2.3 kg)		E6 (9.1 kg)		E8 (45.5 kg)		E10 (227 kg)		E12 (454 kg)	
	Max PTS/Pre-clearance Zone (m)	Max Behavioral Zone (m)	Max PTS/Pre-clearance Zone (m)	Max. Behavioral Zone (m)	Max PTS/Pre-clearance Zone (m)	Max. Behavioral Zone (m)	Max PTS/Pre-clearance Zone (m)	Max Behavioral Zone (m)	Max PTS/Pre-clearance Zone (m)	Max Behavioral Zone (m)
LFC	552	2,820	982	4,680	1,730	7,490	2,970	10,500	3,780	11,900
NARW	552	2,820	982	4,680	1,730	7,490	2,970	10,500	3,780	11,900
MFC	50	453	75	773	156	1,240	337	2,120	461	2,550

Source: Hannay and Zykov 2022.
Notes: Max PTS zone represent $R_{95\%}$ values in meters. Pre-start clearance zones were calculated by selecting the largest PTS threshold (the larger of either the L_{pk} or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites. Behavioral monitoring zones were calculated by selecting the largest TTS threshold (the larger of either the L_{pk} or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.
m = meters; LFC = low-frequency cetaceans; kg = kilograms; L_{pk} = peak sound level; m = meters; MFC = mid-frequency cetaceans; NARW = North Atlantic right whale; SEL = sound exposure level; TTS = temporary threshold shift; UXO = unexploded ordnance

Table 3-14 Summary of Maximum UXO Distances to Non-Auditory Injury and Mortality Thresholds for Marine Mammals – Mitigated Scenario

Threshold Type	Marine Mammal Species	Maximum Distance (m) to Thresholds	
		Adult	Calf
Mortality	Baleen whale/sperm whale	29	108
Lung Injury	Baleen whale/sperm whale	78	237
Onset Gastrointestinal Injury (all species)[a]		125	125

Source: Hannay and Zykov 2022.
Notes: Maximum ranges are based on worst-case scenario modeling results for charge size E12 (454 kilograms) and deepest water depth (45 meters).
[a] Based on 1% of animals exposed (mortality/Lung injury).
m = meters; UXO = unexploded ordnance

The Applicant-proposed mitigation measures outlined for UXO detonations include the implementation of pre-clearance zones and restricting detonations to daylight hours (Table 1-11) with no more than one detonation within a 24-hour period. Ocean Wind has committed that enough vessels would be deployed to provide 100% temporal and spatial coverage of the pre-clearance zones and, if necessary, aerial surveys would be used to provide coverage. Passive acoustic monitoring would also be implemented to acoustically monitor a zone that encompasses a minimum of a 6.2-mile (10 km) radius around the source for all detonations. Table 3-15 outlines the number of ESA-listed marine mammals potentially exposed to sound sources above PTS and behavioral thresholds associated with UXO detonations. As the pre-clearance zones are considerably larger than distances to the mortality, non-auditory injury (lung injury), and gastrointestinal injury thresholds, the potential for these effects would be reduced and considered unlikely to occur. As the behavioral zones are considerably larger than the PTS zones, behavioral disturbance is considered likely. However, how marine mammals may react to underwater detonations is relatively unknown. The low number of potential UXOs identified in the Project area and Ocean Wind's commitment to using a dual noise-mitigation system for all detonations would further reduce all potential underwater noise effects associated with UXO detonations. For UXO detonation, masking is not anticipated to be an issue due to the short time frame over which the effect would occur.

Table 3-15 Number of ESA-Listed Marine Mammal Exposures to Sound Levels above PTS and Behavioral Thresholds for the Detonation of 10 UXOs – Mitigated (10 dB)

Marine Mammal Species		PTS	Behavioral
LFC	NARW[a]	0[b]	8
	Blue whale	0	0
	Fin whale	0[b]	10
	Sei whale	0[b]	0
MFC	Sperm whale	0	0

Source: Hannay and Zykov 2022.
Notes:
Calculated exposures that were ≥0.5 were rounded up to the nearest whole number. Those <0.5 were rounded down.
[a] <1 (0.67) for NARW, 0.94 for fin whales and 0.04 for sei whale PTS exposures were estimated for these species, but due to mitigation measures proposed by the Applicant, no PTS (Level A takes) exposures are expected and no Level A takes have been requested for these species. Behavioral exposure estimates are based on the number of MMPA Level B takes requested in the Letter of Authorization.
dB = decibels; ESA = Endangered Species Act; LFC = low-frequency cetaceans; MFC = mid-frequency cetaceans; NARW = North Atlantic right whale; PTS = permanent threshold shift; UXO = unexploded ordnance

Effects of Exposure to Noise Above the PTS and Mortality/Slight Lung Injury/Gastrointestinal Injury Thresholds

No PTS/mortality/slight lung injury/gastrointestinal injury exposures are expected for blue whales, NARWs, sei whales, and sperm whales from UXO detonations. With the implementation of vessel-based monitoring and aerial surveys to cover the pre-clearance zones, the potential for serious injury is further minimized. The pre-clearance zones would facilitate a delay of UXO detonations if marine mammals are observed approaching or within areas that could be ensonified above sound levels that could result in auditory and non-auditory injury. The proposed requirement that UXO detonations can only commence when these zones (Table 3-13) are fully visible to PSOs allows a high marine mammal detection capability, enabling a high rate of success in implementation of pre-clearance zones to avoid serious injury. With the implementation of these measures, the potential for PTS effects would be reduced such that no species is expected to be exposed to noises above PTS thresholds; thus, the potential for PTS exposure to these ESA-listed species is extremely unlikely to occur and is **discountable**. Therefore, the effects of noise and blast exposure from Project UXO detonations leading to PTS **may affect, not likely to adversely affect** blue whales, NARWs, fin whales, sei whales, and sperm whales.

Effects of Exposure to Noise Above the TTS and Behavioral Thresholds and Masking

Considering UXO detonations, no blue, sei, or sperm whale exposures leading to TTS and/or behavioral disturbance are expected; however, up to ten fin whales, eight NARWs may be exposed to noise levels that exceed TTS and behavioral thresholds (Table 3-15). Blue and sperm whales are unlikely to be exposed to noises above TTS and behavioral thresholds due to their rarity in the Offshore Wind Area. Blue whales prefer deep water and typically occur further offshore in areas with depths of 328 feet (100 meters) or more (Waring et al. 2011). Sperm whales are rarely seen in shallower waters of the continental shelf (less than 1,000 feet [305 meters]) deep and frequent the continental slope in water depths greater than 2,000 feet (NMFS 2010b). The low number of potential UXOs expected (up to 10) further reduces the potential for this effect to these species. Therefore, exposure to underwater noise above TTS and behavioral thresholds from UXO detonations is considered extremely unlikely to occur and **discountable** for blue, sei and sperm whales. Therefore, the effects of noise exposure to Project UXO detonations leading to TTS/behavioral disturbance **may affect, not likely to adversely affect** blue, sei, and sperm whales**.**

The following sections discuss the potential behavioral reactions of fin whales and NARWs to underwater detonations. Although behavioral thresholds may be reached, how species react to UXO detonations, and the subsequence consequence of these reactions is relatively unknown. For UXO detonation, masking is not anticipated to be an issue due to the short time frame over which the effect would occur.

Low-frequency Cetaceans (LFC)

The reaction of marine mammals to underwater explosives is relatively unknown. Detonation of UXOs could startle or temporarily displace migrating or foraging LFCs. UXO detonations would occur in a biologically important area for migrating NARWs. Timing of migrations includes a northward migration during March to April and a southward migration during November to December between summer feeding and winter calving grounds. During this migration period, adults may be accompanied by calves and periodically feed and rest along their migration route (Hayes et al. 2020). Fin whales generally prefer the deeper waters of the continental slope and more often can be found in water greater than 295 feet (90 meters) deep (Hain et al. 1985; Hayes et al. 2020; Waring et al. 2011). To limit potential effects to NARWs, UXO detonations will not occur from January 1 through April 30 to avoid the times of year when NARWs are present in higher densities (see Appendix A) and no UXOs will be detonated during nighttime hours. Any behavioral reactions of NARWs or fin whales are expected to be temporary and would likely include short startle responses to the detonations. LFCs would be expected to resume pre-detonation activities shortly after an explosive event. The low number of potential UXOs identified in the Project area and Ocean Wind’s commitment to using a dual noise-mitigation system for all detonations would further reduce all potential underwater noise effects associated with UXO detonations. The energetic consequences of any startle or avoidance behavior and potential delay in resting or foraging are not expected affect any individual’s ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Detonation of UXOs - TTS and Behavioral Impact Summary

Based on the mitigation and monitoring measures presented and discussed (Table 1-11) the potential for exposure of these ESA-listed species to noise levels leading to TTS/behavioral disruption would be reduced greatly and only occur at the level of the individual animal and are not expected to have population-level effects. However, as discussed above up to ten fin whales, eight NARWs may be exposed to noise above the TTS and behavioral thresholds (Table 3-15). Therefore, the effects of noise exposure to Project UXO detonations leading to TTS/behavioral disturbance **may affect, likely to adversely affect** fin whales and NARWs**.**

3.2.6.2.4.2 Non-impulsive Underwater Noise

Project-generated non-impulsive underwater noise considered in the assessment are vibratory pile driving associated with installation and removal of the cofferdam, noise associated with some HRG surveys, vessel noise, aircraft operations, cable laying and trenching, and WTG operations. A description of the underwater noise modeling is provided and a summary of the results are presented under each activity.

Vibratory Pile Driving (C)

Temporary cofferdams are being considered at four locations to connect the cables to shore:

1. Oyster Creek horizontal directional drilling (HDD), two cofferdams (Atlantic Ocean to Island Beach State Park; sea-to-shore);
2. Island Beach State Park Barnegat Bay HDD, two cofferdams (Barnegat Bay onshore; bay-to-shore);
3. Farm Property HDD, two cofferdams (bayside of Oyster Creek; shore-to-bay); and
4. BL England HDD, one cofferdam (sea-to-shore).

If required, they may be installed either as sheet pile structures into the seafloor or a gravity cell structure placed on the floor using ballast weight. Selection of a preferred design for cofferdams and landfall works is pending additional design and coordination. Ocean Wind anticipates that impacts relating to cofferdam installation and removal would eclipse any potential impacts of alternative methods and, therefore, the underwater noise modeling conducted for the cofferdam installation represents the most conservative values and are carried forward in this BA.

Installation and removal of sheet piles would require the use of a vibratory hammer. A practical spreading loss model was used by JASCO (HDR, Inc. 2022; JASCO 2022) to estimate the extent of potential underwater noise effects as a result of vibratory driving of sheet piles. The 10 meter received level of the vibratory pile driver was assumed to be 165 decibels relative to 1 micropascal measured at 1 meter (dB re 1 µPa-m) based on source levels for vibratory driving of sheet piles published in a pile driving compendia (Illingworth & Rodkin, Inc. 2007, 2017). Using simple geometric spreading loss model [α·Log10 (distance), where α is the spreading loss coefficient] the distance to the behavioral threshold was predicted (e.g., SPL 120 dB re 1 µPa). Practical spreading loss, α = 15, is a common choice of coefficient for shallow water as it lies between spherical, α = 20, and cylindrical, α = 10, spreading. Modeling for the SEL PTS values assumed that the installation of cofferdams would require 18 hours over 2 days to complete, with vibratory pile driving taking place for no longer than 12 hours each 24-hour period over the installation period. It was also assumed that the removal of cofferdams would require 18 hours over 2 days to complete, with vibratory pile driving taking place for no longer than 12 hours each 24-hour period over the installation period. Table 3-16 summarizes the maximum distances to auditory injury (PTS) and behavioral thresholds per hearing group. The number of ESA-listed marine mammal species potentially exposed to noises above thresholds for vibratory sheet installation was estimated by multiplying the maximum distances to thresholds by the highest monthly species density (see Appendix A for additional details regarding species densities used in the modeling) by 4 days of vibratory pile driving and is summarized in Table 3-17. Due to lower densities of marine mammals in the nearshore areas of the cofferdam installation and removal, the transitory nature of marine mammals, and the very short duration of vibratory pile driving, these estimates are likely conservative. Estimated PTS exposures to marine mammal species resulting from vibratory installation and removal of cofferdams was less than one in all cases. No PTS (Level A harassment) takes were requested for ESA-listed marine mammal species in the LOA application from Ocean Wind.

Table 3-16 Maximum Range to PTS and Behavioral Effects, and Applicable Pre-clearance and Shutdown Zones to Be Applied during Vibratory Pile Driving

Hearing Group	Max Range to PTS (m) from L_{E24hr} Thresholds	Pre-clearance Zone (m)	Shutdown Zone (m)	Max Range to Behavioral Effects (m)
LFC	86.7	150	100	10,000
NARW	86.7	150	100	10,000
MFC	7.7	150	50	10,000

LFC = low-frequency cetacean; m = meter; Max = maximum; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PTS = permanent threshold shift; L_{E24hr} = cumulative sound exposure level, 24 hours.

Table 3-17 Number of ESA-Listed Marine Mammals Exposed to Sound Levels Above PTS and Behavioral Thresholds for Vibratory Pile Driving – Cofferdam Installation

Marine Mammal Species		PTS	Behavioral
LFC	NARW	0	11
	Blue whale	0	0
	Fin whale	0	3
	Sei whale	0	0
MFC	Sperm whale	0	0

Sources: HDR, Inc. 2022a; JASCO 2022
Note: Calculated exposures that were ≥0.5 were rounded up to the nearest whole number. Those <0.5 were rounded down. Behavioral exposures are based on the number of MMPA Level B takes requested in the LOA.
ESA = Endangered Species Act; LFC = low-frequency cetaceans; MFC = mid-frequency cetaceans; NARW = North Atlantic right whale; PTS = permanent threshold shift

The Applicant-proposed mitigation measures outlined for vibratory pile driving include pre-clearance zones, shutdown zones, and ramp-up procedures and are summarized in Table 1-11. As outlined in Table 3-16, the pre-clearance zones and shutdown zones cover the largest PTS zone modeled for each species group.

Effects of Exposure to Noise Above the PTS Thresholds

No PTS exposures are expected for any ESA-listed cetacean species during vibratory pile driving; thus there is **no effect**.

Effects of Exposure to Noise Above the Behavioral Thresholds and Masking

Considering vibratory pile driving, up to 11 NARWs and three fin whales may be exposed to noise levels that exceed behavioral thresholds (Table 3-17). Vibratory pile driving is only expected to occur over a 4-day period at four potential shoreline locations: Oyster Creek, Island Beach State Park Barnegat Bay, Farm Property bayside of Oyster Creek, and BL England. Behavioral effects are considered possible and may extend out to 6.2 miles (10 km) from the Project.

Blue, sei, and sperm whales are generally rare in nearshore areas. Therefore, exposure to underwater noise above behavioral thresholds from vibratory pile driving is considered extremely unlikely to occur and **discountable** for these species. Therefore, the effects of noise exposure from Project vibratory pile driving leading to behavioral disruption **may affect, not likely to adversely affect** blue, sei, or sperm whales.

Low-frequency Cetaceans (LFC)

Up to 11 NARWs and three fin whales could be exposed to underwater noise above behavioral thresholds from vibratory pile driving. Due to lower densities of marine mammals in the nearshore areas of the cofferdam installation and removal, the transitory nature of marine mammals, and the very short duration of vibratory pile driving, these estimates are likely conservative. The nearshore areas where vibratory pile driving will occur overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a northward migration during March to April and a southward migration during November to December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route (Hayes et al. 2020). Fin whales are present in the area year-round; however, they generally prefer deeper water greater than 295 feet (90 meters) (Hayes et al. 2020). There is limited information regarding the potential behavioral reactions of LFCs to vibratory pile driving. Potential effects may include avoidance and ceasing feeding activities as with impact pile driving activities. If animals are exposed to underwater noise above behavioral thresholds, the noise could result in displacement of mother and calf pairs from a localized area (e.g., up to 6.2 miles [10 km] from shore; Table 3-16). However, this displacement would be temporary for the duration of activity, which would be a maximum of 12 hours for installation for two days and 18 hours of removal for two days with break in between each period. LFCs would be expected to resume pre-construction activities following the installation/removal period. In addition, the behavioral disturbance area (6.2 miles [10 km] from shore) would not impede the migration of NARWs to critical habitats located to the north and south of the Offshore Wind Area as animals would still be able to pass along offshore areas. The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Mid-Frequency Cetaceans (MFC)

As stated above, sperm whales are generally rare in nearshore areas. Therefore, exposure to underwater noise above behavioral thresholds from vibratory pile driving in nearshores areas is considered extremely unlikely to occur and **discountable** for these species. Therefore, the effects of noise exposure from Project vibratory pile driving leading to behavioral disruption **may affect, not likely to adversely affect** sperm whales.

Vibratory Pile Driving - Behavioral Impact Summary

Based on the mitigation and monitoring measures presented and discussed (Table 1-11), the potential for exposure of these ESA-listed species to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. However, as discussed above, up to 11 NARWs and three fin whales may be exposed to noise above behavioral thresholds (Table 3-17). Therefore, the effects of noise exposure from Project vibratory pile driving leading to behavioral disruption **may affect, likely to adversely affect** NARWs and fin whales**.**

HRG Surveys (pre-C, C, O&M, D)

A total of 3,797 miles (6,110 km) of HRG surveys are estimated to be required in the Offshore Project area and export cable route area. To support the Project, acoustic propagation modeling of HRG survey activities was undertaken by JASCO Applied Sciences. The modeling assumed the Project design information presented herein.

Up to three vessels may be active concurrently within a 24-hour period and would transit at speeds of 4 knots (2 m/s) with a single vessel being able to cover 43.5 miles (70 km) per day. In certain shallow-water areas, vessels may conduct surveys during daylight hours only, with a corresponding assumption that the daily survey distance would be halved (21.7 miles [35 km]). However, for purposes of analysis, a single vessel survey day is assumed to cover the maximum 43.5 miles (70 km). In years 1, 4, and 5, 88 survey days per year are expected. It is estimated that a total of 3,797 miles (6,110 km) would be needed within the Offshore Wind Area and export cable route area during this time. Survey effort would be split between the Offshore Wind Area and the export cable route area: 1,864 miles (3,000 km) for the array cable; 1,429 miles (2,300 km) for the Oyster Creek export cable; 317 miles (510 km) for the BL England export cable; and 186 miles (300 km) for the OSS interconnector cable. During years 2 and 3 (when construction would occur), 180 survey days per year would be required. HRG surveys during WTG and OSS construction and operation would include up to 6,835 miles (11,000 km) of export cable surveys; 6,524 miles (10,500 km) of array cable surveys; 662 miles (1,065 km) of foundation surveys; 155 miles (250 km) of WTG surveys; and up to 1,522 miles (2,450 km) of monitoring and verification surveys.

To cover the requirements of the Project, several HRG surveys were considered in the modeling, including:

1. Shallow-penetration, non-impulsive, non-parametric SBPs (compressed high-intensity radiated pulses [CHIRP SBPs]), 2 to 20 kHz;
2. Medium-penetration, impulsive boomers, 3.5 Hz to 10 kHz; and
3. Medium-penetration, impulsive sparkers, 50 Hz to 4 kHz.

A summary of the specification for representative equipment that was used in the modeling is presented in Table 3-18. Equipment with operating frequencies above 180 kHz would be used but were not considered in modeling as they are above the hearing ranges of all listed species and are therefore not anticipated to cause injury or disturbance.

Table 3-18 Summary of Representative HRG Equipment

Type	Frequency (kHz)	SL_{rms} (dB re 1 μPa-m)	$SL_{0\text{-}pk}$ (dB re 1 μPa-m)	Pulse Duration (ms)	Repetition Rate (Hz)	Beamwidth (degrees)	Reference[a,b]
Non-parametric shallow penetration SBPs (non-impulsive)							
ET 216 (2000DS or 3200 top unit)	2 to 16	195	-	20	6	25	MAN
	2 to 8						
ET 424	4 to 24	176	-	3.4	2	71	CF
ET 512	0.7 to 12	179	-	9	8	80	CF
GeoPulse 5430A	2 to 17	196	-	50	10	55	
Teledyne Benthos Chirp III - TTV 170	2 to 7	197	-	60	15	100	MAN
Medium penetration SBPs (impulsive)							
AA, Dura-spark UHD (400 tips, 500 J)[a]	0.3 to 1.2	203	211	1.1	4	Omni	CF

Type	Frequency (kHz)	SL_{rms} (dB re 1 μPa-m)	$SL_{0\text{-}pk}$ (dB re 1 μPa-m)	Pulse Duration (ms)	Repetition Rate (Hz)	Beamwidth (degrees)	Reference[a,b]
AA, triple plate S-Boom (700–1,000 J)[b]	0.1 to 5	205	211	0.6	4	80	CF

Notes: All source information that used in the modeling are provided.
Table recreated from 86 FR 26465 - Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Marine Site Characterization Surveys Off of New Jersey.

[a] The Dura-spark measurements and specifications provided in Crocker and Fratantonio (2016) were used for all sparker systems proposed for the survey. These include variants of the Dura-spark sparker system and various configurations of the GeoMarine Geo-Source sparker system. The data provided in Crocker and Fratantonio (2016) represent the most applicable data for similar sparker systems with comparable operating methods and settings when manufacturer or other reliable measurements are not available.

[b] Crocker and Fratantonio (2016) provide S-Boom measurements using two different power sources (CSP–D700 and CSP–N). The CSP–D700 power source was used in the 700 J measurements but not in the 1,000 J measurements. The CSP–N source was measured for both 700 J and 1,000 J operations but resulted in a lower SL; therefore, the single maximum SL value was used for both operational levels of the S-Boom.

- = not applicable; AA = Applied Acoustics; CF = Crocker and Fratantonio (2016); dB = decibels; ET = EdgeTech; Hz = hertz;
J = joule; kHz = kilohertz; MAN = manufacturer; Omni = omnidirectional source; ms = milliseconds; μPa = microPascals; re = referenced to; rms = root-mean squared; SBP = sub-bottom profiler; SL = source level; SPL = sound pressure level;
UHD = ultra-high definition

Ranges to PTS thresholds for the HRG sources were calculated using the NMFS (2020) User Spreadsheet Tool and presented in HDR, Inc. (2022a). This tool accounts for the source level, the speed of the vessel, the repetition rate of the source, the pulse duration, and frequency weighting for each source/animal hearing group combination. Ranges to behavioral thresholds were calculated using the NMFS (2020) practical spreading model. Finally, isopleth distances for HRG sources with beamwidths less than 180 degrees were calculated following NMFS Office of Protected Resources interim guidance (NMFS 2019). Source levels and specifications relied upon equipment that was measured in Crocker and Fratantonio (2016), the best available manufacturer specifications (represent maximum output), and/or the closest proxy source measured in Crocker and Fratantonio (2016; see Table 3-18).

The largest PTS isopleth distance for HRG surveys is less than 6.6 feet (2 meters) for all ESA-listed marine mammal species and was 141 for behavioral effects (Table 3-19). No Level A takes of any ESA-list marine mammal species were requested by Ocean Wind as part of its LOA due to the Applicant-proposed mitigation measures outlined in Table 1-11. These mitigation measures include pre-clearance zones, shutdown zones, and ramp-ups. Pre-start clearance surveys and ramp-ups would be conducted for non-impulsive, non-parametric sub-bottom profilers and impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kilohertz. Shutdowns would be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kilohertz. The pre-clearance zones and shutdown zones proposed for the selected HRG surveys cover the maximum PTS zones modeled, part of the behavioral zones for most species, and the entire behavioral zone for NARWs (Table 3-19). Due to the relatively small monitoring zones outlined in Table 3-19, the ability to monitor for marine mammals within those zones is considered high. The pre-clearance and shutdown zones would limit the potential for behavioral effects, particularly to NARWs.

Table 3-19 Maximum Range to PTS and Applicable Pre-clearance and Shutdown Zones to Be Applied during HRG Surveys

Hearing Group	Max Range to PTS (m) using L_{E24hr} Thresholds	Max Range to Behavioral Effects (m) (160 dB)	Shutdown/Pre-clearance Zone (m)
LFC	1.5	141	100
NARW	1.5	141	500
MFC	<1	141	100

Note: Pre-start clearance surveys and ramp-ups would be conducted for non-impulsive, non-parametric sub-bottom profilers and impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kilohertz. Shutdowns would be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kilohertz.
Range to effects are based on the distance to an SPL of 160 dB re 1 µPa.
HRG = high-resolution geophysical; LFC = low-frequency cetacean; m = meters; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PTS = permanent threshold shift; $L_{E24hr\ r}$ = cumulative sound exposure level, 24 hours.

The number of ESA-listed marine mammal species potentially exposed to noises above thresholds for HRG surveys was estimated by using the average density for 12 months for each species, or the annual density when that was the only value available multiplied by either 88 or 180 days of HRG surveys multiplied by the area ensonified per day (43.4 miles [70 km] per day multiplied by the ensonified area). This estimation method was used because it is unknown in which months HRG surveys will occur. Using the average annual density results in a conservative exposure (take) estimate for each species, thereby reducing the risk of the Project needing more takes than authorized. Estimated PTS exposures to marine mammal species resulting from HRG surveys was zero in all cases (Table 3-20).

Table 3-20 Annual and Total Number of ESA-Listed Marine Mammal Exposed to Sound Levels Above PTS and Behavioral Thresholds for HRG Surveys

Marine Mammal Species		Years 1, 4, and 5 (88 days of HRG surveys per year)		Years 2 and 3 (180 days of HRG surveys per year)		Total (years 1, 2, 3, 4, and 5)	
		PTS	Behavioral	PTS	Behavioral	PTS	Behavioral
LFC	NARW	0	3	0	6	0	21
	Blue whale	0	0	0	0	0	0
	Fin whale	0	2	0	3	0	12
	Sei whale	0	0	0	1	0	2
MFC	Sperm whale	0	3	0	3	0	15

Note: Calculated exposures that were ≥0.5 were rounded up to the nearest whole number. Those <0.5 were rounded down.ESA = Endangered Species Act; HRG = high-resolution geophysical; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PTS = permanent threshold shift
Behavioral exposures are based on the number of MMPA Level B takes requested in the Letter of Authorization.

Effects of Exposure to Noise Above the PTS Thresholds

No PTS exposures are expected for any ESA-listed cetacean species during HRG surveys; thus there is **no effect**.

Effects of Exposure to Noise Above Behavioral Thresholds and Masking

Considering HRG surveys, modeling indicates that three to six NARWs, two to five fin whales, zero to one sei whale, and three sperm whales may be exposed to noise levels that exceed behavioral thresholds (Table 3-20) in any survey year. Behavioral effects are considered possible and may extend out to 463 feet (141 meters) from the Project. Blue whales prefer deep water and typically occur farther offshore in areas with depths of 328 feet (100 meters) or more (Waring et al. 2011).

Therefore, exposure to underwater noise above behavioral thresholds and masking from HRG surveys is considered extremely unlikely to occur and **discountable** for blue whales. Therefore, the effects of noise exposure from Project HRG surveys leading to behavioral disturbance **may affect, not likely to adversely affect** blue whales.

For HRG surveys, masking of communications would depend on the frequency at which the survey is completed. A total of 88 survey days in years 1, 4, and 5 and 180 days in years 2 and 3 and would include non-impulsive sources in the 2 to 20 kHz range and impulsive boomers and sparkers in the 3.5 Hz to 10 kHz and 50 Hz to 4 kHz range.

Low-frequency Cetaceans (LFC)

Three to six NARWs, two to five fin whales, and zero to one sei whale could be exposed to underwater noise above behavioral thresholds from HRG surveys on an annual basis depending on survey effort (Table 3-20). The areas where HRG surveys will occur overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a norward migration during March and April and a southward migration during November and December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route. Fin whales are present in the area year-round; however, fin as well as sei whales generally prefer the deeper waters of the continental slope and more often can be found in water greater than 295 feet (90 meters) deep (Hain et al. 1985; Waring et al. 2011; Hayes et al. 2020). There is limited information regarding the potential behavioral reactions of LFCs to HRG surveys. If animals are exposed to underwater noise above behavioral thresholds, it could result in mother and calf pairs being displaced from an immediate location around the vessel (e.g., up to 463 feet [141 meters]; Table 3-19). However, this displacement would be temporary and transient and would occur for the duration of the HRG equipment/vessel transit relative to the receiver (e.g., the marine mammal). The behavioral disturbance area (463 feet [141 meters] from the vessel) would not impede the migration of NARWs to critical habitats located to the north and south of the Offshore Wind Area as animals would still be able to move outside of the behavioral disturbance zone easily or wait until the vessel passes. In addition, the pre-clearance zones and shutdown zones proposed for the selected HRG surveys cover the entire behavioral zone for NARWs and part of the behavioral zones for fin and sei whales (Table 3-20), which would limit the potential for behavioral effects. Due to the relatively small monitoring zones outlined in Table 3-19, the ability to monitor for marine mammals within those zones is considered high. Due to the range of frequencies emitted during HRG surveys, masking of all hearing groups is considered possible. Masking of LFC communications is considered more likely due to the overlap of these surveys with lower-frequency signals produced by these species. However, as the effects of masking would be transient in nature (moving with the vessel) the potential for communications to be masked is reduced.

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Mid-Frequency Cetaceans (MFC)

Up to three sperm whales could be exposed to underwater noise above behavioral thresholds from HRG surveys on an annual basis (Table 3-20). The area over which surveys would occur would not extend to the continental shelf where sperm whales are more commonly observed. If sperm whales are exposed to underwater noise above behavioral thresholds, it could result in localized temporary displaced from an immediate area around the survey vessel (e.g., up to 462 feet [141 meters]; Table 3-19). In addition, the pre-clearance zones and shutdown zones proposed for the selected HRG surveys cover part of the behavioral zones for sperm whales (Table 3-20) which would limit the potential for behavioral effects. Due to the relatively small monitoring zones outlined in Table 3-19 the ability to monitor for marine mammals within those zones is considered high. Masking of high-frequency echolocation clicks used by sperm whales is not anticipated; however, some masking of other communications used by this species is possible. These effects would be transient in nature (moving with the vessel) the potential for communications to be masked for all is considered reduced.

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

HRG Surveys –Behavioral Impact Summary

Based on the mitigation and monitoring measures presented and discussed (Table 1-11) the potential for exposure of these ESA-listed species to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. However, as discussed above, between three to six NARWs, two to five fin whales, zero to one sei whale, and three sperm whales may be exposed to noise above behavioral thresholds (Table 3-20) annually. Therefore, the effects of noise exposure from Project HRG surveys leading to behavioral disturbance and masking **may affect, likely to adversely affect** NARWs, fin whales, sei whales, and sperm whales.

Vessel Noise (pre-C, C, O&M, D)

There are several types of vessels that would be required throughout the life of the Project. Table 1-4 and Table 1-7 outline the type of vessels that would be required for Project construction and operations as well as the maximum number of vessels required by vessel type. Based on information provided by Ocean Wind, construction activities (including offshore installation of WTGs, OSSs, array cables, interconnection cable, and export cable) would require several types of construction vessels, transiting between the various ports and the Project area over the 20-month construction period (Table 1-4, Table 1-5, and Table 1-6). Project vessels include installation vessels to provide a stable platform when on site. It is anticipated that up to two jack-up vessels would be used. Jack-up barges towed by tugs may also be used. Where installation vessels are not used to transport the turbines to the installation site, dedicated transport, feeder barges, or jack-ups would be used for transport. In addition, up to 24 support vessels may be used, including crew boats, anchored hotel vessels, tugs, and other miscellaneous support vessels if needed (e.g., security vessels). Up to eight vessels may be required during the construction and installation of the turbine. The sizes of these vessels range from 325 to 350 feet (99 to 107 meters) in length, from 60 to 100 feet (18 to 30 meters) in beam, and draft from 16 to 20 feet (5 to 6 meters). Additional activities that may require vessels include monitoring initiatives (e.g., marine mammals and fisheries) and HRG surveys. SPL source levels for large vessels range from 177 to 188 dB re 1 μPa-m (McKenna et al. 2012). Smaller support vessels typically produce higher-frequency sound concentrated in the 1,000 to 5,000 Hz range, with source levels ranging from 150 to 180 dB re 1 μPa-m (Kipple 2002; Kipple and Gabriele 2003).

Effects of Exposure to Noise Above the PTS Thresholds

No PTS exposures are expected for any ESA-listed cetacean species during Project vessel activities; thus there is **no effect**.

Effects of Exposure to Noise Above Behavioral Thresholds and Masking

Based on the source levels presented in the literature for vessels similar to those that will be used for the Project (outlined above), behavioral disturbance thresholds could be exceeded.

A comprehensive review of the literature indicates that vessel sound can elicit behavioral reactions in marine mammals and potentially result in masking of their communication space (Richardson et al. 1995). Acoustic responses to vessel sound include alteration of the composition of call types, rate and duration of call production, and actual acoustic structure of the calls. Observed behavioral responses include changes in respiration rates, dive patterns, and swim velocities. These responses have, in certain cases, been correlated with numbers of vessels and their proximity, speed, and directional changes. Responses have been shown to vary by gender and by individual. Southall et al. (2021) reviewed literature sources that looked at the behavioral effects of vessel noise on several marine mammal species: Malme et al. (1986) conducted playback experiments of recorded vessel noises to migrating gray whales; Gordon (1992) performed observational studies on the behavioral responses of sperm whales to whale-watching vessels; Nowacek et al. (2004) conducted controlled exposure experiments on NARWs using a variety of industrial stimulus including vessel noises; and Holt et al. (2009) studied the vocal response of killer whales to vessel presence (cited in Southall et al. 2021). The results of these surveys are outlined for each hearing group below.

Low-frequency Cetaceans (LFC)

Southall et al. (2021) reviewed two studies that looked at the responses of LFCs to vessels as outlined above. Southall et al. (2021) ranked gray whale responses to vessel noise playbacks at a severity score of 5 due to the onset of avoidance behavior (e.g., heading away or increasing range from the source). NARWs were given a behavioral response severity score of 0 to vessel noise (e.g., no detectable response). Rolland et al. (2012) identified an association between exposure to low frequency ship noise and an increase in stress-related metabolites in NARWs, which may contribute to poorer reproductive success and immune suppression.

The areas where vessel transits will occur overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a norward migration during March to April and a southward migration during November to December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route. Fin whales, sei whales, and blue whales generally prefer the deeper waters of the continental slope and more often can be found in water greater than 295 feet (90 meters) (Hain et al. 1985; Waring et al. 2011; Hayes et al. 2020). Based on the available literature, NARWs are not expected to exhibit avoidance behavior to vessel activities (Nowacek et al. 2004) which likely contributes to the strike risk of this species as outlined in Section 3.2.6.7. Fin whales, blue whales, and sei whales show varying levels of behavioral responses to vessel activities ranging from no detectable response to avoidance behaviors. Any behavioral effects would be expected to dissipate once the vessel or individual has left the area and is therefore considered temporary. Behavioral disturbance from Project vessels is not expected to impede the migration of NARWs to critical habitats located to the north and south of the Offshore Wind Area as animals would still be able to move outside of the behavioral disturbance zone or wait until the vessel passes. With the implementation of vessel separation distances outlined in Table 1-11, potential behavioral effects are further reduced. In addition, the vessel speed restrictions outlined for the Project (Table 1-11) could reduce the source levels emitted by certain vessels.

Large vessels generally emit underwater noises in the low frequency bands below 1 kHz that have the potential to overlap with LFC communications. Smaller vessels typically produce higher-frequency sound concentrated in the 1,000 Hz to 5,000 Hz range. Masking of LFC communications is considered possible across large and small vessel frequency spectrums. However, as the effects of masking would be transient in nature (moving with the vessel) the potential for communications to be masked is also considered temporary and transient.

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Mid-Frequency Cetaceans (MFC)

Southall et al. (2021) review two studies that looked at the responses of MFCs to vessels as outlined above. Killer whales in the presence of vessels demonstrated brief or minor changes in vocal rates or signal characteristics potentially related to higher auditory masking potential (rated 4 on the severity scale [Southall et al. 2021]). Sperm whales exposed to multiple vessel exposures exhibited behavioral severity responses of 1 to 4 due to observed changes in acoustic vocalizations (brief or minor changes in vocal rates or signal characteristics potentially related to higher auditory masking potential), diving, and subsurface interval behavior (increased interval between surfacing bouts [Southall et al. 2021]).

The majority of vessel transits is expected to occur between the Offshore Wind Area and coastal ports (see Section 2.1.3.2). The area over which most of vessel transits would occur would, therefore, not extend to the continental shelf where sperm whales are more commonly observed. If sperm whales are exposed to underwater noise above behavioral thresholds, it could result in changes in acoustic vocalizations, changes in diving and subsurface behaviors. These effects would likely be localized the area around the vessel, would be temporary and transient. Sperm whales would be expected to resume pre-exposure activities once the vessel passed or the animal moved out of the disturbance zone. With the implementation of vessel separation distances outlined in Table 1-11, potential behavioral effects are further reduced. In addition, the vessel speed restrictions outlined for the Project (Table 1-11) could reduce the source levels emitted by certain vessels.

Masking of high-frequency echolocation clicks used by sperm whales is not anticipated; however, some masking of other communications used by this species is possible. Observed changes in acoustic vocalizations from Gordon (1992) demonstrate that, in response to whale watching vessel exposures, sperm whales produce brief or minor changes in vocal rates and signal characteristics. These effects would be transient in nature (moving with the vessel) the potential for communications to be masked for all is considered reduced.

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Vessel –Behavioral Impact Summary

Based on the mitigation measures presented and discussed (Table 1-11) the potential for exposure of these ESA-listed marine mammal species to noise levels leading to behavioral disturbance would be reduced at the level of the individual animal and would not be expected to have population-level effects. As discussed above, NARWs, blue whales, fin whales, sei whales, and sperm whales may be exposed to noise above the behavioral thresholds and masking effects depending on the type and speed of the vessel. However, given the interim definition for ESA harassment, the animals ability to avoid harmful noises, and the established mitigation and monitoring measures being proposed (including reduced vessel speeds), the exposure of ESA-listed cetaceans to vessel noise that results in TTS/behavioral disturbance or masking would not rise to the level of take under the ESA is, therefore, **insignificant**. Therefore, noise exposure from Project vessel operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed cetaceans.

Aircraft Noise (C, O&M, D)

Helicopter support would be required during several Project activities through construction, O&M, and decommissioning. The number of helicopter trips required for construction is provided in Table 1-5. Patenaude et al. (2002) showed that aircraft operations could result in temporary behavioral responses from beluga (*Delphinapterus leucas*) and bowhead whales (*Balaena mysticetus*). Responses included short surface durations, abrupt dives, and percussive behaviors (i.e., breaching and tail slapping) (Patenaude et al. 2002). Most observed reactions by bowheads (63%) and belugas (86%) occurred when the helicopter was at altitudes of 492 feet (150 meters) or less and lateral distances of 820 feet (250 meters) or less.

BOEM would require all aircraft operations to comply with current approach regulations for any sighted NARWs or unidentified large whale. Current regulations (50 CFR 222.32) prohibit aircraft from approaching within 1,500 feet (457 meters) of NARWs. BOEM expects that most aircraft operations would occur above this altitude limit except under specific circumstances (e.g., helicopter landings on the service operation vessel or visual inspections of WTGs). With the implementation of these mitigation measures, exposure of noises above PTS, TTS, and behavioral thresholds for all ESA-listed marine mammal species is considered extremely unlikely to occur and **discountable**. Therefore, noise exposure from Project aircraft activities leading to PTS/ behavioral disturbance or masking **may affect, not likely to adversely affect** ESA-listed cetaceans.

Cable Laying or Trenching Noise (C)

Cables would typically be laid and post-lay burial would be performed using a jetting tool, if seabed conditions allow. Cables may remain on the seabed within the Wind Farm Area for up to 2 weeks prior to burial. Alternatively, the array cables may be simultaneously laid and buried. Array cables can be installed using a tool towed behind the installation vessel to simultaneously open the seabed and lay the cable, or by laying the cable and following with a tool to embed the cable. Possible installation methods for these options include jetting, vertical injection, controlled-flow excavation (covered below under Dredging Noise), trenching, and plowing. The controlled-flow excavator is a tool that can be utilized in a variety of water depths and sediment types and functions by projecting a controlled flow of water to displace sediment in a localized area. The controlled-flow excavator is crane operated and hovers above the seabed to allow the controlled flow of water to target specific areas for sandwave clearance.

The estimated number of days required to install each cable section is outlined in Table 3-21 below. Dynamic positioning vessels rated DP2 with associated support craft would be used to install the array cables. Boulder clearance would take place prior to construction to clear the cable corridor in preparation for trenching and burial operations. A combination of displacement plow, subsea grab, or, in shallower waters, a backhoe dredger may be used to clear boulders and undertake route clearance activities. Noise generated by boulder clearance is likely similar to that outlined below for mechanical dredging (e.g., clamshell).

Table 3-21 Number of Installation days for Cable Sections Inshore and Offshore

Cable Section	Estimated Number of Days
Oyster Creek (Inshore Cable)	56
Oyster Creek (Offshore Export Cable)	179
BL England (Offshore Export Cable)	26
Substation Interconnector Cable	13
Wind Farm Area (Array Cable)	112

Source: Ocean Wind 2022.

Cable faults are expected to occur over the life of the Project. Faults would be detected by the wind farm protection system and would require location testing using remote diagnostic testing to identify the exact location along the cable length. Where a fault is detected, cable would be exposed and repaired or replaced. A new section of cable would be jointed aboard the cable-handling vessel. Upon completion of the repair, the cable would be lowered onto the seabed and assessed to determine whether it is on or as close as practicable to the original cable/trench location. Reburial by a jetting tool is expected. Post-burial survey would be completed to determine the success of burial.

During construction, vessels used for array cable installation would include main laying vessels and burial vessels in addition to support vessels. Main laying and burial vessels could include barges or dynamic positioning vessels, each with three associated anchor-handling tugs. Anchoring would occur every 1,640 feet (500 meters). Support vessels would be required including crew boats, service vessels for pre-rigging foundations with cable, and vessels for divers, pre-lay grapnel run, and post-lay inspection. In addition, helicopters may be used for crew changes and miscellaneous purposes (see Aircraft Noise above). The action of laying the cables on the seafloor itself is unlikely to generate high levels of underwater noise. Most of the noise energy would originate from the vessels themselves including propellor cavitation noise and noise generated by onboard thruster/stabilization systems and machinery (e.g., generators), including noise emitted by the tugs when moving the anchors.

There is limited information regarding underwater noise generated by cable-laying and burial activities in the literature. Johansson and Andersson (2012) recorded underwater noise levels generated during a comparable operation involving pipelaying and a fleet of nine vessels. Mean noise levels of 130.5 dB re 1 µPa were measured at 4,924 feet (1,500 meters) from the source. Reported noise levels generated during a jet trenching operation provided a source level estimate of 178 dB re 1 µPa measured at 3.3 feet (1 meter) from the source (Nedwell et al. 2003). This value was used as a proxy for modeling underwater noise fields for the Project jetting operation relative to existing acoustic thresholds for marine mammals in the Offshore Project area. To estimate the extent of behavioral disturbance from cable-laying operations, the Greater Atlantic Region Field Office acoustics spreadsheet for potential behavioral effects from vibratory pile driving was applied (NMFS 2018b. The acoustic spreadsheet used a standard transmission loss constant (15 log) calculation methodology and assumed a stationary source. Cable-laying noise sources associated with the Project were below the established PTS injury thresholds for all marine mammal hearing groups.

Expected acoustic frequencies emitted by these sound sources are more likely to overlap with the hearing range of baleen whales (LFC) than with toothed whales (MFC); however, masking of communications from both hearing groups is possible. These effects are expected to be temporary and intermittent and would occur only for the duration of the activity (Table 3-21).

Effects of Exposure to Noise Above the PTS Thresholds

PTS thresholds for any ESA-listed cetaceans will not be exceeded; therefore, there is **no effect**.

Effects of Exposure to Noise Above Behavioral Thresholds and Masking

Based on the source levels presented in the literature for cable laying activities to those that will be used for the Project (outlined above), behavioral disturbance thresholds could be exceeded, and masking could occur if the animals do not avoid the activities. However, all of the ESA-listed cetaceans are highly mobile and expected to move away from any noise effects that may result in behavioral disturbance.

Low-frequency Cetaceans (LFC)

The areas where cable laying will occur overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a norward migration during March to April and a southward migration during November and December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route. Fin whales are present in the area year-round. Fin whales, sei whales, and blue whales generally prefer the deeper waters of the continental slope and more often can be found in water greater than 295 feet (90 meters) deep (Hain et al. 1985; Waring et al. 2011; Hayes et al. 2020). Any behavioral effects would be expected to dissipate once the operation and vessel or individual has left the area and is, therefore, considered temporary. Behavioral disturbance from cable laying operations is not expected to impede the migration of NARWs to critical habitats located to the north and south of the Offshore Wind Area as animals would still be able to move outside of the behavioral disturbance zone. LFCs would be expected to resume pre-exposure activities once the activity stopped or the animal moved out of the disturbance zone. With the implementation of vessel separation distances outlined in Table 1-11, potential behavioral effects are further reduced.

Masking of LFC communications is considered possible; however, the effects of masking would be transient in nature, moving with the operation/vessel, and occurring in several separate areas as outlined in Table 3-21. The potential for communications to be masked from cable laying operations is, therefore, considered temporary and transient.

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Mid-Frequency Cetaceans (MFC)

The area over which the cable laying operations would occur does not extend beyond the continental slope where sperm whales are more commonly observed. If sperm whales are exposed to underwater noise above behavioral thresholds, effects would likely be localized the area around the operations, would be temporary and transient. Sperm whales would be expected to resume pre-exposure activities once the activity stopped or the animal moved out of the disturbance zone. With the implementation of vessel separation distances outlined in Table 1-11, potential behavioral effects are further reduced. In addition, the vessel speed restrictions outlined for the Project (Table 1-11) could reduce the source levels emitted by certain vessels.

Masking of high-frequency echolocation clicks used by sperm whales is not anticipated; however, some masking of other communications used by this species is possible. These effects would be transient in nature (moving with the operation) and would not overlap with areas frequently used by this species or in areas where they hunt for preferred prey (squid in deep waters).

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Cable Laying - Behavioral Impact Summary

Based on the mitigation measures presented and discussed (Table 1-11) the potential for exposure of these ESA-listed cetaceans to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. Based on the mitigation measures presented and discussed (Table 1-11) the potential for exposure of these ESA-listed cetaceans to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. As discussed above, NARWs, blue whales, fin whales, sei whales, and sperm whales may be exposed to noise above the behavioral thresholds depending on the type of the vessel and equipment used for cable laying operations. However, given the interim definition for ESA harassment, the animal’s ability to avoid harmful noises, and the established mitigation and monitoring measures being proposed (including vessel separation distances), the potential for ESA-listed cetaceans to be exposed to underwater noise exceeding behavioral disruption thresholds from cable laying operations would not rise to the level of take under the ESA is, therefore, considered **insignificant**. Therefore, the effects of noise exposure from Project cable laying and trenching operations leading to behavioral disturbance and masking **may affect, not likely to adversely affect** NARWs, blue whales, fin whales, sei whales, and sperm whales**.**

Dredging (C)

Dredging may be done in the Wind Farm Area and export cable corridors for sandwave clearance. Ocean Wind has indicated that sandwave clearance work could be undertaken by traditional dredging methods such as a mechanical clamshell dredge, as well as hydraulic trailing suction hopper or controlled-flow excavator. Dredging may be required at the HDD in-water exit pit at the Oyster Creek landfall site on the east side of Island Beach State Park and at the HDD in-water exit pit for the BL England site.

Dredging may also be required in the shallow areas of Barnegat Bay to allow vessel access for export cable installation. Locations include the prior channel (west side of Island Beach State Park/east side of Barnegat Bay), the west side of Barnegat Bay at the export cable landfall, and the Oyster Creek section of the federal channel in Barnegat Bay if the USACE is unable to conduct dredging in this area as part of the federal channel dredging that is currently under contract.

Mechanical clamshell dredging refers to grabs used to remove seafloor material. Noise produced by mechanical dredges is emitted from winches and derrick movement, bucket contact with the substrate, digging into substrate, bucket closing, and emptying of material into a barge or scow (Dickerson et al. 2001). Reported sound levels of clamshell dredges include 176 dB re 1 μPa L_{rms} (BC MoTI 2016) and 107 to 124 dB re 1 μPa at 505 feet (154 meters) from the source with peak frequencies of 162.8 Hz (Dickerson et al. 2001; McQueen et al. 2019). Maximum levels occurred when the dredge bucket made contact with the channel bottom in mixed coarse sand or gravel (Dickerson et al. 2001; McQueen et al. 2019). Hydraulic trailing suction hopper dredging and controlled-flow excavation dredging involve the use of a suction to either remove sediment from the seabed or relocate sediment from a particular location on the seafloor. The sound produced by hydraulic dredging results from the combination of sounds generated by the impact and abrasion of the sediment passing through the draghead, suction pipe, and pump. The frequency of the sounds produced by hydraulic suction dredging ranges from approximately 1 to 2 kilohertz, with reported source levels of 172 to 190 dB re 1 μPa at 3.3 feet (1 meter) (Robinson et al. 2011; Todd et al. 2015; McQueen et al. 2019). Robinson et al. (2011) noted that the level of broadband noise generated by suction dredging is dependent on the aggregate type being extracted, with coarse gravel generating higher noise levels than sand.

Effects of Exposure to Noise Above the PTS Thresholds

Based on the available source level information presented above, dredging by mechanical or hydraulic dredges is unlikely to exceed ESA-listed cetaceans PTS thresholds and therefore there is **no effect**. If dredging occurs in one area for relatively long periods, behavioral thresholds could be exceed along with masking of marine mammal communications (Todd et al. 2015; NMFS 2018a).

Effects of Exposure to Noise Above Behavioral Thresholds and Masking

Based on the available source level information presented above, dredging by mechanical or hydraulic dredges and if dredging occurs in one area for relatively long periods, behavioral thresholds could be exceed along with masking of marine mammal communications.

Behavioral responses of marine mammals to dredging activities have included avoidance in bowhead whales, gray whales, minke whales, and gray seals (Bryant et al. 1984; Richardson et al. 1990; Anderwald et al. 2013). Diederichs et al. (2010) found short-term avoidance of dredging activities by harbor porpoises near breeding and calving areas in the North Sea. Pirotta et al. (2013) found that, despite a documented tolerance of high vessel presence, as well as high availability of food, bottlenose dolphins spent less time in the area during periods of dredging. The study also showed that with increasing intensity in the activity, bottlenose dolphins avoided the area for longer durations (with one instance being as long as 5 weeks; Pirotta et al. 2013).

Low-frequency Cetaceans (LFC)

The offshore areas and cable lay routes where dredging will occur overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a norward migration during March to April and a southward migration during November to December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route. Fin whales are present in the area year-round. Fin whales, sei whales, and blue whales generally prefer the deeper waters of the continental slope and more often can be found in water greater than 295 feet (90 meters) deep (Hain et al. 1985; Waring et al. 2011; Hayes et al. 2020). The nearshore dredging activities are less likely to interact with blue and sei whales as these species are rarely observed in nearshore waters. Based on the literature, avoidance of dredging activities by LFCs is possible. However, any behavioral effects would be expected to dissipate once the activity ceases or individual has left the area and is therefore considered temporary. The exact duration or number of dredging events required to support the Project are unknown at this time. Behavioral disturbance from dredging is not expected to impede the migration of NARWs to critical habitats located to the north and south of the Offshore Wind Area as animals would be able to travel in areas undisturbed by Project activities. LFCs would be expected to resume pre-exposure activities once the activity stopped or the animal moved out of the disturbance zone.

Masking of LFC communications is considered possible; however, the effects of masking would be temporary for the duration of the activity. The potential for communications to be masked from cable laying operations is therefore considered temporary and transient.

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual’s ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Mid-Frequency Cetaceans (MFC)

The area over which the dredging operations would occur does not extend beyond the continental slope where sperm whales are more commonly observed. If sperm whales are exposed to underwater noise above behavioral thresholds, effects would likely be localized and temporary. Based on the literature, avoidance of dredging activities by MFCs is possible. However, sperm whales would be expected to resume pre-exposure activities once the activity stopped or the animal moved out of the disturbance zone.

Masking of high-frequency echolocation clicks used by sperm whales is not anticipated; however, some masking of other communications used by this species is possible. These effects would be temporary and would not overlap with areas frequently used by this species or in areas where they hunt for preferred prey (squid in deep waters).

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, o– calve.

Dredging - TTS and Behavioral Impact Summary

Based on the mitigation measures presented and discussed (Table 1-11) the potential for exposure of these ESA-listed cetaceans to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. As discussed above, NARWs, blue whales, fin whales, sei whales, and sperm whales may be exposed to noise above the TTS and behavioral thresholds during dredging operations. However, given the animals ability to avoid harmful noises and the established mitigation and monitoring measures proposed the potential for ESA-listed cetaceans to be exposed to underwater noise exceeding behavioral disturbance thresholds from dredging operations is considered **insignificant**. Therefore, the effects of noise exposure from Project dredging leading to behavioral disturbance **may affect, not likely to adversely affect** NARWs, blue whales, fin whales, sei whales and sperm whales**.**

WTG Operations (O&M)

Sound is generated by operating WTGs due to pressure differentials across the airfoils of moving turbine blades and from mechanical noise of bearings and the generator converting kinetic energy to electricity. Sound generated by the airfoils, like aircraft, is produced in the air and enters the water through the air-water interface. Mechanical noise associated with the operating WTG is transmitted into the water as vibration through the foundation and subsea cable. Both airfoil sound and mechanical vibration may result in long-term, continuous noise in the offshore environment. Measured underwater sound levels in the literature are limited to geared smaller wind turbines (less than 6.15 MW), as summarized by Tougaard et al. (2020). Underwater noise generated by these smaller-geared turbines is of a low frequency and at relatively low SPLs near the foundation, dissipating to ambient background levels within 0.6 miles (1 km) (Dow Piniak et al. 2012; Elliott et al. 2019; summarized in Tougaard et al. 2020). Tougaard et al. 2009 measured SPLs ranging between 109 and 127 dB re 1 μPa underwater 45.9 and 65.6 feet (14 and 20 meters) from the foundations at frequencies below 315 Hz up to 500 Hz. Wind turbine acoustic signals above ambient background noise were detected up to 2,066.9 feet (630 meters) from the source (Tougaard et al. 2009). Noise levels were shown to increase with higher wind speeds (Tougaard et al. 2009). Another study detected SPLs of 125 to 130 dB re 1 μPa up to 984.3 feet (300 meters) from operating turbines in frequencies between 875 and 1,500 Hz (Lindeboom et al. 2011). At 164.0 feet (50 meters) from a 3.6 MW monopile wind turbine, Pangerc et al. (2016) recorded maximum SPLs of 126 dB re 1 μPa with frequencies of 20 to 330 Hz, which also varied with wind speed. Kraus et al. (2016)

measured ambient noise conditions at three locations adjacent to the proposed South Fork Wind Farm over a 3-year period and identified baseline levels of 102 to 110 dB re 1 μPa. They also found that maximum operational noise levels typically occurred at higher wind speeds when baseline noise levels are higher due to wave action.

Available data on large direct-drive turbines are sparse. Direct-drive turbine design eliminates the gears of a conventional wind turbine, which increases the speed at which the generator spins. Direct-drive generators are larger generators that produce the same amount of power at slower rotational speeds. Only one study of direct-drive turbines presented in Elliott et al. (2019) was available in the literature. The study measured SPLs of 114 to 121 dB re 1 μPa at 164.0 feet (50 meters) for a 6 MW direct-drive turbine.

Based on measurements from WTGs 6.15 MW and smaller, Stöber and Thomsen (2021) estimated that operational noise from larger (10 MW WTG), current-generation WTGs would generate higher source levels (177 dB re 1 μPa-m) than earlier research. Additionally, Stöber and Thomsen (2021) estimates that a shift from gear-driven wind turbines to direct drive turbines would decrease sound levels by 10 dB resulting in a range to the 120 dB re 1 μPa behavioral threshold of 1.4 km (0.9 miles). Using the least-squares fits from Tougaard et al. (2020), SPLs from 11.5 MW turbines (in 20 m/s, gale-force wind) would be expected to fall below the same behavioral threshold within 245 m (about 800 ft). In lighter, 10 m/s winds (~20 kts) the predicted range to threshold would be only 140 m (about 460 ft). Both models were based on small turbines and a small sample size, adding uncertainty to the modeling results. Stöber and Thomsen (2021) use only the loudest measurements from each study cited. While this is reasonable practice for most sound source studies, sound from an operating WTG can be expected to correlate with wind speed and therefore with higher environmental noise. Scaling the loudest sound measurements linearly with turbine power will scale environmental noise up along with it and can be expected to overestimate sound levels from larger turbines and is especially concerning as no correlation coefficient was provided to assess the goodness of fit. Tougaard et al. (2020) take wind speed into account for each of the measurements in their fit and scale the level with WTG power using a logarithmic measurement. Because of these factors, range estimates based on Tougaard et al. (2020) are considered more relevant to this assessment.

Effects of Exposure to Noise Above the PTS Thresholds

Based on the currently available data for turbines smaller than 6 MW, underwater noise from WTG operations from offshore wind activities is unlikely to cause PTS in ESA-listed cetaceans. Therefore, exposure of noises above PTS thresholds from WTG operations and for all ESA-listed cetaceans is considered extremely unlikely to occur and **discountable**. Therefore, the effects of noise exposure from Project WTG operations leading to PTS **may affect, not likely to adversely affect** any ESA-listed cetaceans.

Effects of Exposure to Noise Above Behavioral Thresholds and Masking

Based on the available source level and modeling information presented above, underwater noise from WTG operations could exceed behavioral thresholds and cause masking of communications. However, more acoustic research is warranted to characterize SLs originating from large direct-drive turbines, the potential for those turbines to cause TTS effects, and to what distance behavioral and masking effects are likely. Because of this, BOEM has included a monitoring requirement that the Applicant conduct underwater noise monitoring during WTG operations, particularly during high wind events (Table 1-11).

Jansen and de Jong (2016) and Tougaard et al. (2009) concluded that marine mammals would be able to detect operational noise within a few thousand feet of 2 MW WTGs, but the effects would have no significant impacts on individual survival, population viability, distribution, or behavior. Lucke et al. (2007) exposed harbor porpoise to simulated noise from operational wind turbines and found masking effects at 128 dB re 1 μPa in the frequencies 0.7, 1,000, and 2,000 Hz. This suggests the potential for a reduction in effective communication space within the wind farm environment for marine mammals that communicate primarily in frequency bands below 2,000 Hz. Any such effects would likely be dependent on hearing sensitivity of the individual and the ability to adapt to low-intensity changes in the noise environment.

Low-frequency Cetaceans (LFC)

The Offshore Wind Area where WTGs operations will occur overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a norward migration during March and April and a southward migration during November to December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route. Fin whales are present in the area year-round. Fin whales, sei whales, and blue whales generally prefer the deeper waters of the continental slope and more often can be found in water greater than 295 feet (90 meters) deep (Hain et al. 1985; Waring et al. 2011; Hayes et al. 2020). Underwater noise emitted by WTGs are generally in the lower frequency spectrum below 2,000 Hz and overlap with the hearing sensitivity and communications used by LFCs. The full extent of how WTG operations may affect LFC behavior is unknown. NARWs do not appear particularly sensitive to other low frequency sounds emitted by vessels (Nowacek et al. 2004); however, the animals may still be adversely affected by noise stimuli even in the absence of overt behavioral reactions (Rolland et al. 2012).

Behavioral disturbance from WTG operations is not expected to impede the migration of NARWs to critical habitats located to the north and south of the Offshore Wind Area as animals would be able to travel beyond the disturbance area around the Offshore Wind Area (should they avoid it). The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual’s ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Masking of LFC communications is considered likely but as with behavioral disturbance, the extent of these effects is unknown. NARWs appear to be particularly sensitive to the effects of masking by underwater anthropogenic noise and have faced significant reductions in their communication space. Calling right whales in the Stellwagen Bank National Marine Sanctuary were exposed to noise levels greater than 120 dB re 1 µPa for 20% of the time during peak feeding months (Hatch et al. 2012). Communication disruptions caused by anthropogenic noise have implications on the physiological health of NARWs with potential population-level consequences. Over the last 50 years NARWs have been reported to shift their “upcalls” (communication used between mother and calf during separation events) to a higher-frequency band (Tennessen and Parks 2016). Rolland et al. (2012) identified an association between exposure to low frequency ship noise and an increase in stress-related metabolites in NARWs, which can potentially contribute to poorer reproductive success and immune suppression. Anthropogenic noise has also been highlighted as a probable cause for shifts in NARW distribution between 2004 and 2014, with decreased relative detections in the Gulf of Maine and increases in the Mid-Atlantic region after 2010 (Davis et al. 2017). Reduced communication space caused by anthropogenic noise could potentially contribute to the population fragmentation and dispersal of the NARW (Hatch et al. 2012; Brakes and Dall 2016).

Mid-Frequency Cetaceans (MFC)

The Offshore Wind Area where WTGs operations will occur does not extend beyond the continental slope where sperm whales are more commonly observed. If sperm whales are exposed to underwater noise above behavioral thresholds, effects would be confined to the Offshore Wind Area. Sperm whales would be expected to resume pre-exposure activities once the animal moved out of the disturbance zone.

Masking of high-frequency echolocation clicks used by sperm whales is not anticipated; however, some masking of other communications used by this species is possible. These effects are not expected to overlap with areas frequently used by this species or in areas where they hunt for preferred prey (i.e., squid in deep waters).

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

WTG Operations –Behavioral Impact Summary

Based on the mitigation measures presented and discussed (Table 1-11) the potential for exposure of these ESA-listed cetaceans to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. As discussed above, NARWs, blue whales, fin whales, sei whales, and sperm whales may be exposed to noise above the behavioral thresholds during WTG operations, particularly during high wind events when ambient underwater noise levels are also elevated. However, given the animals ability to avoid harmful noises, and the monitoring measures being proposed, the potential for ESA-listed cetaceans to be exposed to underwater noise exceeding behavioral disturbance thresholds from WTG operations is considered **insignificant**. Therefore, the effects of noise exposure from Project WTG operations leading to behavioral disturbance and masking **may affect, not likely to adversely affect** NARWs, blue whales, fin whales, sei whales, and sperm whales**.**

3.2.6.2.4.3 Summary of Underwater Noise Effects

Noise generated from Project activities include impulsive (e.g., impact pile driving, UXO detonations, some HRG surveys) and non-impulsive sources (e.g., vibratory pile diving, some HRG surveys, vessels, aircraft, cable laying or trenching, dredging, turbine operations). Of those activities, impact pile driving and UXO detonations could cause PTS/injury-level effects to marine mammals. UXO detonation have the potential to cause mortality and non-auditory injury (lung injury and gastrointestinal injury). All noise sources have the potential to cause behavioral-level effects, and some may also cause TTS and masking in certain species. The Applicant-proposed mitigation measures outlined in Table 1-11 and the BOEM proposed measures outlined in Table 1-12 are expected to be effective in limiting the potential for PTS and non-auditory injury and mortality effects in most marine mammal species as described above; however, the potential for some PTS, behavioral effects, and masking remain.

Table 3-22 summarizes the number of ESA-listed cetaceans potentially exposed to underwater noises above PTS and behavioral thresholds for all underwater noise sources.

Table 3-22 Number of ESA-Listed Marine Mammal Exposed to Sound Levels Above PTS and Behavioral Thresholds

Marine Mammal Species		PTS	Behavioral
Impact Pile Driving – WTG (10 dB attenuation)[a]			
LFC	NARW	0	12
	Blue whale	0	4
	Fin whale	6	13
	Sei whale	0	1
MFC	Sperm whale	0	3

Marine Mammal Species		PTS	Behavioral
Impact Pile Driving – OSS (10 dB attenuation, 48 pin piles)[a]			
LFC	NARW	0	3
	Blue whale	0	0
	Fin whale	0	2
	Sei whale	0	1
MFC	Sperm whale	0	3
Vibratory Pile Driving[b]			
LFC	NARW	0	11
	Blue whale	0	0
	Fin whale	0	3
	Sei whale	0	0
MFC	Sperm whale	0	0
HRG Surveys (Annual)			
LFC	NARW	0	3–9
	Blue whale	0	0
	Fin whale	0	2–5
	Sei whale	0	0–1
MFC	Sperm whale	0	3
UXO (10 detonations, 10 dB mitigation)[c]			
LFC	NARW	0	8
	Blue whale	0	0
	Fin whale	0	10
	Sei whale	0	1
MFC	Sperm whale	0	0

Notes: Inclusive of wind turbine generator and OSS installation impact pile driving scenarios, vibratory pile driving for cofferdam installation and removal, detonation of 10 unexploded ordnances, and high-resolution geophysical survey scenarios.
[a] Küsel et al. 2022.
[b] HDR, Inc. 2022a; JASCO 2022.
[c] Hannay and Zykov 2022.
dB = decibels; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; OSS = offshore substation; PTS = permanent threshold shift; UXO = unexploded ordnance; WTG = wind turbine generator

3.2.6.2.4.4 Effects on Prey Organisms

ESA-listed marine mammals in the Offshore Wind Area feed on a variety of invertebrates and fish as described in Table 3-23 below in Section 3.2.6.4.

The susceptibility of invertebrates to human-made sounds is unclear, and there is currently insufficient scientific basis to establish biological effects thresholds (Finneran et al. 2016). The available research on the topic is limited and relatively recent (Pine et al. 2012; Hawkins and Popper 2014; Carroll et al. 2016; Edmonds et al. 2016; Weilgart 2018). This research indicates that invertebrate sound sensitivity is restricted to particle motion, the effect of which dissipates rapidly such that any effects are localized (Edmonds et al. 2016). Detonation of UXO, however, could temporarily reduce the abundance of invertebrates in proximity to the activity. However, in response to such an effect, cetaceans would likely move to other foraging areas not affected by detonations to feed. In particular, it is unlikely that Project activities to measurably affect the invertebrate forage base of NARWs, blue and sei whales who feed primarily on invertebrate zooplankton.

Impact pile driving and UXO detonations may temporarily reduce the abundance of fish, eggs, and larvae in proximity to activity. Table 3-43 and Table 3-45 outline the potential distances in which physiological injury, recoverable injury, TTS and behavioral effects could occur to small fish, eggs and larvae. Project activities could temporarily reduce the abundance of fish for fin whales in proximity to the activity. Sperm whales feed primarily in the deep waters off the continental slope are extremely unlikely to be affected by reduction in prey items in the shallower waters of the Offshore Wind Area. With the implementation of ramp-ups, the potential for serious injury to pre fishes are minimized. Ramp-up would facilitate a gradual increase of energy to allow marine life to leave the area prior to the start of operations at full energy that could result in injury. Ramp-ups could be effective in deterring prey fish from certain Project activities (e.g., impact pile driving) prior to exposure resulting in a serious injury. The potential for serious injury to fish is also minimized by using a noise mitigation system during all impact pile driving operations and UXO detonations. Although fish within may be injured or killed within the exposure ranges outline in Table 3-45, resulting effects on marine mammals would be localized and short-term and would not alter the natural variability of prey species. For example, capelin are a primary forage species targeted by fin whales when they are available in abundance. Capelin and other marine forage fish like herring, anchovies, and sardines have short lifespans and variable recruitment rates. Species with this type of reproductive strategy commonly display rapid and dramatic changes in abundance from year to year in response to environmental variability (Sinclair 1988; Leggett and Frank 1990; Shikon et al. 2019) and shifts in distribution in response to changing climatic conditions (Carscadden et al. 2013). As a result, fin whales would likely move to other areas to forage on fish in response to any loss or avoidance of the Project area by these species. Sperm whales are wide-ranging, adaptive predators and feed primarily in the deep waters off the continental slope. Sperm whales only occasionally prey on types of organisms likely to occur in the Offshore Wind Area (Leatherwood et al. 1988; Pauly et al. 1998) and are extremely unlikely to be affected by reduction in prey items in the shallower waters of the Offshore Wind Area.

The effects to ESA-listed cetaceans due to reduction in prey items from underwater noise generated by the Project would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, impacts from underwater noise sources due to the Proposed Action **may affect, not likely to adversely affect** prey organisms of ESA-listed cetaceans.

3.2.6.3. Dredging Effects on Marine Mammals [C]

As mentioned in Section 3.2.6.2, dredging for the Project may occur in the Wind Farm Area and export cable corridors for sandwave clearance. Ocean Wind has indicated that sandwave clearance work could be undertaken by traditional dredging methods such as a mechanical clamshell dredge, as well as hydraulic trailing suction hopper or controlled-flow excavator. Dredging may be required at the HDD in-water exit pit at the Oyster Creek landfall site on the east side of Island Beach State Park and at the HDD in-water exit pit for the BL England site. Dredging may also be required in the shallow areas of Barnegat Bay to allow vessel access for export cable installation. Locations include the prior channel (west side of Island Beach State Park/east side of Barnegat Bay), the west side of Barnegat Bay at the export cable landfall, and the Oyster Creek section of the federal channel in Barnegat Bay if the USACE is unable to conduct dredging in this area as part of the federal channel dredging that is currently under contract. Dredging for the Project is anticipated to be less than 1 acre / 7,000 yd^3 (5,352 m^2). Approximately 18,000 yd^3 (13,762 m^3) of sediment would be removed from a 3.7-acre (0.01 km^2) area to maintain the Oyster Creek federal navigation channel to its authorized 200-foot width and 8-foot depth (61-meter width and 2.4-meter depth). However, since the environmental review for maintenance dredging to authorized depth and width is covered under the USACE federal permit as part of their Barnegat Inlet Federal Navigation Project, the effects of these actions are not considered in the following analysis. Inshore dredging is proposed to occur over less than one month.

The activity of mechanical dredging would consist of lowering an open clamshell bucket through the water column and once the bucket contacts the seafloor, closing the bucket jaws to trap and scoop the sediment that is then brought to the surface. Hydraulic dredges use water withdrawals that trail along the seafloor removing sediment. Noise impacts to marine mammals from dredging is discussed in Section 3.2.6.2. The size of ESA-listed whales compared to the clamshell bucket or cutterhead and the fact that a whale would have to be directly below the dredge on the seafloor indicates that physical interactions between the mechanical and hydraulic dredge and ESA-listed whales is extremely unlikely to occur. Additionally, dredging in Barnegat Bay would not employ PSOs, while dredging at landfalls and during sandwave clearance may employ PSOs. Pelagic prey items are extremely unlikely to be affected due to the operation of both dredges on the seafloor. Sperm whales are not through to forage within the Project area, therefore no effects to their prey are anticipated. Sand lance would be the most likely prey item to become entrained in a hydraulic dredge due to their bottom orientation and burrowing within sandy sediments that require clearing by the Project. Fin and sei whales prey on sand lance (Table 3-23). Reine and Clarke (1998) found that not all fish entrained in a hydraulic dredge are expected to die. Studies summarized in Reine and Clarke (1998) indicate a mortality rate of 37.6% for entrained fish. It is expected that dredging in sandwaves to allow for cable installation will result in the entrainment and mortality of some sand lance. However, given the size of the area where dredging will occur, the short duration of dredging, the expectation that most entrained sand lance will survive, and that sand lance are only one of several species available for fin and sei whales to forage on while in the action area, it is expected any impact of the loss of sand lance on these species to be so small that it cannot be meaningfully measured, evaluated, or detected.

Therefore, dredging due to the Proposed Action will have **no effect** on ESA-listed whales.

3.2.6.4. Habitat Disturbance Effects on Marine Mammals (C, O&M, D)

Habitat disturbance related to the Project would occur through all three phases of construction, O&M, and decommissioning. Potential effects to ESA-listed marine mammals and their prey from habitat disturbance are analyzed below and range from short- to long-term impacts. Individual stressors under habitat disturbance encompass displacement from physical disturbance of sediment; behavioral changes due to the presence of structures; changes in oceanographic and hydrological conditions due to presence of structures; conversion of soft-bottom habitat to hard-bottom habitat; concentration of prey species due to the reef effect; and secondary entanglement due to an increased presence of recreational fishing in response to the reef effect. The physical presence of the structures in the water column and their influence on marine mammal behavior, the changes in oceanographic conditions from structure presence, and the conversion of soft-bottom habitat to hard-bottom are all drivers of potential long-term effects to marine mammals and their prey.

3.2.6.4.1 Displacement from Physical Disturbance of Sediment (C, D)

Construction effects to marine mammals from temporary physical disturbance of the seabed could result from boulder and sandwave clearance, anchoring, cable trenching and installation. Effects from these activities would be limited to short-term displacement of prey species residing on top of or within the top few feet of surface sediments, particularly during installation of the inter-array and export cables. The restoration of marine soft-sediment habitats occurs through a range of physical (e.g., currents, wave action) and biological (e.g., bioturbation, tube building) processes (Dernie et al. 2003). Disturbed areas not replaced with hardened structures or scour protection (discussed later in this subsection) would resettle and the benthic community returned to normal typically within 1 year (Dernie et al. 2003; Department for Business, Enterprise and Regulatory Reform 2008). A total of 4,481 acres (18.1 km^2) is proposed for disturbance including boulder clearance along the inter-array, substation and export cables, and vessel anchoring, but exclusive of the maximum area for conversion to hardened structures (Table 1-3). Two of the baleen whale species addressed in this consultation, blue whales and NARWs, are pelagic filter feeders that do not forage in or rely on benthic habitats (Table 3-23). While fin and sei whales prey upon sand lance, they also consume other schooling species found in the Project area such as the Atlantic herring (Table 3-23). Further, while sand lance may be temporarily disturbed in the Project area, suitable habitat abounds in the New Jersey continental shelf outside the Project area (further explained below). Sperm whales are known to prey on bottom-oriented organisms (Table 3-23); however, their feeding grounds are located off the continental shelf beyond the Project Area (Roberts et al. 2016).

Habitat disturbance effects to marine mammals during decommissioning would likely yield similar short-term effects described for construction. The removal of up to 101 WTG and OSS foundations and associated inter-array and export cables would result in temporary disturbance of the benthic communities. The removal of these components would result in up to disturbed 4,041.6 acres (16.4 km^2). The benthic community, including prey species of the fin and sei whales, could be temporarily displaced, potentially for 1 year before returning to normal (Dernie et al. 2003; Department for Business, Enterprise, and Regulatory Reform 2008).

Given the limited area affected and the lack of overlap with important benthic feeding habitats for ESA-listed cetaceans, and the temporary nature of the disturbance, effects from seabed disturbance during construction and decommissioning would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**.

3.2.6.4.2 Behavioral Changes due to the Presence of Structures (O&M)

During the O&M phase of the Project, the proposed installation of up to 101 WTG and OSS foundations would remain until decommissioning and constitute long-term obstacles in the water column that could alter the normal behavior and distribution of aquatic organisms in the Wind Farm Area. Up to 98 turbines and three substations are proposed for installation. The below surface parameters of the tubular WTG foundations are 37 feet (11 meters) in diameter at the seafloor and taper to 27 feet (8 meters) in diameter at the sea surface (Figure 1-3). Accounting for the variable depth range within the wind farm area of 49 to 118 feet (15 to 36 meters), two-dimensionally the WTG foundations will appear as vertical seafloor to surface structures of 604 to 1,455 square yards (168 to 406 square meters), assuming maximum bottom diameter) spaced 0.8 to 1 nm (1.5 to 1.9 km) apart in a grid-like pattern.

There is limited data on the potential behavioral disturbance effect to marine mammals from the presence of structures particularly for offshore wind farm of comparable size (up to 101 large physical structures in a grid-like pattern over approximately 68,450 acres [277 km^2]). Five turbines constituting Block Island Wind and two pilot turbines for Coastal Virginia Offshore Wind have not presented data with observable changes in marine mammal movement (NMFS 2021a).

Studies in the UK have focused on the harbor porpoises (*Phocoena phocoena*), a species particularly sensitive to underwater noises (Southall et al. 2007). Harbor porpoise behavior and abundance were not affected by O&M of the Horns Rev offshore wind project in the North Sea as evidenced by acoustic activity (Tougaard et al. 2006). The Horns Rev project is closer in size to the Proposed Action at 80 foundations; however, geared turbines were used instead of direct-drive and spacing is closer together (0.27 nm [0.5 km] compared to a minimum of 0.8 nm [1.5 km]). Nysted, a 72-turbine offshore wind farm in the Baltic Sea, recorded significant decreases in acoustic activity of harbor porpoise during construction and immediately post-construction, but activity slowly increased over 10 years during operations, though not fully to pre-construction levels (Tielmann et al. 2007; Tielmann and Carstensen 2012). The Nysted turbines are also spaced more closely than the Project, from 0.3 to 0.5 nm (0.5 to 0.9 km).

It is difficult to separate out any behavioral reactions of marine mammal to the presence of WTGs during operations to the underwater noise the structures may emit. To assess the potential effect of the structures on marine mammal behavior we need to consider the operational noises from the structures. This is considered in Section 3.2.6.2 and not discussed further.

3.2.6.4.3 Changes in Oceanographic and Hydrological Conditions due to Presence of Structures (O&M)

The presence of vertical structures in the water column could also cause a variety of long-term hydrodynamic effects during O&M, which could impact prey species of ESA-listed whales. Atmospheric wakes, characterized by reduced downstream mean wind speed and turbulence along with wind speed deficit, are documented with the presence of vertical structures. Magnitude of atmospheric wakes can change relative to instantaneous velocity anomalies. In general, lower impacts of atmospheric wakes are observed in areas of low wind speeds. Several hydrodynamic processes have been identified to exhibit changes from vertical structures:

1. Advection and Ekman transport are directly correlated with shear wind stress at the sea surface boundary. Vertical profiles from Christiansen et al. 2022 exhibit reduced mixing rates over the entire water column. As for the horizontal velocity, the deficits in mixing are more pronounced in deep waters than in well-mixed, shallow waters, which is likely favored by the influence of the bottom mixed layer in shallow depths. In both cases, the strongest deficits occur near the pycnocline depth.
2. Additional mixing downstream has been documented from Kármán vortices and turbulent wakes due to the pile structures of wind turbines (Carpenter et al. 2016; Grashorn and Stanev 2016; Schultze et al. 2020).
3. Up-dwelling and down-dwelling dipoles under contact of constant wind directions affecting average surface elevation of waters have been documented as the result of offshore wind farms (Broström 2008; Paskyabi and Fer 2012; Ludewig 2015). Mean surface variability is between 1 and 10%.
4. With sufficient salinity stratification, vertical flow of colder/saltier water to the surface occurs in lower sea surface level dipoles and warmer/less saline water travels to deeper waters in elevated sea surface heights (Ludewig 2015; Christiansen et al. 2022). This observation also suggested impacts on seasonal stratification, as documented in Christiansen et al. 2022. However, the magnitude of salinity and temperature changes with respect to vertical structures is small compared to the long-term and interannual variability of temperature and salinity.

The potential hydrodynamic effects identified above from the presence of vertical structures in the water column therefore affect nutrient cycling and could influence the distribution and abundance of fish and planktonic prey resources throughout O&M (van Berkel et al. 2020). Modeling for the Project found that the physical presence of WTG foundations would result in a turbulent wake downstream of each turbine, with a calculated negligible areal impediment of less than 1% of the wind farm area (Ocean Wind 2022, COP Vol II Section 2.1.2.2.2). Several studies have modeled and theorized potential impacts, but overall science is limited as to what environmental effects will accompany the hydrologic changes brought about by a large turbine installation at the proposed spacing in an environment such as the U.S. OCS. Increased localized mixing could impact seasonal stratification (Carpenter et al. 2016), which could affect prey presence or distribution.

Although operational noise is recognized as a potential effect mechanism, insufficient information is available to characterize how the presence of WTG foundations in the water column would affect the behavior of whales, fish, and other organisms (Thompson et al. 2015; Long 2017). Long (2017) compiled several years of observer data for marine mammal and bird interactions with tidal and wave energy testing facilities in Scotland. The study was unable to identify any changes in behavior or distribution associated with the presence of ocean energy structures once construction was complete, concluding that the available data were insufficient to determine the presence or absence of significant effects. As aggregations of plankton, which provide a dense food source for NARWs and fin whales to efficiently feed upon, are concentrated by physical and oceanographic features, increased mixing may disperse aggregations and may decrease efficient foraging opportunities. Potential effects of hydrodynamic changes in prey aggregations are specific to listed species that feed on plankton, whose movement is largely controlled by water flow, as opposed to other listed species that eat fish, cephalopods, crustaceans, and marine vegetation, which are either more stationary on the seafloor or are more able to move independent of typical ocean currents, such as fin whales, NARWs, and sei whales (Table 3-23). The degree of effect on planktonic prey species was not hypothesized to be significant due to the effects to hydrodynamics, which would be limited to an area within a few hundred meters of individual turbines (Miles et al. 2017; Schultze et al. 2020). As a result, any effects from the changes in oceanographic and hydrological conditions due to presence of structures would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**.

Table 3-23 Primary Prey Items of ESA-Listed Marine Mammals within the Project Area

Species	Primary Prey Items	Sources	Prey Occurs in Project area (Y/N)
Fin Whale	krill (*Thysanoessa inermis*, *Meganyctiphanes norvegica*); capelin (*Mallotus villosus*); herring (*Clupea harengus*); sand lance (*Ammodytes* spp.)	Borobia et al. 1995	Y (except capelin and krill)
North Atlantic Right Whale	calanoid copepods (*Calanus finmarchicus*; *Pseudoclanus* spp.; *Centropages* spp.)	Pace and Merrick 2008 NMFS 2011 Grieve et al. 2017	Y
Sei Whale	calanoid copepods (*Calanus finmarchicus*); capelin (*Mallotus villosus*); Atlantic herring (*Clupea harengus*); northern sand lance (*Ammodytes dubius*)	Prieto et al. 2014 Grieve et al. 2017	Y (except capelin)
Sperm Whale	squid; demersal octopus, fish, shrimp, crabs, and shark	Kawakami 1980 Leatherwood et al. 1988 Pauly et al. 1998	Y (However, it is unlikely for a sperm whale to forage in depths found in the Project area [49 to 118 feet; 15 to 36 meters]).

3.2.6.4.4 Conversion of Soft-bottom Habitat to Hard-bottom Habitat (O&M)

Long-term O&M effects to marine mammal prey species from the loss of soft-bottom habitat and conversion of soft-bottom habitat to hard-bottom habitat may occur if this habitat shift resulted in changes in use of the area by listed species or in the availability, abundance, or distribution of forage species. The only forage fish species that is expected to be affected by these habitat alterations would be sand lance. The maximum case for conversion from soft to hardened substrate through scour protection for the Project is 439.4 acres (1.8 km^2; Table 1-2). As sand lance are strongly associated with sandy substrate, and the Project would result in a loss of such soft bottom, there would be a reduction in availability of habitat for sand lance that theoretically could result in a localized reduction in the abundance of sand lance in the Action Area. Sand lance select medium to coarse-grained sand for burrowing and the New Jersey continental shelf is mostly composed of medium-sized sand (MMS 1999; Holland et al. 2005). The continental shelf off New Jersey is about 93 miles (150 km) wide and roughly 124 miles (200 km) long, yielding an area of approximately 7,413,161 acres (30,000 km^2) (Milliman 1972). Even in a worst-case scenario assuming that the reduction in the abundance of sand lance in the Action Area is directly proportional to the amount of soft substrate lost, it would be expected to be an unmeasurable reduction in the sand lance available as forage for fin and sei whales in the Action Area. Given this small, localized reduction in sand lance and that sand lance are only one of many species the fin and sei whales may feed on in the Action Area, any effects from the conversion of soft-bottom habitat to hard-bottom habitat are expected to be so small that they could not be measured, detected, or evaluated and are **insignificant**.

3.2.6.4.5 Concentration of Prey Species due to the Reef Effect (O&M, D)

The reef effect is another habitat-related result of in-water structures due to long-term O&M effects on marine mammal prey species. Russell et al. (2014) found clear evidence that seals were attracted to a European wind farm, apparently attracted by the abundant concentrations of prey created by the artificial reef effect. The artificial reef effect created by these structures forms biological hotspots that could support species range shifts and expansions and changes in biological community structure resulting from a changing climate (Raoux et al. 2017; Methratta and Dardick 2019; Degraer et al. 2020). There is no example of a large-scale offshore renewable energy project within the geographic analysis area for marine mammals. However, in a smaller-scale project, it is not expected that any reef effect would result in an increase in species preyed on by NARWs, fin whales, or sei whales, and sperm whales and blue whales are not expected to forage in the shallow waters of the offshore wind lease areas (NMFS 2021a). Although reef effects may aggregate fish species and potentially attract increased predators, they are not anticipated to have any measurable effect on ESA-listed marine mammals. Based on the available information, it is expected that there may be an increase in abundance of schooling fish that sei or fin whales may prey on but that this increase would be so small that the effects to sei or fin whales cannot be meaningfully measured, evaluated, or detected. Because it is not expected that sperm or blue whales would forage in the Project area (due to the shallow depths), the physical presence of structures during O&M is not expected that any impacts to the forage base for sperm or blue whales would occur. The potential beneficial, yet not measurable, increase in aggregation of prey species of the fin and sei whale due to the reef effect would be removed following decommissioning.

As a result, any effects from the concentration of prey species due to the reef effect would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**.

3.2.6.4.6 Summary of Habitat Disturbance Effects

As described in the section above, any effects from habitat disturbance on marine mammals is so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of habitat disturbance from Project structures **may affect, not likely to adversely affect** ESA-listed cetaceans**.**

3.2.6.5. Secondary Entanglement due to an Increased Presence of Recreational Fishing in Response to Reef Effect (O&M)

Another long-term impact of the presence of structures during O&M is the potential to concentrate recreational fishing around foundations, potentially increasing the risk of marine mammal entanglement in both lines and nets and increasing the risk of injury and mortality due to infection, starvation, or drowning (Moore and van der Hoop 2012). These structures could also result in fishing vessel displacement or gear shift. The potential impact on marine mammals from these changes is uncertain. However, if a shift from mobile gear to fixed gear occurs due to inability of fishermen to maneuver mobile gear, there would be a potential increase in the number of vertical lines, resulting in an increased risk of marine mammal interactions with fishing gear. Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARWs and may be a limiting factor in the species' recovery (Knowlton et al. 2012). Johnson et al. (2005) reports that 72% of NARWs show evidence of past entanglements. Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pace 2021). Entanglement may also be responsible for high mortality rates in other large whale species (Read et al. 2006). Abandoned or lost fishing gear may become tangled with foundations, reducing the chance that abandoned gear would cause additional harm to marine mammals and other wildlife, although debris tangled with WTG foundations may still pose a hazard to marine mammals. These potential long-term, intermittent impacts would be low in intensity and persist until decommissioning is complete and structures are removed. As a result, any effects from the secondary entanglement due to an increased presence of recreational fishing in response to reef effect would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of secondary entanglement due to an increased presence of recreational fishing in response to the reef effect from Project structures **may affect, not likely to adversely affect** ESA-listed cetaceans**.**

3.2.6.6. Turbidity Effects on Marine Mammals (C & D)

Construction is likely to result in elevated levels of turbidity in the immediate proximity of bed-disturbing activities like pile driving, placement of scour protection, vessel anchoring, and burial of the array and offshore export cables as well as removal processes during decommissioning. A total of 4,481 acres (18 km^2) is proposed for disturbance with potential to increase turbidity, including boulder clearance along the inter-array, substation and export cables, vessel anchoring, WTG and substation foundations. There would be temporary increases in sediment suspension and deposition during activities that entail the disturbance of the seabed. APMs to minimize and reduce the potential for adverse effects from water quality changes on marine mammals resulting from the Project have been proposed (COP Vol II, Table 1.1-2, Ocean Wind 2022).

The Wind Farm Area is characterized by medium to coarse-grained sediments, and the resulting sediment plume that results from temporary and intermittent bottom-disturbing activities is expected to settle out of the water column within a few hours. The installation of array cables and offshore export cables would include site preparation activities (e.g., sandwave clearance, boulder removal) and cable installation via jet plow, mechanical plow, or mechanical trenching, which can cause temporary increases in turbidity and sediment resuspension. Other projects using similar installation methods (e.g., jet plowing, pile driving) have been characterized as having minor impacts on water quality due to the short-term and localized nature of the disturbance (Latham et al. 2017). Sediment dispersion modeling was conducted for three other offshore wind projects with conditions representative of the Wind Farm Area (see COP Volume II, Section 2.1.2.2.1 for detailed descriptions; Ocean Wind 2022). The modeling indicated that sediments resuspended during trenching would settle quickly to the seabed within the trench, potential plumes would be limited to right above the seabed and not within the water column, and concentrations greater than 10 mg/L would be short in duration (up to 6 hours) and limited to within approximately 164 to 656 feet (50 to 200 meters) of the center of the trench. However, Vinhaterio et al. (2018) modeled offshore turbidity levels during the proposed installation of an inter-array cable at 100 mg/L up to 131 feet (40 meters) from the source, with turbidity returning to ambient levels in 0.3 hours post-installation. Jet plow activities in nearshore areas such as Barnegat Bay for the Project would be similar to the modeling results for other shallow-water areas where the mostly fine sediment (silts and clays) were projected to persist for 2 days at very low levels of 10 mg/L above background (Normandeau 2015). These impacts on water quality for finer sediments are anticipated to be localized adjacent to the trench and temporary in nature.

As described in Johnson (2018), NMFS has determined that elevated TSS could result in effects on listed whale species under specific circumstances (e.g., high TSS levels over long periods during dredging operations). In general, marine mammals are not subject to impact mechanisms that injure fish (e.g., gill clogging, smothering of eggs and larvae), so injury-level effects are unlikely. Behavioral impacts, including avoidance or changes in behavior, increased stress, and temporary loss of foraging opportunity, could occur but only at high TSS levels (Johnson 2018). Todd et al. (2015) postulated that dredging and related turbidity impacts could affect the prey base for marine mammals, but the significance of those effects would be highly dependent on site-specific factors. Given that presence of ESA-listed marine mammals is focused on offshore areas that may experience up to 100 mg/L at 131 feet (40 meters) from the source for less than 20 minutes, the small-scale and short-term changes from Project construction and decommissioning activities that increase turbidity (e.g., inter-array and export cable installation and vessel anchoring) are not likely to have measurable effects on ESA-listed whales.

Data are not available regarding whales' avoidance of localized turbidity plumes; however, Todd et al. (2015) suggest that since marine mammals often live in turbid waters, significant impacts from turbidity are not likely. If elevated turbidity caused any behavioral responses such as avoiding the turbidity zone or changes in foraging behavior, such behaviors would be temporary, and any negative impacts would be short term and temporary. Cronin et al. (2017) suggest that NARWs may use vision to find copepod aggregations, particularly if they locate prey concentrations by looking upward. However, Fasick et al. (2017) indicate that NARWs certainly must rely on other sensory systems (e.g., vibrissae on the snout) to detect dense patches of prey in very dim light (at depths greater than 525 feet [160 meters] or at night). If turbidity from cable installation caused foraging whales to leave the area, there would be an energetic cost of swimming out of the turbid area. However, whales could resume foraging behavior once they were outside of the turbidity zone. Recent studies indicate that whales are likely able to forage in low visibility conditions, and thus could continue to feed in the elevated turbidity (Todd et al. 2015).

Increased turbidity effects during construction and decommissioning could impact the prey species of marine mammals, both in offshore and inshore environments, such as the SAV near the inshore export cable route in Barnegat Bay. Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute reaction is expected (Wilber and Clark 2001). However, as mentioned previously, sedimentation effects would be temporary and localized, with regions returning to previous levels soon after the activity.

North Atlantic right whales feed almost exclusively on copepods (Table 3-23). Of the different kinds of copepods, NARWs feed especially on late-stage *Calanus finmarchicus*, a large calanoid copepod (Baumgartner et al. 2007), as well as *Pseudocalanus* spp. And *Centropages* spp. (Pace and Merrick 2008). Because a right whale's mass is 10 or 11 orders of magnitude larger than that of its prey (late-stage *C. finmarchicus* is approximately the size of a small grain of rice), right whales are very specialized and restricted in their habitat requirements—they must locate and exploit feeding areas where copepods are concentrated into high-density patches (Pace and Merrick 2008).

Fin whales in the North Atlantic eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lance (Table 3-23) (NMFS 2010a). Fin whales feed by lunging into schools of prey with their mouth open, using their 50 to 100 accordion-like throat pleats to gulp large amounts of food and water. A fin whale eats up to 2 tons of food every day during the summer months. An average sei whale eats about 2,000 pounds (907 kg) of food per day. They can dive 5 to 20 minutes to feed on plankton (including copepods and krill), small schooling fish, and cephalopods (including squid) by both gulping and skimming. Sperm whales hunt for food during deep dives, with feeding occurring at depths of 1,640 to 3281 feet (500 to 1,000 meters) (NMFS 2010b). Deepwater squid make up the majority of their diet (NMFS 2010b). Given the shallow depths of the Project area where sedimentation would occur, it is extremely unlikely that any sperm whales would be foraging in the area affected by sedimentation and extremely unlikely that any potential sperm whale prey would be affected by sedimentation.

Copepods exhibit diel vertical migration; that is, they migrate downward out of the euphotic zone at dawn, presumably to avoid being eaten by visual predators, and they migrate upward into surface waters at dusk to graze on phytoplankton at night (Baumgartner and Fratantoni 2008; Baumgartner et al. 2011). Baugmartner et al. (2011) conclude that there is considerable variability in this behavior and that it may be related to stratification and presence of phytoplankton prey with some copepods in the Gulf of Maine remaining at the surface and some remaining at depth. Because copepods even at depth are not in contact with the substrate, no burial or loss of copepods is anticipated during installation of the cable. No scientific literature could be identified evaluated the effects to marine copepods resulting from exposure to TSS. Based on what is known about effects of TSS on other aquatic life, it is possible that high concentrations of TSS could negatively affect copepods. However, given that 1) the expected TSS levels are below those that are expected to result in effects to even the most sensitive species evaluated; 2) the sediment plume would be transient and temporary (i.e., persisting in any one area for no more than 3 hours); 3) elevated TSS is limited to the bottom 9.8 feet (3 meters) of the water column; and 4) elevated TSS plumes would occupy only a small portion of the WDA at any given time, any effects to copepod availability, distribution, or abundance on foraging whales would be so small that they could not be meaningfully evaluated, measured, or detected.

As explained above, elevated TSS would be experienced along the cable corridor during cable installation. Anticipated TSS levels are below the levels expected to result in the mortality of fish that are preyed upon by fin or sei whales or Atlantic sturgeon. In general, fish can tolerate at least short-term exposure to high levels of TSS. Wilber and Clarke (2001) reviewed available information on the effects of exposure of estuarine fish and shellfish to suspended sediment. In an assessment of available information on sublethal effects to non-salmonids, they report that the lowest observed concentration-duration combination eliciting a sublethal response in white perch (*Morone americana*) was 650 mg/L for 5 days, which increased blood hematocrit (Sherk et al. 1974, in Wilber and Clarke 2001).

Regarding lethal effects, Atlantic silversides (*Menidia menidia*) and white perch were among the estuarine fish with the most sensitive lethal responses to suspended sediment exposures, exhibiting 10% mortality at sediment concentrations less than 1,000 mg/L for durations of 1 and 2 days, respectively (Wilber and Clarke 2001). Forage fish in the Action Area would be exposed to maximum TSS concentration-duration combinations far less than those demonstrated to result in sublethal or lethal effects of the most sensitive non-salmonids for which information is available. Based on this, no mortality of any forage fish is expected; therefore, no reduction in fish as prey for fin or sei whales is anticipated.

During construction and decommissioning of the proposed Project, vessel traffic would increase in and around the Wind Farm Area, leading to potential discharges of uncontaminated water and treated liquid wastes. COP Table 8.2-1 lists types of waste potentially produced by the proposed Project (COP Volume I, Section 8.2; Ocean Wind 2022). Ocean Wind would only be allowed to discharge uncontaminated water (e.g., uncontaminated ballast water and uncontaminated water used for vessel air conditioning) or treated liquid wastes overboard (e.g., treated deck drainage and sumps). Other waste such as sewage, and solid waste or chemicals, solvents, oils, and greases from equipment, vessels, or facilities would be stored and properly disposed of on land or incinerated offshore. Mitigation measures employed by Ocean Wind (Table 1-11) during dredging to decrease turbidity include:

1. Utilizing closed environmental clamshell bucket equipped with sensors;
2. Controlled lift speed;
3. Holding times for water decanting;
4. No barge overflow;
5. Limited rinsing and hosing of barge to prevent runoff;
6. Discharge of decant water into same water body from which it came;
7. Water quality (TSS and turbidity) monitoring; and
8. Silt curtain (along shallow areas versus construction area) as feasible.

Mitigation measures employed by Ocean Wind (Table 1-11) during jetting installation to decrease turbidity include:

1. Modifying installation speed and jetting pressure to minimize sediment resuspension;
2. Water quality (TSS and turbidity) monitoring; and
3. Silt curtain (along shallow areas versus construction area) as feasible.

Additionally, there would be increased vessel anchoring during the construction of offshore components of the proposed Project. The maximum proposed area affected by vessel anchoring from the Project is 19 acres (0.08 km^2). Anchoring would cause increased turbidity levels, which would be localized, short-term, and minor during construction. Any effects from increased turbidity levels from construction activities on marine mammals or their prey is so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of increased turbidity levels from Project construction activities **may affect, not likely to adversely affect** ESA-listed cetaceans.

3.2.6.7. Vessel Traffic Effects on Marine Mammals (pre-C, C, O&M, D)

Project-related vessels, including those used in pre-construction, construction, O&M, and decommissioning, pose a potential collision risk to marine mammals. Based on information provided by Ocean Wind, construction activities (including offshore installation of WTGs, OSSs, array cables, interconnection cable, and export cable) would require several types of vessels (Table 1-5; Ocean Wind 2022), transiting between the various ports and the Project area an estimated total of 2,859 vessel trips over the 20-month construction period, or approximately 143 trips per month (COP Volume I, Section 4.1; Ocean Wind 2022). The construction vessels that would be used for Project construction are described Table 1-4. Vessel parameters of those used for O&M are listed in Table 1-7 and trips details of O&M vessel types as well as their approximate drafts are detailed in Table 1-8. An estimated maximum 3,392 vessel trips would be required yearly for O&M activities for the Project.

Vessels used for decommissioning would be similar to those used in construction. Construction vessels would travel between the Wind Farm Area and the following ports that are expected to be used during construction: Atlantic City, New Jersey, as a construction management base; Paulsboro, New Jersey, or from Europe directly for foundation fabrication and load out; Norfolk, Virginia, or Hope Creek, New Jersey, for WTG pre-assembly and load out; and Port Elizabeth, New Jersey, or Charleston, South Carolina, or directly from Europe for cable staging. All O&M transits would occur from Atlantic City, New Jersey, to the Project area.

Vessel collisions are a major source of mortality and injury for many marine mammal species (Laist et al. 2001; Vanderlaan and Taggart 2007; Martin et al. 2016; Hayes et al. 2021), indicating the importance of protective measures to minimize risks to vulnerable species. If a vessel strike does occur, the impact on marine mammals would range from minor injury to mortality of an individual, depending on the species and severity of the strike. Almost all sizes and classes of vessels have been involved in collisions with marine mammals around the world, including large container ships, ferries, cruise ships, military vessels, recreational vessels, commercial fishing boats, whale-watch vessels, research vessels and even jet skis (Dolman et al. 2006). Research into vessel strikes and marine mammals has focused largely on baleen whales given their higher susceptibility to a strike because of their larger size, slower maneuverability, larger proportion of time spent at the surface foraging, and inability to actively detect vessels using sound (i.e., echolocation). Focused research on vessels strikes on toothed whales is lacking.

A vessel strike on a marine mammal may result in either injury or mortality. Injuries are typically the result of one of two mechanisms: either blunt force trauma from impact with the vessel, or lacerations from contact with the propellers (Wiley et al. 2016). Depending on the severity of the strike and the injuries inflicted, the mammal may or may not recover (Wiley et al. 2016). The orientation of the marine mammal with respect to vessel trajectory will affect the severity of the injury (Vanderlaan and Taggart 2007; Martin et al. 2016). Other factors that affect the probability of a marine mammal-vessel strike and its severity include:

1. Number, species, age, size, speed, health, and behavior of animal(s) (Vanderlaan and Taggart 2007; Martin et al. 2016);
2. Number, speed, and size of vessel(s) (Vanderlaan and Taggart 2007; Martin et al. 2016);
3. Habitat type characteristics (Gerstein et al. 2005; Vanderlaan and Taggart 2007);

4. Operator's ability to avoid collisions (Martin et al. 2016); and
5. Vessel path (Vanderlaan and Taggart 2007; Martin et al. 2016).

The following factors can also impair the ability of a marine mammal to detect and locate the sound of an approaching vessel:

1. Attenuation of low frequency vessel sound near the surface (i.e., Lloyd mirror effect);
2. Decreased propeller sound at the bow as a vessel's length increases (i.e., spreading loss);
3. Impedance of forward-projecting propeller sound due to hull shape and relative placement of keel (above-keel propeller location resulting in acoustic shadowing); and
4. Ambient (background) sound interfering with the sound of an approaching vessel (i.e., acoustic masking).

Vessel speed and size are also important factors for determining the probability and severity of vessel strikes. The size and bulk of the large vessels inhibits the ability for crew to detect and react to marine mammals along the vessel's transit route. In 93% of marine mammal collisions with large vessels reported in Laist et al. (2001), whales were either not seen beforehand, or were seen too late to be avoided. Laist et al. (2001) reported that the most lethal or severe injuries are caused by ships 262 feet (80 meters) or longer travelling at speeds greater than 13 knots (6.7 m/s). A more recent analysis conducted by Conn and Silber (2013) built upon collision data collected by Vanderlaan and Taggart (2007) and Pace and Silber (2005) and included new observations of serious injury to marine mammals as a result of vessel strikes at lower speeds (e.g., 2 and 5.5 knots [1.0 and 2.8 m/s]). The relationship between lethality and strike speed was still evident; however, the speeds at which 50% probability of lethality occurred was approximately 9 knots (4.6 m/s). Smaller vessels have also been involved in marine mammal collisions. Minke, humpback, and fin whales have been killed or fatally wounded by whale-watching vessels around the world (Jensen and Silber 2003. Strikes have occurred when whale watching boats were actively watching whales as well as when they were transiting through an area, with the majority of reported incidences occurring during active whale watching activities (Laist et al. 2001 and Jensen and Silber 2004). However, Ocean Wind has committed to a range of APMs and established a Vessel Strike Avoidance Policy to minimize the potential for vessel collisions and impacts to marine mammals (Table 1-11). These include strict adherence to NMFS Regional Viewing Guidelines for vessel strike avoidance, as well as the following measures:

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 that 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, in 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. 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).
3. If an animal or group of animals is sighted in the vessel's path or in 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) has moved beyond the associated separation distance (except for voluntary bow riding dolphin species).

4. All vessels will comply with NMFS regulations and speed restrictions and state regulations as applicable for NARW (Table 1-11).
5. All vessels will comply with the approved adaptive speed plan which will include additional measures including travel within established NARW slow zones.
6. Ocean Wind will submit a final NARW Vessel Strike Avoidance Plan at least 90 days prior to commencement of vessel use that details the Adaptive Plan and specific monitoring equipment to be used. The plan will, at minimum, describe how PAM, in combination with visual observations, will be conducted to ensure the transit corridor is clear of NARWs. The plan will also provide details on the vessel-based observer protocols on transiting vessels.
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 below).
8. If an animal or group of animals is sighted in the vessel's path or in 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) has moved beyond the associated separation distance (except for voluntary bow riding dolphin species).
9. Vessels will maintain, to the extent practicable, separation distances of:
   - >546 yards (500 meters) from any sighted NARW or unidentified large marine mammals; and
   - >109 yards (100 meters) from all other whales.

During construction, 86% of the vessels and 79% of the vessel trips would travel between the WDA and Atlantic City, New Jersey (Table 3-24). Five vessels and 149 trips would travel between the WDA and Paulsboro, New Jersey, or Europe for foundation scope. Two vessels and 99 trips would travel between the WDA and Norfolk, Virginia, or Hope Creek, New Jersey, for WTG scope. Fifteen vessels and 346 vessel trips would travel between the WDA and Port Elizabeth, New Jersey, Charleston, South Carolina, or Europe for cable staging. Based on the density of marine mammals in the Project area and a maximum of 2,859 vessel trips over 2 years during construction and installation, there is a low risk of vessel collision with a marine mammal due to Project vessel traffic (Appendix A) (Roberts et al. 2016a, 2016b, 2017, 2018, 2021a, 2021b).

Table 3-24 Potential Primary Ports and Estimated Total Number of Vessels and Trips Needed for Construction Activities

Primary Port	Purpose	Total Number of Vessels	Total Number of Trips
Atlantic City, New Jersey	Construction Management – All CTVs	134	2,259
Paulsboro, New Jersey	Foundation Scope	5	149
OR Europe		5	149
Norfolk, Virginia	WTG Scope	2	99
OR Hope Creek, New Jersey		2	99
Port Elizabeth, New Jersey	Cable Staging	15	346
OR Charleston, South Carolina		15	346
OR Europe		15	346

Source: Ocean Wind 2022.
Note: These values do not include primary substation installation vessels (2) and trips (12) because potential port locations for this activity were not known. All CTV captures all support and transport vessel numbers and trips.

CTV = crew transfer vessel; WTG = wind turbine generator

The operational conditions combined with planned APMs (see Table 1-11 for all vessel strike avoidance measures) would minimize collision risk during construction and installation. Between November 1 and April 30, vessels of all sizes would operate port to port (from ports in New Jersey, New York, Maryland, Delaware, and Virginia) at 10 knots (5.1 m/s) or less (Table 1-11). Vessels transiting from other ports outside those described would operate at 10 knots (5.1 m/s) or less when within any active SMA or within the Offshore Wind Area, including the Lease Area and export cable route (Table 1-11). Between May 1 and October 31, all underway vessels (transiting or surveying) operating at greater than 10 knots (5.1 m/s) would have a dedicated visual observer (or NMFS-approved automated visual detection system) on duty at all times to monitor for marine mammals within a 180-degree direction of the forward path of the vessel (90 degrees port to 90 degrees starboard). Visual observers must be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, and fog). The dedicated visual observer must receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements (Table 1-11). Visual observers may be third-party observers (i.e., NMFS-approved PSOs) or crew members (Table 1-11). Additionally, PAM networks would be used to check the vessel transit corridor for NARWs year-round to allow for vessel speed restrictions prior to NARWs being sighted. Because vessel strikes are not anticipated given the relatively low number of vessel trips and the monitoring and mitigation activities required to avoid encountering marine mammals, this BA concludes that vessel strikes are unlikely to occur. Therefore, the anticipated effects on marine mammals are considered minor. In the event of an unanticipated vessel strike of a marine mammal by any vessel supporting the Project, Ocean Wind must immediately cease the activities until BOEM is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with all applicable laws (e.g., ESA, MMPA) and COP approval conditions (Table 1-11).

Ocean Wind has estimated that Project O&M would involve daily trips of CTVs or Surface Effect Ships (SESs) (i.e., high-speed crew transfer air-cushion catamarans) trips except in severe weather, or approximately 115,150 vessel trips over the lifetime of the Project, originating from the Atlantic City O&M facility. Specifications for the vessels that would be used for Project O&M are described in Table 1-7. While the CTVs’ lack of in-water hull reduces the likelihood of a subsurface collision, marine mammals resting or breathing on the surface could be affected by these vessels. Additionally, the high speed of the vessels allows less reaction time for both the marine mammal and for the vessel operator conducting a maneuver to avoid the marine mammal. The design of SESs was initially spurred in the early 1960s by needs of the U.S. Navy and USCG with goals to develop ships capable of sustaining speeds of 80 knots (41 m/s) (Church 1989). However, development for offshore wind crew transfer capabilities shows operational speeds of 43.5 knots (22 m/s) in wave heights up to 6.6 feet (2 meters) (Maritime Executive 2021). Based on the density of ESA-listed marine mammals in the Project area and a maximum of 283 trips per month over the operational life of the Project, there are periods of time where there is a moderate risk of encountering an ESA-listed marine mammal, particularly NARWs and fin whales (Roberts et al. 2017, 2018, 2021b). The vessel speed restrictions and vessel strike avoidance plan implemented for construction would also apply to O&M vessels (Table 1-11). This plan includes speed restrictions of 10 knots (5.1 m/s) or less for all vessels regardless of size from November 1 to April 30 when transiting from port to port, within the Lease Area and export cable route, or within the boundaries of any Dynamic Management Area (DMA) or SMA. Vessel speed of 10 knots (5.1 m/s) or less for all vessels regardless of size would also apply to any DMA year-round. AIS would be required on all project vessels to monitor the number of vessels in operation, their routes, and compliance with vessel speed restrictions. From May 1 to October 31, underway vessels regardless of size (transiting or surveying) and operating at greater than 10 knots (5.1 m/s), would have a dedicated visual observer or NMFS approved automated visual detection system on duty at all times. Observers would monitor for marine mammals within 180 degrees of the forward path of the vessel (90 degrees port to 90 degrees starboard) and have alternative monitoring technology for periods of low visibility. Sea state is not the only factor that impacts PSO effectiveness, Further mitigation and monitoring measures for the Project are outlined in Table 1-11. Based on the density of ESA-listed marine mammals in the Project area and a maximum of 283 trips per month over the operational life of the Project, there are periods of time where there is a moderate risk of encountering an ESA-listed marine mammal, particularly NARWs and fin whales (Roberts et al. 2017, 2018, 2021b). However, the operational conditions, combined with planned APMs (see Table 1-11 for all vessel strike avoidance measures), would minimize collision risk during construction and installation. Vessel strikes are not anticipated when monitoring and mitigation activities are effectively designed and implemented, as outlined; thus the potential for vessel strikes to ESA-listed cetaceans species is **discountable**. Therefore, the effects of vessel strikes from Project vessel activities leading to injury or mortality **may affect, not likely to adversely affect** ESA-listed cetaceans**.**

3.2.6.8. Monitoring Surveys Effects on Marine Mammals [pre-C, C, O&M]

Monitoring surveys for the Project are proposed during the initial three phases of pre-construction, construction, and O&M. Monitoring surveys during decommissioning are possible; however, the proposed plans do not extend to that phase. The details of each survey type are provided in Section 1.3.4. Many of the potential impacts to ESA-listed marine mammal species arising from monitoring surveys during pre-construction, construction, and O&M are related to increased vessel traffic, underwater vessel noise, and increased for potential for vessel strikes. These stressors are discussed in Sections 3.2.6.2 and 3.2.6.7, respectively. Effects of survey methods include; habitat disturbance during trawling, dredging, and pot setting, potential for entrapment, or entanglement in monitoring gear.

Impacts to ESA-listed marine mammals specific to each survey type and equipment are described below in this section. The underwater noise effects generated by the survey methods used in the benthic monitoring plan (multibeam echosounder and side-scan sonar methods) used for habitat monitoring are similar to, but of lower magnitude than, the HRG survey methods described in Section 1.3.4.1. As these effects have already been considered, they are not addressed further in this assessment.

3.2.6.8.1 Trawl Surveys

The trawl vessel, captain, and sampling equipment used for the Fisheries Monitoring Plan will be the same as that used by the Northeast Area Assessment and Monitoring Program (NEAMAP). The sampling procedures are modeled after the NEAMAP for data compatibility. The NEAMAP trawl survey occurs in three similar shallow nearshore areas off New Jersey. NMFS' opinion on the *Continued Prosecution of Fisheries and Ecosystem Research Conducted and Funded by the Northeast Fisheries Science Center and the Issuance of a Letter of Authorization under the Marine Mammal Protection Act for the Incidental Take of Marine Mammals pursuant to those Research Activities* (dated June 23, 2016) concluded that impacts to NARWs, humpback whales, fin whales, sei whales, and blue whales, if any, as a result of trawl gear use would be expected to be discountable. The NEAMAP tow density is approximately one tow per 39 mi^2 (100 km^2) and a density of approximately one tow per 6 mi^2 (15 km^2) is planned for the Project. The NEAMAP survey effort includes three separate trawl vessels off southern New England, Massachusetts, and the Mid-Atlantic conducting 150 20-minute tows twice per year or 300 hours per year and 1,800 hours over a 6-year period. The total effort of trawl surveys for the Project is 53.3 hours per year and 320 hours total, which is roughly one-sixth of the total effort of the NEAMAP. Large whale species have the speed and maneuverability to avoid oncoming mobile gear (NMFS 2016b). The slow speed of mobile gear and the short tow times further reduce the potential for entanglements or other interactions. Observations during mobile gear use have shown that entanglement or capture of large whale species is extremely rare and unlikely (NMFS 2016b). Although the trawl methods analyzed in commercial fisheries are comparable to the fishery monitoring methods proposed, the proposed trawl effort and tow times (20 minutes) for the proposed fisheries monitoring surveys are less than that previously considered by NMFS for commercial trawling activities. Consequently, the likelihood of interactions with listed species of marine mammals is lower than commercial fishing activities. The eDNA sampling surveys would be conducted coincidentally with the trawl surveys and subject to the same mitigation measures. Based on the above analysis, the potential for entanglement of ESA-listed cetaceans in bottom trawl equipment is considered extremely unlikely to occur and is **discountable**.

After descending through the water column, the trawl gear used in the Ocean Wind monitoring survey activities operates on or very near the bottom. Right whales feed on copepods and blue whales on krill exclusively, which are expected to pass through trawl gear used for the Project and not be affected by turbidity created by the gear. Sperm whales feed on deep water species that do not occur in the area to be surveyed. Fin and sei whales consume prey species that have potential to be removed by trawl gear. However, the biological opinion for the NEFSC surveys are estimated to remove a negligible few hundred tons of prey fish per year total compared to the overall fish consumption of blue, humpback, and fin whales (NMFS 2016b). As mentioned, trawl survey effort for the Project is about 17% of the total effort for the NEAMAP surveys. Therefore, effects from the proposed bottom trawl survey activities on the availability of prey of ESA-listed cetaceans are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

3.2.6.8.2 Structure-Associated Fishes Surveys

Chevron traps and BRUVs have the potential to cause adverse impacts on marine mammals resulting from entanglement in lines and floats. The Final EIS, Regulatory Impact Review, and Initial Regulatory Flexibility Analysis for Amending the Atlantic Large Whale Take Reduction Plan (ALWTRP): Risk Reduction Rule provides an analysis of data that shows entanglement in commercial fisheries gear represents the highest proportion of all documented serious and non-serious incidents reported for North Atlantic right and fin whales (NOAA 2021c). Entanglement was the leading cause of serious injury and mortality for NARWs and fin whales from 2010 to 2018 for cases where the cause of death could be identified (NOAA 2021c).

The ALWTRP was recently amended in 2021 and includes a combination of seasonal area closures and fishing gear modifications that are intended to reduce the risk of serious injury or mortality as a result of entanglement in commercial fishing gear of NARWs, fin whales, and humpback whales. One required component of the ALWTRP has been the use of weak links for trap/pot fisheries in some areas (NOAA 2021c). The requirements have been modified over time to include more areas and to lower breaking strengths (Borggaard et al. 2017). As discussed in the ALWTRP, it is believed that the weak links allow the buoy to break away and the rope to pull though the baleen if an entanglement occurs, although it is difficult to assess how well the weak link reduces serious injury and mortality (NOAA 2021c).

Another recommended risk reduction measure proposed is the use of weak rope or weak insertions. Based up Knowlton et al. (2016), it is assumed that weak rope (engineered to break at 1,700 pounds [771 kg] or less) would allow whales to break free from the ropes and avoid a life-threatening entanglement (NOAA 2021c). Equipment used in the fisheries monitoring surveys would employ the use of both weak link and weak rope technologies that are consistent with the proposed changes in the ALWTRP. Additionally, traps and BRUVs would have limited soak times of <90 minutes and the vessel would remain on location during deployment. Lastly, neither traps nor BRUVs would be deployed if marine mammals are sighted near the proposed sampling station. For all structure-associated fish surveys, 15-minute marine mammal monitoring would be conducted prior to deployment of gear. If marine mammals are sighted during the survey and are considered to be at risk of interaction with the research gear, then the sampling station is either moved or canceled or the activity is suspended until there are no sightings of any marine mammal for 15 minutes within 1 nm (1,852 meters) of the sampling location (Table 1-11). Therefore, impacts to marine mammals are expected to be insignificant and discountable based upon the limited number of associated buoy lines, the implementation of NOAA-required risk reduction measures, and that entanglement in gear would be extremely unlikely to occur. The structure-associated fishes surveys would be supplemented with rod-and-reel surveys and subject to the same mitigation measures. Additionally, rod-and-reel fishing trials would last no longer than 3 minutes with a total of 16 to 25 trials per station. Given the short soak time and the continued observation for marine mammals, the rod-and-reel surveys pose minimal risk to the marine mammals in the Project area. Based on the above analysis, the potential for entanglement of ESA-listed cetaceans in structure-associated fishes survey equipment is considered extremely unlikely to occur and is **discountable**.

The proposed trap survey activities would not have any effects on the availability of prey for NARWs, blue whales, fin whales, sei whales, and sperm whales. Right whales and sei whales feed on copepods (Perry et al. 1999). Copepods are very small organisms that will pass through trap gear rather than being captured in it. Similarly, fin whales feed on krill and small schooling fish (e.g., sand lance, herring, mackerel) (Aguilar 2002). The size of the trap gear is too large to capture any fish that may be prey for listed whales. Sperm whales feed on deep water species that do not overlap with the study area where trap activities will occur.

Therefore, effects from the proposed structure-associated fishes survey activities on the availability of prey of ESA-listed cetaceans are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

3.2.6.8.3 Clam, Oceanography, and Pelagic Fish Surveys

The equipment used in the clam, oceanography, and pelagic fish surveys pose minimal risk to marine mammals. Tows for the clam survey have a very short duration of 120 seconds, and the vessel is subject to similar mitigation measures as the trawl survey. For all clam surveys, 15-minute marine mammal monitoring would be conducted prior to deployment of gear. If marine mammals are sighted during the survey and are at risk of interaction with the research gear, then the sampling station is either moved or canceled or the activity is suspended until there are no sightings of any marine mammal for 15 minutes within 1 nm (1,852 meters) of sampling location (Table 1-11). Given the short soak time and the pre-deployment and continued observation for marine mammals, the clam surveys pose minimal risk to marine mammals in the Project area. Based on the above analysis, the potential for entanglement of ESA-listed cetaceans in clam, oceanography, and pelagic fish survey equipment is considered extremely unlikely to occur and is **discountable**. Both the oceanography and pelagic fish surveys are non-extractive and subject to the same mitigation as the structure-associated fish surveys (Table 1-11). Therefore, effects from the proposed clam, oceanography, and pelagic fish survey activities on the availability of prey of ESA-listed cetaceans are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

3.2.6.8.4 Acoustic Telemetry Surveys

Acoustic telemetry to monitor for tagged fish, elasmobranchs, and invertebrates would be conducted during pre-construction, construction, and O&M phases of the Project. Surveys would employ a combination of fixed hydrophone receivers attached to piers, bulkheads, and floating docks, deployed from a vessel during the structure-associated fishes survey, and attached to a glider during the pelagic fish surveys. The fixed hydrophones would be attached to existing inshore structures and do not pose a risk to marine mammals. The mobile hydrophone deployed during the structure-associated fishes survey will be subject to the same pre- and continuous marine mammal observational periods and, therefore, present a discountable amount of risk to marine mammals (Table 1-11). Additionally, the hydrophone attached to the glider is non-extractive and would average 0.45 knots (0.23 m/s). The potential for entanglement of ESA-listed cetaceans in acoustic telemetry survey equipment is considered extremely unlikely to occur and is **discountable**.

3.2.6.8.5 Passive Acoustic Monitoring

The use of PAM buoys or autonomous PAM devices to monitor for Project noise and presence of vocalizing marine mammals have been proposed by Ocean Wind during construction and O&M phases of the Project (HDR, Inc. 2022a). Specific Project activities that would require PAM include UXO detonation, HRG surveys, impact pile driving, and ensuring the vessel transit corridor is clear of NARWs (Table 1-11). The use of PAM for mitigation and monitoring were considered as part of the Proposed Action in the LOA under the MMPA (HDR, Inc. 2022a).

Based on previous consultations, BOEM anticipates requiring that moored and autonomous PAM systems that may be used for monitoring would either be stationary (e.g., moored) or mobile (e.g., towed, autonomous surface vehicle [ASVs], or autonomous underwater vehicle [AUVs]), respectively. Moored PAM systems would use the best available technology to reduce any potential risks of entanglement. PAM system deployment would follow the same procedures as those described in the previous section to avoid and minimize impacts on ESA-listed species, as detailed in BOEM's BA on data collection activities (BOEM 2021b). The potential for entanglement of ESA-listed cetaceans in PAM survey equipment is considered extremely unlikely to occur and is **discountable**.

Autonomous PAM systems could have hydrophone equipment attached that operates autonomously in a defined area. ASVs and AUVs in very shallow water can be operated remotely from a vessel or by line of sight from shore by an operator and in an unmanned mode. These autonomous systems are typically very small, lightweight vessels and travel at slow speeds. ASVs and AUVs produce virtually no self-generated noise and are not expected to pose a risk of injury to marine mammals from collisions due to their low mass, small size, and slow operational speeds. The potential for injury of ESA-listed cetaceans from ASVs and AUVs is considered extremely unlikely to occur and is **discountable.**

3.2.6.8.6 Summary of Monitoring Survey Effects

As described in the sections above, any effects from monitoring surveys (e.g., entanglement, reductions in prey or strikes) on marine mammals are considered extremely unlikely to occur and **discountable** or are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the effects of monitoring surveys from the Project **may affect, not likely to adversely affect** ESA-listed cetaceans.

3.2.6.9. Electromagnetic Field Effects on Marine Mammals [O&M]

The Project would install 384 miles (618 km) of high-voltage, direct current cables for inter-array, offshore export, and substation interconnection. Effects from power transmission cables during O&M resulting from generated EMF have the potential to impact marine mammals over the long-term life of the Project. To protect the cable and minimize EMF effects to marine species, the target burial depth for the inter-array, substation, and export cables is 4 to 6 feet (1.2 to 1.8 meters). Normandeau (2011) reviewed available evidence on marine mammal sensitivity to human-created EMF in the scientific literature. Although the scientific evidence is generally limited, available studies suggest that baleen and toothed whales, including the ESA-listed species known or likely to occur in the Action Area, are likely sensitive to magnetic fields based on the presence of magnetosensitive anatomical features and observed behavioral and physiological responses. Marine mammals are likely to orient to the earth's magnetic field for navigation, suggesting they may have the ability to detect induced magnetic fields from underwater electrical cables. Assuming a 50-mG (5.0 µT) sensitivity threshold (Normandeau 2011), marine mammals could theoretically be able to detect EMF effects from other, similar, inter-array and export cables, but only in close proximity to cable segments lying on the bed surface. Individual marine mammals would have to be within 3 feet (0.9 meters) or less of those cable segments to encounter EMF above the 50 mG (5.0 µT) detection threshold. As described in Section 3.2 and Table 3-23, four of the ESA-listed marine mammal species analyzed in this assessment are baleen whales that commonly feed in the water column, away from the benthos (e.g., blue whales, fin whales, NARWs, and sei whales). Though sperm whales are known to feed on benthic organisms, waters where this foraging takes place are deeper and not expected to occur in the Project area (Kawakami 1980; Leatherwood et al. 1988; Pauly et al. 1998). Given the low field intensities involved and the likely lack of interaction between ESA-listed whales and the benthos in the Project area, any EMF effects on marine mammals are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the effects of EMF from the Project **may affect, not likely to adversely affect** ESA-listed cetaceans**.**

3.2.6.10. Air Emissions (Vessel Discharges and Offshore Equipment) (C, O&M, D)

The proposed Project's WTGs, substations, and offshore and onshore cable corridors would not themselves generate air pollutant emissions during normal operations. However, air pollutant emissions from equipment used in the construction, O&M, and decommissioning phases could affect air quality in the geographic analysis area and nearby coastal waters and shore areas. Most emissions would occur temporarily during construction, offshore in the Wind Farm Area, along the offshore and onshore export cable routes, and at the construction staging areas. Additional emissions related to the Project could also occur at nearby ports used to transport material and personnel to and from the Project site. Emissions from offshore activities would occur during pile and scour protection installation, offshore cable laying, turbine installation, and substation installation. Offshore construction-related emissions also would come from diesel-fueled generators used to temporarily supply power to the WTGs and substations so that workers could operate lights, controls, and other equipment before cabling is in place. There also would be emissions from engines used to power pile-driving hammers and air compressors used to supply compressed air to noise-mitigation devices during pile driving (if used). Emissions from vessels used to transport workers, supplies, and equipment to and from the construction areas would result in additional air quality impacts. A summary of estimated emissions during construction of the Project is provided in Table 3-25. APMs to minimize air emissions include the using of low sulfur fuels to the extent practicable, selecting engines designed to reduce air pollution to the extent practicable, limiting engine idling time, complying with international standards regarding air emissions from marine vessels, and the implementing a dust control plan.

Table 3-25 Estimated Ocean Wind 1 Construction Emissions in OCS Permit Area (U.S. tons)

Period	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO_2e
OCS Permit Area Year 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OCS Permit Area Year 2	1,342	7,486	244.3	232.8	94.5	216.6	424,114
Total	**1,342**	**7,486**	**244.3**	**232.8**	**94.5**	**216.6**	**424,114**

CO = carbon monoxide; CO_2e = carbon dioxide equivalent; OCS = Outer Continental Shelf; NO_X = nitrogen oxides; PM_{10} = particulate matter 10 micrometers or less in diameter; $PM_{2.5}$ = particulate matter 2.5 micrometers or less in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compounds.

During O&M, air quality impacts are anticipated to be smaller in magnitude compared to construction and decommissioning. Offshore O&M activities would consist of WTG operations, planned maintenance, and unplanned emergency maintenance and repairs. The WTGs operating under the Proposed Action would have no pollutant emissions. Pollutant emissions from O&M would be mostly the result of operations of ocean vessels and helicopters used for maintenance activities. A summary of the emissions resulting from the Project during O&M is provided in Table 3-26. The Project would produce greenhouse gas emissions that contribute to climate change; however, its contribution would be less than the emissions reductions from fossil-fueled sources during operation of the Project. The Project must demonstrate compliance with the NAAQS.

Table 3-26 Ocean Wind 1 O&M Emissions (U.S. tons)

Period	CO	NOX	PM10	PM2.5	SO2	VOC	CO2e
Annual	40	159	5.6	5.4	0.9	4.1	11,912
Lifetime (35 years)	1,411	5,576	196	191	31	144	416,907

Source: COP Volume II, Table 2.1.3-4 (Ocean Wind 2022)
CO = carbon monoxide; CO_2e = carbon dioxide equivalent; OCS = Outer Continental Shelf; NO_X = nitrogen oxides; PM_{10} = particulate matter 10 micrometers or less in diameter; $PM_{2.5}$ = particulate matter 2.5 micrometers or less in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compounds

The impact from air pollutant emissions is anticipated to be minor and short-term in nature. Any effects to air quality from the construction and operations phases of the Proposed Action are likely to be very small. Given the types of activities and vessels needed for construction and decommissioning (e.g., driving and removing piles, and laying and removing cable) are similar, it is assumed the effects to air quality from decommissioning are similar to those of construction such that the air quality effects from the Proposed Action as a whole are still likely to be minor. At this time, there is no information on the effects of air quality on listed marine mammal species that may occur in the action area. However, as the NAAQS are designed to ensure that air quality does not significantly deteriorate from baseline levels, it is reasonable to conclude that any effects to listed marine mammals from these emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are **insignificant**. Therefore, the effects of air emissions from the Project **may affect, not likely to adversely affect** ESA-listed cetaceans**.**

3.2.6.11. Lighting of Structures (C, O&M, D)

The Project would introduce artificial light sources to the Project area over the short-term on construction and decommissioning vessels and long-term installation stationary light sources over O&M. Artificial light has the potential to aggregate and alter community composition of fish and invertebrates (McConnell et al. 2010; Davies et al. 2016). Zooplankton also respond to artificial light, effecting their vertical distribution within the water column (Orr et al. 2013). Blue whales, fin whales, NARWs, and sei whales are thought to feed at night (Víkingsson 1997; Baumgartner et al. 2003; Baumgartner and Fratantoni 2008; Guilpin et al. 2019). Sperm whales also forage at night but are expected to feed in deeper waters outside the Project area. While the effects of artificial lighting on marine mammals themselves are largely unknown, impacts are anticipated to be negligible if appropriate design techniques and uses are employed (Orr et al. 2013). Lighting-related best management practices (BMPs) committed by the Project include red wavelength-emitting diode obstruction lighting; lighting that flashes 30 flashes per minute; use of an aircraft detection lighting system that turns on lights in response to an aircraft in proximity of the wind farm to reduce total time lights are on; and directional shielding of aeronautical obstruction lights to prevent visibility below the horizontal plane. The employed mitigation measures are expected to reduce short- and long-term artificial light so that the effects to marine mammals and their prey are likely so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are **insignificant**. Therefore, the effects of lighting of structures from the Project **may affect, not likely to adversely affect** ESA-listed cetaceans**.**

3.2.6.12. Unexpected/Unanticipated Events (C, O&M, D)

Unexpected and unanticipated events are not part of the Proposed Action but have a low potential to occur and are considered in the Draft EIS. These unlikely events have the potential to impact marine mammals and include vessel collision and allision with foundations, failure of WTGs due to a weather event, oil spill, or chemical release.

In the event of a vessel collision/allision with a turbine, fluids contained within the turbine may be released or a catastrophic failure or collapse of the turbine may occur. Measures in place to minimize the risk of vessel collision/allision include turbine depiction on navigation charts, compliant lighting and marking of turbines detailed in Section 3.2.6.11, and proper spacing of the turbines in consideration of navigational safety. The Navigational Risk Assessment prepared for the Project determined that it is highly unlikely that a vessel will strike a foundation and even in the unlikely event that such a strike did occur, the collapse of the foundation is highly unlikely even when considering the largest and heaviest vessels that could transit the WDA. Therefore, based on this information, any effects to listed marine mammals that could theoretically result from a vessel collision/allision are extremely unlikely and not reasonably certain to occur.

Most hurricane events within the Atlantic generally occur from mid-August to late October, and the majority of all events occur in September (Donnelly et al. 2004). On average, hurricanes occur every 3 to 4 years within 90 to 170 miles of the New Jersey coast (NJDEP 2010). Most historical cyclones affecting the Project area are tropical storms, and storms as powerful as Category 3 hurricanes have affected the area. Hurricane Sandy occurred in 2012 and caused the highest storm surges and greatest inundation on land in New Jersey. Marine observations at the Cape May National Ocean Service recorded sustained wind speeds at 52 knots (27 m/s) and an estimated inundation of 3.5 feet (1.06 meters) (Blake et al. 2013). The Bejarano et al. (2013) modeling indicates the only incidents calculated to occur within the life of the Proposed Action are spills of up to 90 to 440 gallons (340.7 to 1,665.6 liters) of WTG fluid or a diesel fuel spill of up to 2,000 gallons (7,570.8 liters) with model results suggesting that such spills would occur no more frequently than once in 10 years and once in 10 to 50 years, respectively. However, this modeling assessment does not account for any of the spill prevention plans that will be in place for the Project which are designed to reduce risk of accidental spills or releases. Considering the predicted frequency of such events (i.e., no more than three WTG fluid spills over the 25-year life of the WTGs and no more than one diesel spill over the life of the Project), and the reduction in risk provided by adherence to USCG and BSEE requirements as well as adherence to the spill prevention plan both of which are designed to eliminate the risk of a spill of any substance to the marine environment; therefore, any fuel or WTG fluid spill is extremely unlikely and not reasonably certain to occur; as such, any exposure of listed marine mammals to any such spill is also extremely unlikely and not reasonably certain to occur. In the unlikely event of a spill, if a response was required by the EPA or the USCG, there would be an opportunity for the NMFS to conduct a consultation with the lead federal agency on the oil spill response which would allow the NMFS to consider the effects of any oil spill response on listed marine mammals in the Action Area.

The risk of a spill in the extremely unlikely event of a collapse is limited by the containment built into the structures. As explained above, catastrophic loss of any of the structures is not reasonably certain to occur; therefore, the spill of oil from these structures is also not reasonably certain to occur. Modeling presented by BOEM in the BA (from Bejarano et al. 2013) indicates that there is a 0.01% chance of a “catastrophic release” of oil from the wind facility in any given year. Given the 25-year life of this Project, the modeling supports the determination that such a release is not reasonably certain to occur. An additional potential impact of vessel traffic on marine mammals or their prey is spills from refueling or collision. Impacts on individual marine mammals, including decreased fitness, health effects, and mortality, may occur if individuals are present in the vicinity of a spill, but accidental releases are expected to be rare and injury or mortality are not expected to occur. Furthermore, all vessels associated with the proposed Project would comply with the USCG requirements for the prevention and control of oil and fuel spills, and Ocean Wind would not allow any refueling of vessels while at sea (Ocean Wind 2022). Proper vessel regulations and operating procedures would minimize effects on marine mammals and their prey resulting from the release of debris, fuel, hazardous materials, or waste (BOEM 2012). The potential for unexpected and unanticipated events to occur are considered extremely unlikely to occur and are therefore **discountable**. Therefore, the effects of unexpected and unanticipated events from the Project **may affect, not likely to adversely affect** ESA-listed cetaceans**.**

3.3. SEA TURTLES

Four species of sea turtles are considered in this BA: the leatherback sea turtle, loggerhead sea turtle, Kemp's ridley sea turtle, and green sea turtle. A digital aerial baseline survey of marine wildlife was conducted off the southern shores of New York and northern shores of New Jersey. The survey boundaries overlap with the northern portion of the Project area. Sea turtle abundance increased from the coastal zones out to the shelf break. Densities of sea turtles were most abundant in the summer months. Although the study area did not include Project boundaries, it could be extrapolated that sea turtles will be generally abundant in the warmer months (NYSERDA 2021).

Atlantic nesting sites for the leatherback sea turtles are concentrated in the southeast United States, below North Carolina (NMFS and USFWS 2020). Sea turtle nesting does not occur in New Jersey, and there are no nesting beaches or other critical habitats in the vicinity of the Project (GARFO 2021). Individuals occurring in the Project area are either migrating or foraging and are likely to spend the majority of time below the surface. Sea turtles can remain underwater for extended periods, ranging from several minutes to several hours, depending on factors such as daily and seasonal environmental conditions and specific behavioral activities associated with dive types (Hochscheid 2014). Such physiological traits and behavioral patterns allow them to spend as little as 3% to 6% of their time at the water's surface (Lutcavage and Lutz 1997). These adaptations are important because sea turtles often travel long distances between their feeding grounds and nesting beaches (Meylan 1995).

The combination of sightings, strandings, and bycatch data provide the best available information on sea turtle distribution in the Project area. This section includes species descriptions, status, likelihood of occurrence in the Action Area, and information about feeding habits and hearing ability that are relevant to this effects analysis provided in the following sections. Likelihood of occurrence is summarized from data for each of the four sea turtle species from the most current sightings surveys off New Jersey's nearshore waters (NJDEP 2010; Palka et al. 2017), the NMFS Sea Turtle Stranding and Salvage Network (STSSN) (NMFS 2021b), and recent and historic population or density estimates from NMFS and the U.S. Navy, where available. Population dynamics and habitat use of different sea turtle species along the New Jersey shore are still poorly understood. Sea turtles are wide ranging and long lived, making population estimates difficult, and survey methods vary depending on species (TEWG 2007; NMFS and USFWS 2013, 2015a, 2015b). Because sea turtles have large ranges and highly migratory behaviors, the current condition and trend of sea turtles are affected by factors outside of the Project area.

The suitability of Mid-Atlantic OCS sea turtle foraging habitats is shifting as a result of current climate change trends. For example, pelagic foraging habitats for leatherback sea turtles in the North Atlantic are strongly associated with the 59°F (15°C) isotherm, which is shifting northward at a rate of approximately 124 miles (200 km) per decade (McMahon and Hays 2006). Other sea turtle species are likely to shift their range in response to changing temperature conditions and changes in the distribution of preferred prey (Hawkes et al. 2009). Numerous fish and invertebrate species on the Mid-Atlantic OCS are currently undergoing or likely to undergo changes in abundance and distribution in response to climate change impacts (Hare et al. 2016; Rogers et al. 2019). The implications of these range shifts are difficult to predict and will likely vary by species. For example, loggerhead sea turtles exhibit a high degree of dietary flexibility (Ruckdeschel and Shoop 1988; Plotkin et al. 1993; Seney and Musick 2007) and may more readily adapt to changes in ecosystem structure than dietary specialists like leatherbacks. Rare species like green sea turtles that are currently at the northern limit of their range could become more common in the Action Area as summer temperature conditions become more favorable. Resource managers will need to consider these trends and adapt management to meet evolving species requirements to ensure their long-term conservation.

Sea turtles in the geographic analysis area are subject to a variety of ongoing human-caused impacts, including collisions with vessels, entanglement with fishing gear, fisheries bycatch, dredging, anthropogenic noise, pollution, disturbance of marine and coastal environments, effects on benthic habitat, accidental fuel leaks or spills, waste discharge, and climate change. Sea turtle migrations can cover long distances, and these factors can have impacts on individuals over broad geographical scales. Climate change has the potential to impact the distribution and abundance of prey due to changing water temperatures, ocean currents, and increased acidity. Illegal harvest of eggs and mature adults and incidental fisheries mortality remain significant threats, particularly outside the United States. Predation on depleted population groups and diseases (e.g., fibropapillomatosis) are also emerging risks (NMFS and USFWS 2007a).

3.3.1 North Atlantic Distinct Population Segment of Green Sea Turtle

The green sea turtle is the largest of the hard-shelled sea turtles, growing to a maximum length of approximately 4 feet (1.2 meters) and weighing up to 440 pounds (200 kg) (NMFS and USFWS 1991). The species inhabits tropical and subtropical waters around the globe. They are most commonly observed feeding in shallow waters of reefs, bays, inlets, lagoons, and shoals that are abundant in algae or marine grass, such as eelgrass (NMFS and USFWS 2007a). Individuals display fidelity for specific nesting habitats, which are concentrated in lower latitudes well south of the Action Area. The primary breeding areas in the United States are located in southeast Florida (NMFS and USFWS 1991). Nesting also occurs annually in Georgia, South Carolina, North Carolina, and Texas (NMFS 2022a).

In summer, the distribution of foraging subadults and adults can expand to include subtropical waters at higher latitudes. Juveniles and subadults are occasionally observed in Atlantic coastal waters as far north as Massachusetts (NMFS and USFWS 1991), including Cape Cod Bay (CETAP 1982; Seminoff et al. 2015), and may be present in the Offshore Wind Area. As Green sea turtles spend the majority of their lives in coastal foraging grounds (Seminoff et al. 2015), they may also be present in the nearshore areas of Project.

Green sea turtles spend most of their lives in coastal foraging grounds, including open coastline waters (NMFS and USFWS 2007a). They often return to the same foraging grounds following periodic nesting migrations (Godley et al. 2002). However, some remain in the open ocean habitat for extended periods and possibly never recruit to coastal foraging sites (Pelletier et al. 2003). Once thought to be strictly herbivorous, more recent research indicates that this species also forages on invertebrates, including jellyfish, sponges, sea pens, and pelagic prey while offshore, and sometimes in coastal habitats (Heithaus et al. 2002).

Piniak et al. (2016) studied hearing sensitivity in green sea turtles and determined species hearing range extends from 50 Hz to 1.6 kHz, with the greatest sound sensitivity from 200 to 400 Hz. The scientific understanding of how green sea turtles use sound and hearing is not well developed.

3.3.1.1. Current Status

The green sea turtle was originally listed under the ESA in 1978 as threatened across its range. The listing was subsequently updated in 2016 (81 FR 20057), confirming threatened status across the range, with specific breeding populations in Florida and the Pacific Coast of Mexico listed as endangered (Seminoff et al. 2015). The primary nesting beaches are Costa Rica, Mexico, United States (Florida), and Cuba. Green sea turtles in the Project area belong to the North Atlantic DPS of green sea turtles and listed as threatened (81 FR 20057). According to Seminoff et al. (2015), nesting trends are generally increasing for this DPS. The most recent status review for the North Atlantic DPS estimates the number of female nesting sea turtles to be approximately 167,424 individuals (NMFS and USFWS 2015b). Critical habitat has not been designated. The species was listed on the basis of significant population declines resulting from egg harvesting, incidental mortality in commercial fisheries, and nesting habitat loss.

3.3.1.2. Potential Habitat Surrounding and within Project Area

Green sea turtles are found in the Pacific Ocean, Atlantic Ocean, Indian Ocean, Caribbean Sea, and Mediterranean Sea, primarily in tropical or, to a lesser extent, subtropical waters. However, juveniles and subadults are occasionally observed in Atlantic coastal waters as far north as Massachusetts (NMFS and USFWS 1991).

Green sea turtles do not nest on beaches in the Project area; their primary nesting beaches in the Atlantic Ocean and Caribbean Sea are in Costa Rica, Mexico, the United States (Florida and up to North Carolina), and Cuba. According to Seminoff et al. (2015), nesting trends are generally increasing for this population. Because of their association with warm waters, green sea turtles are uncommonly found in New Jersey waters during the summer, foraging on marine algae and marine grasses (CWFNJ 2021).

Green sea turtles are commonly associated with drift lines or surface current convergences, which commonly contain floating *Sargassum* capable of providing small sea turtles with shelter and sufficient buoyancy to raft upon (NMFS and USFWS 1991). They rest underwater in coral recesses, the underside of ledges, and sand-bottom areas that are relatively free of strong currents and disturbance from natural predators and humans. The NMFS STSSN rescued eight green sea turtles between 1995 and 2005, of which six had evidence of human interactions with fishing activities, boat strikes, and impingement on a power plant grate (NJDEP 2006). From 2010 to 2020, the STSSN reported seven offshore and two inshore green sea turtle strandings within Zone 39, which encompasses southern New Jersey (NMFS 2021b). Additionally, the U.S. Navy indicates that the density of green sea turtles in the Project area during summer, the season with the highest density, ranges from 0 to 2.338 animals per 38.6 mi^2 (100 km^2) (U.S. Navy 2007), which equates to an instantaneous estimate of approximately 0 to 6.5 green sea turtles within the 68,450-acre (277 km^2) Wind Farm Area. Based on this information, the occurrence of green sea turtles in the Project area is expected to be uncommon and limited to small numbers.

3.3.2 Leatherback Sea Turtle

The leatherback sea turtle is the largest living and the most widely distributed sea turtle species, ranging broadly from tropical and subtropical to temperate regions of the world's oceans (NMFS and USFWS 2020). Adults can reach up to 2,000 pounds (900 kg) and can be more than 6 feet (2 meters) long (NMFS and USFWS 2007b; NMFS 2012a). The species has unique characteristics that distinguish it from other sea turtles. Instead of bony plates, it has a carapace consisting of a leather-like outer layer of oil-saturated connective tissue covering a nearly continuous layer of small dermal bones (NMFS and USFWS 1992). Unlike other predatory sea turtles with crushing jaws, the leatherback has evolved a sharp-edged jaw for consuming soft-bodied oceanic prey such as jellyfish and salps (NMFS 2012a).

Leatherback sea turtles in the Project area belong to the Northwest Atlantic population, which is one of seven leatherback populations globally. The species was listed as endangered under the ESA in 1970 (35 FR 8491), inclusive of all populations.[6] Nesting beaches in the United States are concentrated in southeastern Florida from Brevard County south to Broward County (USFWS 2015; NMFS and USFWS 2020). Leatherbacks are a pelagically oriented species, but they are often observed in coastal waters along the United States continental shelf (NMFS and USFWS 2020). Leatherbacks have been sighted along the entire coast of the eastern United States from the Gulf of Maine in the north and south to Puerto Rico, the Gulf of Mexico, and the U.S. Virgin Islands (NMFS and USFWS 2020).

Leatherback sea turtles are dietary specialists, feeding almost exclusively on jellyfish, siphonophores, and salps, and the species' migratory behavior is closely tied to the availability of pelagic prey resources

[6] NMFS and USFWS have not designated DPSs for leatherback sea turtles because the species is listed as endangered throughout its global range (85 Federal Register 48332); however, after reviewing the best available information, USFWS and NMFS (2020) identified seven leatherback populations that meet the discreteness and significance criteria of the DPS Policy, including the Northwest Atlantic population.

(Eckert et al. 2012; NMFS and USFWS 2020). James et al. (2006) studied leatherbacks' migratory behavior using satellite tags and observed that the timing of southerly migration ranges widely, extending from mid-August to mid-December, but with a distinct peak in October. The continental slope to the east and south of Cape Cod and the OCS south of Nantucket appear to be hotspots, where several tagged leatherback sea turtles congregated to feed for extended periods. These findings are consistent with Kraus et al. (2016), who recorded most of their leatherback sightings in the same area. The migratory corridors between breeding and northerly feeding areas appear to vary widely, with some individuals traveling through the OCS and others using the open ocean far from shore (James et al. 2006).

In a study tracking 135 leatherbacks fitted with satellite tracking tags, the species was identified to inhabit waters with sea surface temperatures ranging from 52°F to 89°F (11°C to 32°C) (Bailey et al. 2012). The leatherback sea turtle dives the deepest of all sea turtles to forage and is thought to be more tolerant of cooler oceanic temperatures than other sea turtles. The study also found that oceanographic features such as mesoscale eddies, convergence zones, and areas of upwelling attracted foraging leatherbacks because these features are often associated with aggregations of jelly fish. Unlike the other three species, the leatherback does not use shallow waters to prey on benthic invertebrates or sea grasses.

Dow Piniak et al. (2012) determined that the hearing range of leatherback sea turtles extends from approximately 50 to 1,200 Hz, which is comparable to the general hearing range of turtles across species groups. Leatherbacks' greatest hearing sensitivity is between 100 and 400 Hz. The scientific understanding of how leatherback sea turtles use sound and hearing is not well developed.

3.3.2.1. Current Status

Leatherback sea turtles are listed as endangered under the ESA (35 FR 8491), inclusive of all DPSs. It feeds largely on jelly fish and is highly pelagic in nature but is commonly observed in coastal waters along the U.S. OCS (NMFS and USFWS 2020). The breeding population (total number of adults) estimated in the North Atlantic is 34,000 to 94,000 (TEWG 2007; NMFS and USFWS 2013). NMFS and USFWS (2020) concluded that the Northwest Atlantic population has a total index of nesting female abundance of 20,659 females with a decreasing nest trend at nesting beaches with the greatest known nesting female abundance.

Critical habitat for the Northwest Atlantic population is designated in the U.S. Virgin Islands and does not occur in the Project area (NMFS and USFWS 2020). Primary threats to the species include illegal harvesting of eggs, nesting habitat loss, and shoreline development. In-water threats include incidental catch and mortality from commercial fisheries, vessel strikes, anthropogenic noise, marine debris, oil pollution, and predation by native and exotic species (NMFS and USFWS 2020).

3.3.2.2. Potential Habitat Surrounding and within Project Area

Leatherback sea turtles are found in the Pacific Ocean, Atlantic Ocean, Indian Ocean, Caribbean Sea, and Mediterranean Sea. The species is highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale et al. 1994; Eckert et al. 1998, 1999). In the North Atlantic Ocean, leatherback sea turtles regularly occur in deep waters (greater than 328 feet [100 meters]) and have been reported in depths ranging from 3 to 13,618 feet (1 to 4,151 meters), with a median sighting depth of 131.6 feet (40.1 meters) (CETAP 1982). They occur in waters ranging from 44.6°F to 81°F (7°C to 27.2°C) (CETAP 1982). They can be found in the coastal waters of New Jersey throughout the year, but primarily in the summer and fall, when they forage on soft-bodied animals such as jellyfish and sea squirts (CWFNJ 2018).

From 2010 through 2020, the STSSN reported 12 offshore and six inshore leatherback sea turtle strandings within Zone 39, which encompasses southern New Jersey (NMFS 2021b). During NJDEP (2010) aerial and shipboard surveys for marine mammals and sea turtles, sightings included a total of 12 leatherback sea turtles in waters ranging from 59 to 98 feet (18 to 30 meters) deep, with a mean depth of

79 feet (24 meters). Sightings were recorded from 6.4 to 22.5 miles (5.6 to 19.6 nm, 10.3 to 36.2 km) from shore, with a mean distance of 17.8 miles (15.5 nm, 28.6 km). The sea surface temperatures associated with leatherback sea turtle sightings ranged from 64.6 to 68.5°F (18.1 to 20.3°C), with a mean temperature of 66.2°F (19.0°C). Leatherback sea turtles undergo extensive migrations in the western North Atlantic and usually start arriving along the New Jersey coast in late spring/early summer (Shoop and Kenney 1992; James et al. 2006). The U.S. Navy indicates that the density of leatherback sea turtles in the Project area during summer, the season with the highest density, ranges from 1.889 to 4.135 animals per 38.6 mi^2 (100 km^2) (U.S. Navy 2007), which equates to an instantaneous estimate of approximately 5.2 to 11.5 leatherback sea turtles within the 68,450-acre (277 km^2) Wind Farm Area. Based on this information, it is likely that leatherback sea turtles are common in New Jersey and likely in the Project area from May to November (U.S. Navy 2007).

The Marine Mammal Stranding Center in New Jersey rescued 177 leatherback sea turtles between 1995 and 2005, and 10 between 2013 and 2018. Of the sea turtles rescued in these time intervals, 14% had been struck by boat propellers, 8% had an interaction with fishery equipment, and 2% had been struck by a boat (Schoelkopf 2006).

3.3.3 Northwest Atlantic Ocean Distinct Population Segment of Loggerhead Sea Turtle

The loggerhead sea turtle is a globally distributed species found in temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (NMFS and USFWS 2008). Loggerheads are the most common sea turtle species observed in offshore and nearshore waters along the U.S. East Coast, and virtually all of these individuals belong to the Northwest Atlantic Ocean DPS. Most of the loggerhead sea turtles nesting in the eastern United States occur from North Carolina through southwest Florida. Some nesting also occurs in southern Virginia and along the Gulf of Mexico coast westward into Texas (NMFS and USFWS 2008; Conant et al. 2009). Foraging loggerhead sea turtles range widely—they have been observed along the entire Atlantic coast of the United States as far north as the Gulf of Maine (Shoop and Kenney 1992) and northward into Canadian waters.

The loggerhead sea turtle has a powerful beak and crushing jaws specially adapted to feed on hard-bodied benthic invertebrates, including crustaceans and mollusks. Mollusks and crabs primary food items for juvenile loggerheads (Burke et al. 1993). Although loggerheads are dietary specialists, the species demonstrates the ability to adjust its diet in response to changes in prey availability in different geographies (Ruckdeschel and Shoop 1988; Plotkin et al. 1993). For example, loggerheads in the Gulf of Mexico feed primarily on crabs, but sea pens are also a major part of the diet. Loggerheads in Chesapeake Bay, Virginia, primarily targeted horseshoe crabs (*Limulus polyphemus*) in the early to mid-1980s but subsequently shifted their diet to blue crabs in the late 1980s, and then to finfish from discarded fishery bycatch in the mid-1990s (Seney and Musick 2007).

Martin et al. (2012) and Lavender et al. (2014) used behavioral and auditory brainstem response methods to identify the hearing range of loggerhead sea turtles. Both teams identified a generalized hearing range from 50 Hz to 1.1 kHz, with greatest hearing sensitivity between 100 and 400 Hz. The scientific understanding of how loggerhead sea turtles use sound and hearing is not well developed.

3.3.3.1. Current Status

The Northwest Atlantic Ocean DPS of loggerhead sea turtle was listed as federally threatened under the ESA effective on October 24, 2011 (76 FR 58868). The regional abundance estimate in the Northwest Atlantic OCS in 2010 was approximately 588,000 adults and juveniles of sufficient size to be identified during aerial surveys (interquartile range of 382,000 to 817,000 [NEFSC and SEFSC 2011]). The three largest nesting subpopulations responsible for most of the production in the western North Atlantic (peninsular Florida, northern United States, and Quintana Roo, Mexico) have all been declining since at least the late 1990s, thereby indicating a downward trend for this population (TEWG 2009). While some progress has been made since publication of the 2008 Loggerhead Sea Turtle Recovery Plan, the recovery units have not met most of the critical benchmark recovery criteria (NMFS and USFWS 2019).

Critical habitat for Northwest Atlantic Ocean DPS of loggerhead sea turtles was designated in 2014 (79 FR 39755; 79 FR 51264). The four designated critical habitat units are nesting beaches in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. No designated critical habitat occurs within New Jersey. Factors affecting the conservation and recovery of this species include beach development, related human activities that damage nesting habitat, and light pollution (NMFS and USFWS 2008). In-water threats include bycatch in commercial fisheries, vessel strikes, anthropogenic noise, marine debris, legal and illegal harvest, oil pollution, and predation by native and exotic species (NMFS and USFWS 2008).

3.3.3.2. Potential Habitat Surrounding and within Project Area

Loggerhead sea turtles range widely and have been observed along the entire Atlantic coast as far north as Canada (Shoop and Kenney 1992; Brazner and McMillan 2008; Ceriani et al. 2014). The AMAPPS surveys reported loggerhead sea turtles as the most commonly sighted sea turtles on the OCS waters from New Jersey to Nova Scotia, Canada. During the December 2014 to March 2015 aerial abundance surveys, 280 individuals were recorded (Palka et al. 2017). The NJDEP (2010) aerial and shipboard surveys recorded a total of 615 loggerhead sea turtle sightings between January 2008 and December 2009. The loggerhead sea turtle was the second most frequently sighted species during the survey, and the vast majority of sightings were during the summer (NJDEP 2010). From 2010 through 2020, STSSN reported 139 offshore and 74 inshore loggerhead sea turtle strandings within Zone 39, which encompasses southern New Jersey (NMFS 2021b). Loggerheads are stranded far more often than other sea turtles in New Jersey (NMFS 2021b), as they have a higher relative abundance. Additionally, the U.S. Navy indicates that the density of loggerhead sea turtles in the Project area during summer, the season with the highest density, ranges from 1.631 to 9.881 animals per 38.6 mi^2 (100 km^2) (U.S. Navy 2007), which equates to an instantaneous estimate of approximately 4.5 to 27.4 loggerhead sea turtles within the 68,450-acre (277 km^2) Wind Farm Area. Collectively, available information indicates that loggerhead sea turtles are expected to occur commonly as adults, subadults, and juveniles from the late spring through fall, with the highest probability of occurrence from July through September. Based on this information, it is likely that loggerhead sea turtles would be common in New Jersey and likely within the Project area from May to November (U.S. Navy 2007).

3.3.4 Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle is one of the smallest of sea turtle species. Adults can weigh between 70.5 and 108 pounds (32 and 49 kg) and reach up to 24 to 28 inches (60 to 70 cm) in length (NMFS and USFWS 2007c). Kemp's ridley sea turtles are most commonly found in the Gulf of Mexico and along the U.S. Atlantic coast. Juvenile and subadult Kemp's ridley sea turtles are known to travel as far north as Cape Cod Bay during summer foraging (NMFS et al. 2011). All Kemp's ridley sea turtles belong to a single population that is endangered under the ESA (35 FR 18319). The species is primarily associated with habitats on the OCS, with preferred habitats consisting of sheltered areas along the coastline, including estuaries, lagoons, and bays (Burke et al. 1994; NMFS 2019) and nearshore waters less than 120 feet (36.5 meters) deep (Shaver et al. 2005; Shaver and Rubio 2008), although it can also be found in deeper offshore waters. The species is coastally oriented, rarely venturing into waters deeper than 160 feet (50 meters). It is primarily associated with mud sand-bottomed habitats, where primary prey species are found (NMFS and USFWS 2007c). Nesting typically occurs from April to July and nests during the day, unlike most other sea turtles. Most nesting areas are in the western Gulf of Mexico, primarily Tamaulipas and Veracruz, Mexico. Some nesting occurs periodically in Texas and few other U.S. states, occasionally extending up the Atlantic coast to North Carolina. Kemp's ridley sea turtles return to beaches, often in groups, to nest every 1 to 3 years and lay an average of two to three clutches per season (NOAA Fisheries 2022). Recent models indicate a persistent reduction in survival and/or recruitment to the nesting population, suggesting that the population is not recovering (NMFS and USFWS 2015a). Evaluations of hypothesized causes of the nesting setback, including the Deepwater Horizon oil spill in 2010, have been inconclusive, and experts suggest that various natural and anthropogenic causes could have contributed to the nesting setback either separately or synergistically (Caillouet et al. 2018).

Kemp’s ridley sea turtles are generalist feeders that prey on a variety of species, including crustaceans, mollusks, fish, jellyfish, and tunicates, and forage on aquatic vegetation (Carr and Caldwell 1956; Byles 1988; Schmid 1998). However, the preferred diet of the Kemp’s ridley sea turtle is crabs (NMFS and USFWS 2007c). The species is also known to ingest natural and anthropogenic debris (Burke et al. 1993, 1994; Witzell and Schmid 2005).

Dow Piniak et al. (2012) concluded that sea turtle hearing is generally confined to lower frequency ranges below 1.6 kHz, with the greatest hearing sensitivity between 100 and 700 Hz, varying by species. Bartol and Ketten (2006) determined that Kemp’s ridley hearing is more limited, ranging from 100 to 500 Hz, with greatest sensitivity between 100 and 200 Hz. The scientific understanding of how Kemp’s ridley sea turtles use sound and hearing is not well developed.

3.3.4.1. Current Status

The Kemp’s ridley sea turtle was listed as endangered at the species level with the passage of the ESA in 1970 (35 FR 18319). The species has experienced large population declines due to egg harvesting, loss of nesting habitat to coastal development and related human activity, bycatch in commercial fisheries, vessel strikes, and other anthropogenic and natural threats. The species began to recover in abundance and nesting productivity since conservation measures were initiated following listing. However, since 2009, the number of successful nests has declined markedly (NMFS and USFWS 2015a). Potential explanations for this trend, including the Deepwater Horizon oil spill in 2010, have proven inconclusive, suggesting that the decline in nesting may be due to a combination of natural and anthropogenic stressors (Caillouet et al. 2018). Current threats include incidental fisheries mortality, ingestion, and entanglement in marine debris, and vessel strikes (NMFS and USFWS 2015a).

The population was severely reduced by 1985 due to intensive egg collection and fishery bycatch, with a low of 702 nests counted from an estimated 250 nesting females on three primary nesting beaches in Mexico (NMFS and USFWS 2015a; Bevan et al. 2016). Recent estimates of the total population of age 2 years and older is 248,307; however, recent models indicate a persistent reduction in survival or recruitment, or both, in the nesting population, suggesting that the population is not recovering to historical levels (NMFS and USFWS 2015a). A record high number of Kemp’s sea turtle nests were recorded in 2017 (24,586 in Mexico and 353 in Texas). In 2019 there were 11,090 nests, a 37.61% decrease from 2018, and a 54.89% decrease from 2017. This decline is typical due to the reproduction biology of the species, as females nest approximately every 2 to 3 years (NPS 2021). Using the standard International Union for Conservation of Nature protocol for sea turtle assessments, the number of mature individuals was recently estimated at 22,341; the assessment concluded the current population trend is unknown (Wibbels and Bevan 2019).

3.3.4.2. Potential Habitat Surrounding and within Project Area

Kemp’s ridley sea turtles are typically found in shallow coastal waters in the Project area in the summer and fall (CWFNJ 2018), when they forage in a variety of benthic habitat types, including seagrass beds (Carr and Caldwell 1956; Byles 1988), oyster reefs (Schmid 1998), sandy bottoms (Morreale et al. 1992), mud bottoms (Ogren 1989; Schmid 1998), or complexes of these communities (Ogren 1989; Rudloe et al. 1991).

The Marine Mammal Stranding Center in New Jersey rescued an average of 45 Kemp’s ridley turtles each year between 1995 and 2005, of which 18% had become impinged on power plant grates, 4% had been struck by boat propellers, and 20% showed signs of other impacts (NJDEP 2006). From 2010 through

2020, the STSSN reported 11 offshore and five inshore Kemp's ridley sea turtle strandings within Zone 39, which encompasses southern New Jersey (NMFS 2021b). Additionally, the U.S. Navy indicates that the density of Kemp's ridley sea turtles in the Project area during summer, the season with the highest density, ranges from 0 to 0.0186 animals per 38.6 mi^2 (100 km^2) (Appendix A; U.S. Navy 2007), which equates to approximately 0 to 1 Kemp's ridley sea turtles within the 68,450-acre (277 km^2) Wind Farm Area. Kemp's ridley sea turtles commonly occur in inshore and nearshore New Jersey waters as they migrate to the North Atlantic in May and June and forage for crabs in SAV (Keinath et al. 1987; Musick and Limpus 1997). These often are juveniles foraging for food and return to the Gulf of Mexico as coastal waters cool in fall (Musick and Limpus 1997). Based on this information, Kemp's ridley sea turtles could occur infrequently as juveniles and subadults from July through September, potentially occurring as late as November. The highest likelihood of occurrence is in coastal nearshore areas adjacent to Ocean City and Barnegat Bay, where the Project's export cable system is anticipated to make landfall, as they seek protected shallow-water habitats. It is therefore likely that Kemp's ridley sea turtles are present in the Project area from May to November.

3.3.5 Effects Analysis for Sea Turtles

3.3.5.1. Underwater Noise

3.3.5.1.1 Effects on Sea Turtles

Potential adverse auditory effects to sea turtles from Project-generated underwater noise includes PTS, TTS, and behavioral disruption; potential non-auditory effects to sea turtles from Project-generated underwater noise (UXO detonations only) includes mortality, lung injury, and gastrointestinal injury. The underwater noise modeling that was conducted for marine mammals for impact pile driving and UXO detonations also considered sea turtles and are summarized in Section 3.2.6.2. As with marine mammals, animal movement modeling was used to predict sea turtle exposure ranges and the number of individuals exposed. Sea turtle densities used to predict the number of individuals exposed to underwater noises above regulatory thresholds are summarized in Appendix A. The section below provides an overview of the available information on sea turtle hearing, the thresholds applied, the results of the underwater noise modeling conducted, and the impact consequences for each potential activity.

3.3.5.1.1.1 Auditory Criteria for Injury and Disturbance

Sea turtle auditory perception is thought to occur through a combination of both bone and water conduction rather than air conduction (Lenhardt 1982; Lenhardt and Harkins 1983). Detailed descriptions of sea turtle ear anatomy are found in Ridgway et al. (1969), Lenhardt et al. (1985), and Bartol and Musick (2003). Sea turtles do not have external ears, but the middle ear is well adapted as a peripheral component of a bone conduction system. The thick tympanum is disadvantageous as an aerial receptor but enhances low-frequency bone conduction hearing (Lenhardt et al. 1985; Bartol et al. 1999; Bartol and Musick 2003). A layer of subtympanal fat emerging from the middle ear is fused to the tympanum (Ketten and Bartol 2006; Bartol 2004, 2008). This arrangement enables sea turtles to hear low-frequency sounds while underwater. Vibrations can also be conducted through the bones of the carapace to reach the middle ear. Based on studies of semi-aquatic turtles, Christensen-Dalsgaard et al. (2012) speculated that the sea turtle ear may not be specialized for bone conduction, but rather that sound-induced pulsations may drive the tympanic disc if the middle ear cavity is air-filled.

The limited data available on sea turtle hearing abilities are summarized in Table 3-27. The frequency range of best hearing sensitivity of sea turtles ranges from ~100 to 700 Hz; however, there is some sensitivity to frequencies as low as 50 Hz, and possibly as low as 30 Hz (Ridgway et al. 1969).

There is limited data on the ability of sea turtles to hear or be affected by underwater noise that would be generated by the Project. Thresholds outlined for auditory and non-auditory effects to sea turtles have been developed by using fish as surrogates (Popper et al. 2014; U.S. Navy 2017). Underwater non-auditory thresholds for sea turtles used to model UXO detonations are the same thresholds outlined for marine mammals and presented in Section 3.3.5.1.

Table 3-27 Hearing Capabilities of Sea Turtles

Sea Turtle Species	Hearing Range (Hertz)	Hearing Highest Sensitivity (Hertz)	Source
Green (*Chelonia mydas*)	60–1,000	300–500	Ridgway et al. 1969
	100–800	600–700 (juveniles) 200–400 (subadults)	Bartol and Ketten 2006; Ketten and Bartol 2006
	50–1,600	50–400	Piniak et al. 2012a, 2016
Loggerhead (*Caretta caretta*)	250–1,000	250	Bartol et al. 1999
	50–1,100	100–400	Martin et al. 2012; Lavender et al. 2014
Kemp's ridley (*Lepidochelys kempii*)	100–500	100–200	Bartol and Ketten 2006; Ketten and Bartol 2006
Leatherback (*Dermochelys coriacea*)	50–1,200	100–400	Piniak et al. 2012b

Table 3-28, Table 3-29, and Table 3-31 outline the acoustic thresholds used in the assessment for the onset of PTS, TTS, and/or behavioral disruptions for sea turtles. Behavioral criteria for impact and vibratory pile driving were developed by the U.S. Navy in consultation with NMFS and was based on exposure to air guns noise presented in McCauley et al. (2000) (U.S. Navy 2017). Impact pile driving produces repetitive, impulsive sounds like air gun shots. In addition, the working group that prepared the American National Standards Institute Sound Exposure Guidelines provides quantitative and qualitative descriptors of sea turtle behavioral responses to pile driving and explosives (Popper et al. 2014). These thresholds include qualitative descriptors for behavior, masking, TTS and recoverable injury. Recoverable injuries include hair cell damage, minor internal or external hematoma, etc. (none of these injuries are likely to result in mortality; Popper et al. 2014). The received SPL at which sea turtles are expected to actively avoid air gun exposures, 175 dB re 1 μPa is also expected to be the received sound level at which sea turtles would actively avoid exposure to impact pile driving (impulsive) and vibratory pile driving (non-impulsive) activities (U.S. Navy 2017).

As outlined above for marine mammals, auditory masking occurs when sound signals used by sea turtles (e.g., predator vocalizations and environmental cues) overlaps in time and frequency with another sound source (e.g., pile driving). Popper et al. (2014) concluded that continuous noise that is detectable by sea turtles can mask signal detection. As with behavioral effects, the consequences of masking to sea turtle fitness are unknown. The frequency range of best hearing sensitivity estimated for sea turtles is estimated at 100 to 700 Hz. Masking is therefore more likely to occur with sound sources that have dominant low frequency spectrums such as vessel activities, vibratory pile driving, and WTG operations. These activities also have high-duty cycles (e.g., are continuous) and, therefore, have a higher chance of affecting sea turtle communications.

Table 3-28 Acoustic Impact Thresholds[a] for Sea Turtles – Impulsive Sources

PTS		TTS		Behavioral[b]
$L_{pk,0\text{-}pk}$ Unweighted	$L_{E,24h}$ Weighted	$L_{pk,0\text{-}pk,}$ Unweighted	$L_{E, 24h}$ Weighted	L_{rms} Unweighted

PTS		TTS		Behavioral[b]
232	204	226	189	175

Source: U.S. Navy 2017
Notes: Peak sound pressure level ($L_{pk,0\text{-}pk}$) has a reference value of 1 μPa, and weighted sound exposure level accumulated over 24 hours ($L_{E,24h}$) has a reference value of 1 μPa^{2}s. In this table, thresholds are abbreviated to be more reflective of International Organization for Standardization standards (ISO 2017). The note “unweighted” is included to indicate $L_{pk,0\text{-}pk}$ and L_{rms} are flat weighted or unweighted within the generalized hearing range of sea turtles (i.e., below 2 kHz). The “TU-Weighted” note associated with cumulative sound exposure level thresholds indicates the designated sea turtle weighting function. The weighted cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these thresholds will be exceeded. PTS permanent threshold shift; TTS = temporary threshold shift.
[a] Dual metric thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds are recommended for consideration.
[b] All sources – currently, there are not enough data to derive separate thresholds for different source types.
kHz = kilohertz; $L_{E,}$24h = cumulative sound exposure level; $L_{pk,\ 0\text{-}pk}$ = peak sound pressure level; L_{rms} = root mean squared sound pressure level;
PTS = permanent threshold shift; TTS = temporary threshold shift; μPa = micropascal; μPa^{2}s = micropascal squared second

Table 3-29 Acoustic Impact Thresholds[a] for Sea Turtles – Non-Impulsive Sources

PTS	TTS	Behavioral[b]
$L_{E,\ 24h}$ Weighted	$L_{E,24h}$ Weighted	L_{rms} Unweighted
220	200	175

Source: U.S. Navy 2017
Notes:
Peak sound pressure level ($L_{pk,0\text{-}pk}$) has a reference value of 1 μPa, and weighted sound exposure level accumulated over 24 hours ($L_{E,24h}$) has a reference value of 1 μPa^{2}s. In this table, thresholds are abbreviated to be more reflective of International Organization for Standardization standards (ISO 2017). The note “unweighted” is included to indicate $L_{pk,0\text{-}pk}$ and L_{rms} are flat weighted or unweighted within the generalized hearing range of sea turtles (i.e., below 2 kHz). The “TU-Weighted” note associated with cumulative sound exposure level thresholds indicates the designated sea turtle weighting function. The weighted cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these thresholds will be exceeded.
[a] Dual metric thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds are recommended for consideration.
[b] All sources – currently, there are not enough data to derive separate thresholds for different source types
kHz = kilohertz; $L_{E,24h}$ = cumulative sound exposure level; $L_{pk,\ 0\text{-}pk}$ = peak sound pressure level; L_{rms} = root mean squared sound pressure level;

PTS = permanent threshold shift; TTS = temporary threshold shift; μPa = micropascal; μPa^{2}s = micropascal squared second

Table 3-30 Qualitative Acoustic Impact Guidelines for Sea Turtles

Impairment			Behavior
Recoverable Injury	TTS	Masking	
Impact Pile Driving			
(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low

Impairment			Behavior
Recoverable Injury	TTS	Masking	
Explosives			
(N) High (I) High (F) Low	(N) High (I) High (F) Low	N/A	(N) High (I) High (F) Low
Continuous Sounds			
(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low

Notes: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative– terms as near (N – tens of meters)– intermediate (I – hundreds of meters), and far (F – thousands of meters). Guidelines are not provided for masking for explosive events since the animals are not exposed to more than a one or few explosive events, and masking would not last beyond the period of exposure. For continuous sounds, data is based on fish, knowing they will respond to sounds and their hearing sensitivity; however there are no data on exposure or received levels that enable guideline numbers to be provided.
Recoverable injury – injuries, including hair cell damage, minor internal or external hematoma, etc. None of these injuries are likely to result in mortality.
TTS = temporary threshold shift

3.3.5.1.1.2 Non-auditory Injury Criteria for Explosives (Unexploded Ordnance)

NMFS has adopted criteria used by the U.S. Navy to assess the potential for non-auditory injury from underwater explosive sources as presented in U.S. Navy (2017). The criteria include thresholds for the following non-auditory effects: mortality, lung injury and gastrointestinal injury. Unlike auditory thresholds, these depend upon an animal's mass and depth. Table 3-33 provides mass estimates used in the assessment. For sea turtles, a harbor seal (*Phoca vitulina*) pup and adult masses are used as conservative surrogate values as outlined in U.S. Navy (2017). Table 3-5 and Table 3-6 in Section 3.2.6.2 present the equations used to calculate thresholds. For the BA, the more conservative 1% thresholds have been applied when determining the consequence of the effects and the number of sea turtles potentially exposed.

Single blast events within a 24-hour period are not presently considered by NMFS to produce behavioral effects if they are below the onset of TTS thresholds for frequency-weighted SEL ($L_{E,24h}$) and peak pressure levels. As only one charge detonation per day is planned for the Project, the effective disturbance threshold for single events in each 24-hour period is the TTS onset (Table 3-3).

Table 3-31 Representative Pup and Adult Mass Estimates Used for Assessing Impulse-based Onset of Lung Injury and Mortality Threshold Exceedance Distances

Impulse Animal Group	Representative Species	Pup Mass (kg)	Adult Mass (kg)
Sea Turtles	Harbor Seal (Phoca vitulina)	8	60

Source: Hannay and Zykov 2022
Note: These values are based on the smallest expected animals for the species that might be present within Project areas. Masses listed here are used for assessing impulse-based onset of lung injury and mortality threshold exceedance distances. kg = kilograms

3.3.5.1.1.3 Assessment of Effects

Impulsive Underwater Noise

Project-generated impulsive underwater noise includes impact pile driving associated with the installation of the WTGs and OSS, some HRG surveys, and the potential detonation of UXOs. Acoustic propagation modeling of impact pile driving and UXO detonations was undertaken by JASCO Applied Sciences to determine distances to PTS and disturbance thresholds for sea turtles (Hannay and Zykov 2022; Küsel et al. 2022).

Impact Pile Driving (C)

Noise from impact pile driving for the installation of WTGs and OSS foundations would occur intermittently during the installation of offshore structures. Table 3-22 summarizes the maximum exposure ranges to PTS and behavioral thresholds for the worst-case impact pile driving scenario for ESA-listed sea turtles.

Table 3-32 $ER_{95\%}$ (in meters) PTS Zones and Applicable Pre-clearance and Shutdown Zones to Be Applied during Impact Pile Driving (with 10 dB attenuation)

Hearing Group	Max PTS Zones – $ER_{95\%}$		Pre-clearance/Shutdown Zones (m)		Behavior zones – $ER_{95\%}$ (m)	
	Summer	Winter	Summer	Winter	Summer	Winter
Sea Turtles	300	440	500	500	1,060	1,260

Source: Küsel et al. 2022.
Notes: ER95% (exposure range) values represent the distance from the sound source that includes 95% of simulated sea turtles (e.g., animats) that would be exposed to noises above PTS and behavioral threshold. Worst-case scenario presented, included modeling of two monopiles per 24-hour period. Monopile foundation assumed tapered 8- to 11-meter-diameter piles. 50-meter penetration depth. 4,000 kJ hammer energy.
dB = decibels; $ER_{95\%}$ = 95th percentile exposure range; kJ = kilojoules; m = meters; max = maximum; PTS = permanent threshold shift

The Applicant-proposed mitigation to be applied for sea turtles during impact pile driving includes pre-clearance and shutdown zones (Table 1-11). As outlined in Table 3-34, the pre-clearance zones and shutdown zones cover the maximum PTS exposure ranges modeled for sea turtles. This 500-meter zone is expected to be able to be monitored effectively during daylight operations. Ocean Wind has also stated that pile driving during nighttime hours could occur when a pile installation is started during daylight and, due to unforeseen circumstances, would need to be finished after dark and that new piles could be initiated after dark to meet schedule requirements. Therefore, in addition to passive acoustic monitoring, the Applicant is proposing to use other visual monitoring techniques would be implemented during nighttime installation or during periods of daytime low visibility. These include thermal or infrared cameras, night vision devices, and infrared spotlight. The efficacy of these other monitoring devices is relatively unknown; however, in support of the request for nighttime piling, Ocean Wind conducted a marine mammal monitoring field demonstration project in spring 2022. Results of this study have yet to be released. However, one of the goals of the study was to demonstrate the efficacy of its nighttime monitoring methods. In response to this request and to support low-visibility monitoring during the daytime, BOEM will require Ocean Wind to develop an AMP for Pile Driving (BOEM proposed measure in Table 1-12, #21). The AMP should incorporate pertinent field demonstration results (e.g., based on Thayer-Mahan results) and prove the efficacy of the night vision devices proposed by Ocean Wind (e.g., mounted thermal/IR camera systems, hand-held or wearable NVDs, IR spotlights) in detecting protected marine mammal and turtle species to the full extent of the established shutdown and clearance zones as demonstrated during daytime operational monitoring. The plan will be reviewed and approved by NMFS and BOEM. If the efficacy of the technology is not proven through empirical evidence (i.e., the field demonstration project and other field evidence) and the AMP for Pile Driving, then nighttime impact pile driving would not occur, unless to finalize piles started during daylight hours. Specifically, no new piles could be initiated after dark if BOEM and NMFS do not approve the nighttime monitoring plan and the technology proposed. In addition, the Applicant is proposing that, if during nighttime pile driving, a PSO is unable to monitor the visual clearance or shutdown zones with available NVDs (due to light pollution from the platform) nighttime pile driving will not commence or will be halted (as safe to do so).

To limit effects to NARWs, pile installation would only occur from May 1 through December 31, during the time of year when sea turtles are present in the region in higher numbers (see Appendix A). As the pre-clearance and shutdown zones cover the maximum PTS zones modeled for sea turtles, the potential for PTS effects is reduced. In addition, the potential for behavioral effects would be mitigated based on the application of the 500-meter pre-clearance and shutdown zones. The number of individual sea turtles predicted to receive sound levels above PTS and behavioral exposure criteria with a 10 dB attenuation during impact pile-driving activities over the duration of the Proposed Action are shown in Table 3-33 and Table 3-34.

Table 3-33 WTG Monopile Foundations: Number of Sea Turtles Predicted to Receive Sound Levels above Exposure Criteria (with 10 dB Attenuation) for a Total of 98 Monopiles

Sea Turtle Species	PTS	Behavior
Kemp’s ridley turtle	<1	15
Leatherback turtle	<1	7
Loggerhead turtle	8	169
Green turtle	<1	<1

Source: Küsel et al. 2022.
Note: Worst-case scenario presented, included modeling of two monopiles per 24-hour period and the results for the $L_{E,24h}$ threshold. Monopile foundation assumed tapered 8- to 11-meter-diameter piles. 50-meter penetration depth. 4,000 kilojoule hammer energy. Exposure ranges were used to calculate values which incorporated animal movement modeling; however, no aversion behaviors (e.g., avoidance) or mitigation measures (e.g., shutdown zones) other than the 10 dB attenuation were incorporated into the calculations.
dB = decibels; $L_{E,24h}$ = cumulative sound exposure level; PTS = permanent threshold shift; WTG = wind turbine generator

Table 3-34 OSS Installation: Number of Sea Turtles Predicted to Receive Sound Levels above Exposure Criteria (with 10 dB Attenuation)

Sea Turtle Species	Option 1: Three Monopiles		Option 2: 48 Pin Piles	
	PTS	Behavior	PTS	Behavior
Kemp’s ridley turtle	<1	<1	0	<1
Leatherback turtle	<1	<1	0	<1
Loggerhead turtle	<1	6	0	15
Green turtle	<1	<1	0	<1

Source: Küsel et al. 2022
Note: Worst-case scenario presented, included modeling of two monopiles per 24-hour period and the results for the SEL_{cum} threshold. Monopile foundation assumed tapered 8- to 11-meter-diameter piles. 50-meter penetration depth. 4,000 kilojoule hammer energy. Exposure ranges were used to calculate values which incorporated animal movement modeling; however, no aversion behaviors (e.g., avoidance) or mitigation measures (e.g., shutdown zones) other than the 10 decibel attenuation were incorporated into the calculations.
dB = decibels; OSS = offshore substation; PTS = permanent threshold shift

Effects of Exposure to Noise Above the PTS Thresholds

PTS exposures are expected to be less than 1 for Kemp's ridley, leatherback, and green sea turtles for impact pile driving activities, thus the potential for PTS is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project impact pile driving leading to PTS **may affect, not likely to adversely affect** Kemp's ridley, leatherback, and green sea turtles.

Modeling indicates that up to eight individual loggerhead turtles may be exposed to underwater noise levels above PTS thresholds from impact pile driving noise. The potential for serious injury is minimized by the implementation of pre-clearance, shutdown zones, and ramp-ups for impact pile driving operations that would facilitate a delay of pile driving if turtles were observed approaching or within areas that could be ensonified above sound levels that could result in auditory injury. As mentioned above, these measures also make it unlikely that any ESA-listed turtle will be exposed to impact pile driving noise that would result in severe hearing impairment or serious injury and would more likely have the potential to result in slight PTS (i.e., minor degradation of hearing capabilities at some hearing thresholds). In addition, ramp-ups could be effective in deterring turtles from impact pile driving activities prior to exposure resulting in a serious injury. The potential for serious injury is also minimized by using a noise mitigation system during all impact pile driving operations. The proposed requirement that impact pile driving can only commence when the pre-clearance zones (Table 1-11) are fully visible to PSOs allows a high sea turtle detection capability, and enables a high rate of success in implementation of these zones to avoid serious injury. However, exposures leading to PTS are still possible. Therefore, the effects of noise exposure from Project impact pile driving leading to PTS **may affect, likely to adversely affect** loggerhead sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

Considering impact pile driving activities, up to 15 Kemp's ridley turtles, seven leatherback turtles, 184 loggerhead turtles, and less than one green turtle may be exposed to noise levels that exceed behavioral thresholds (Table 3-33 and Table 3-34).

Much of the knowledge of the behavioral reactions of sea turtles to underwater sounds has been derived from very few studies, in laboratory settings and in enclosed field environments. Behavioral reactions of sea turtles to impulsive sounds (e.g., seismic surveys) may include rising to the surface, altered swimming patterns, avoidance, and habituation (Lenhardt 1994; Moein et al. 1995; McCauley et al. 2000a, 2000b). The consequences of potential behavioral changes to sea turtle fitness are unknown.

Lenhardt (1994) demonstrated that avoidance reactions of sea turtles in captivity were elicited when the animals were exposed to low frequency tones. Moein et al. (1995) also conducted experiments on caged loggerhead sea turtles and monitored the behavior of the animals when exposed to seismic activities in the 175 to 179 dB re 1 μPa at 1 meter. Avoidance to the seismic source was observed at first exposure; however, the sea turtles eventually habituated to the sound over time. Avoidance was also demonstrated by O'Hara and Wilcox (1990), who found that sea turtles in a canal would avoid the area where seismic work was being conducted, although the received levels were not measured. Weir (2007) reported no obvious avoidance by sea turtles at the sea surface as recorded by ship-based observers to seismic sounds, although the observers noted that fewer sea turtles were observed at the surface when the air gun array was active versus when it was inactive. McCauley et al. (2000) studied the response of two captive (1 green and 1 loggerhead) turtles in a single cage to the noise of a single airgun in two trials. The turtles displayed increased swimming activity above SELs of 155 decibels relative to 1 micropascal squared second (dB re 1 re $\mu Pa^2 s$) and showed increasingly agitated swimming behavior above 164 dB re 1 re $\mu Pa^2 s$. It was postulated that the agitated swimming may have resulted in avoidance from the source if the animals had not been constrained by a cage (McCauley et al. 2000).

Popper et al. (2014) suggest that in response to impact pile driving activities, sea turtles have a high risk for behavioral disturbance and masking effects in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). The risk for TTS and other recoverable injuries were considered high in near field, and low in the intermediate and far field (Popper et al. 2014).

Modeling indicates that less than one green sea turtle would be exposed to noise levels exceeding behavioral thresholds, considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project impact pile driving leading to behavioral thresholds **may affect, not likely to adversely affect** green sea turtles.

Modeling indicates that up to 15 Kemp's ridley, seven leatherback, and 184 loggerhead sea turtles may be exposed to noise levels that exceed behavioral thresholds (Table 3-33 and Table 3-34). While the mitigation and monitoring measures and the animal's ability to avoid areas of loud construction noise are expected to decrease the potential exposure of these ESA-listed species to underwater noise above behavioral disturbance thresholds, the possibility still exists and cannot be discounted. Therefore, the effects of noise exposure from Project impact pile driving leading to behavioral disturbance **may affect, likely to adversely affect** Kemp's ridley, leatherback, and loggerhead sea turtles.

UXO Detonations (C)

As outlined above for marine mammals (Section 3.2.6.2), Ocean Wind may encounter UXOs on the seabed in the Lease Area and along export cable routes. While non-explosive methods may be employed to lift and move these objects, some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could kill, injure, or disturb sea turtles. Ocean Wind conducted modeling of acoustic fields for UXO detonations which is described in detail in Section 3.2.6.2). Ranges to auditory injury (PTS), non-auditory injury (mortality, slight lung injury and gastrointestinal injury) and the behavioral threshold were calculated based on the representative body mass of harbor seal pups as surrogates for sea turtles and used to determine the number of individuals potentially exposed. Table 3-35 summarizes the maximum ranges to PTS and behavioral thresholds per charge weight bin for sea turtles. Ranges to PTS thresholds were larger than ranges to mortality, slight lung injury and gastrointestinal injury criteria per charge eight bin. See Table 3-36 for charge size E12 (1,000 pounds [454 kg]) (Hannay and Zykov 2022). Therefore the pre-clearance zones for sea turtles were based on the ranges to PTS threshold.

Table 3-35 Maximum PTS Zones and Applicable Pre-clearance Zones (m) to Be Applied during UXO Detonations for Sea Turtles - Mitigated

Charge Size									
E4 (2.3 kg)		E6 (9.1 kg)		E8 (45.5 kg)		E10 (227 kg)		E12 (454 kg)	
PTS/Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone
<50	203	54	448	159	870	348	1,780	472	2,250

Source: Hannay and Zykov 2022
Notes: UXO charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). Four Project sites (S1-S4) were chosen and modeled for the detonation of each charge weight bin.
PTS zone represent maximum/largest $R_{95\%}$ values in meters calculated per charge size bin (e.g., E/kg). Pre-start clearance zones were calculated by selecting the largest distance to the PTS threshold. The chosen values were the most conservative per charge weight bin across each of the Four modeled sites.
kg = kilograms; E = equivalent; TNT = trinitrotoluene; m = meters; PTS = permanent threshold shift; $R_{95\%}$ = 95th percentile exposure range; UXO = unexploded ordinance

Table 3-36 Maximum UXO Ranges (meters) to Non-Auditory Injury Thresholds for Sea Turtles – Mitigated (10 dB Attenuation)

Injury Type	Adult	Pup
Mortality - Impulse (severe lung injury)	224	332
Injury - Impulse (slight lung injury)	429	607
Gastrointestinal Injury[a]	125	125

Notes: Maximum ranges are based on worst-case scenario modeling results: charge size E12 (454 kilograms), deepest water depth (45 meters).
[a] Based on 1% of animals exposed (mortality/lung injury) (Hannay and Zykov 2022).
dB = decibels; UXO = unexploded ordnance

The Applicant-proposed mitigation for UXO detonations include pre-clearance zones, restricting detonations to daylight hours and the use of a dual noise mitigation system for all detonations to achieve a 10 dB attenuation (Table 1-11). Ocean Wind has committed that enough vessels would be deployed to provide 100% temporal and spatial coverage of the pre-clearance zones and, if necessary, aerial surveys would be used to provide coverage. Table 3-37 outlines the number of ESA-listed turtles potentially exposed to sound sources above PTS, behavioral thresholds and non-auditory thresholds associated with UXO detonations. Calculations were conducted separate from the modeling exercise presented in Hannay and Zykov (2022). The calculations used the largest ranges to thresholds for the maximum charge weight (E12; 1,000 pound [454 kg]) scenario presented in Hannay and Zykov 2022 and the highest density months for each species outlined in Appendix A (summer for all species except leatherback turtle where fall densities were highest). As Ocean Wind is committing to a 10 dB attenuation for all detonations, the number of exposed sea turtles outlined in Table 3-37 are based on the mitigated ranges presented in Table 3-35 and Table 3-36.

Table 3-37 Total Number of ESA-Listed Sea Turtle Exposed to Sound Levels above PTS, Non-Auditory Mortality/Injury and Behavioral Thresholds for the Detonation of 10 UXOs – Mitigated (10 dB)

Sea Turtle Species	PTS	Mortality - Impulse (severe lung injury)	Injury - Impulse (slight lung injury)	Gastrointestinal Injury	Behavior
Kemp’s ridley turtle	0	0	0	0	<1 (0.47)
Leatherback turtle	0	0	0	0	<1 (0.39)
Loggerhead turtle	<1 (0.59)	<1 (0.29)	1 (0.97)	0	13 (13.38)
Green turtle	0	0	0	0	0

Source: Distances to thresholds taken from Hannay and Zykov (2022); densities compile from various sources outlined in Appendix A.

Note: Calculation used the largest ranges which were for sea turtle masses (using harbor seals pup as a surrogate as outlined in U.S. Navy [2017]) for the maximum charge weight (E12 [454 kg]) presented in Hannay and Zykov (2022) and the highest density months for each species outlined in Appendix A.
dB = decibels; ESA = Endangered Species Act; kg = kilograms; PTS = permanent threshold shift; UXO = unexploded ordnance

Effects of Exposure to Noise Above the PTS and Mortality/Slight Lung Injury/Gastrointestinal Injury Thresholds

Because direct studies of explosive impacts on sea turtles have not been conducted, the below discussion of injurious effects is based on studies of other animals, generally marine mammals. The generalizations that can be made about in-water explosive injuries to other species should be applicable to turtles, with consideration of the unique anatomy of turtles. For example, it is unknown if the sea turtle shells may afford it some protection from internal injury.

If an animal is exposed to an explosive blast underwater, the likelihood of injury depends on the charge size, the geometry of the exposure (distance to the charge, depth of the animal and the charge), and the size of the animal. In general, an animal would be less susceptible to injury near the water surface because the pressure wave reflected from the water surface would interfere with the direct path pressure wave, reducing positive pressure exposure. However, rapid under-pressure phase caused by the negative surface-reflected pressure wave above an underwater detonation may create a zone of cavitation that may contribute to potential injury. In general, blast injury susceptibility would increase with depth, until normal lung collapse (due to increasing hydrostatic pressure) and increasing ambient pressures again reduce susceptibility.

Primary blast injury is injury that results from the compression of a body exposed to a blast wave. This is usually observed as barotrauma of gas-containing structures (e.g., lung and gut) and structural damage to the auditory system (Greaves et al. 1943; Richmond et al. 1973; Office of the Surgeon General 1991). The lungs are typically the first site to show any damage, while the solid organs (e.g., liver, spleen, and kidney) are more resistant to blast injury (Clark and Ward 1943). Recoverable injuries would include slight lung injury, such as capillary interstitial bleeding, and contusions to the gastrointestinal tract. More severe injuries would significantly reduce fitness and likely cause death in the wild. Rupture of the lung may also introduce air into the vascular system, producing air emboli that can cause a stroke or heart attack by restricting oxygen delivery to critical organs. In this discussion, primary blast injury to auditory tissues is considered gross structural tissue injury distinct from noise-induced hearing loss.

Data on observed injuries to sea turtles from explosives is generally limited to animals found following explosive removal of offshore structures (Viada et al. 2008), which can attract sea turtles for feeding opportunities or shelter. Klima et al. (1988) observed a turtle mortality subsequent to an oil platform removal blast, although sufficient information was not available to determine the animal’s exposure. Klima et al. (1988) also placed small sea turtles (less than 15.4 pounds [7 kg]) at varying distances from piling detonations. Klima et al. (1988) also placed small sea turtles (less than 15.4 pounds [7 kg]) at varying distances from piling detonations. Some of the turtles were immediately knocked unconscious or exhibited vasodilation over the following weeks, but others at the same exposure distance exhibited no effects. Incidental impacts on sea turtles were documented for exposure to a single 1,200-pound (540 kg) underwater charge off Panama City, Florida, in 1981. The charge was detonated at mid-depth in water 120 feet (37 meters) deep. Although details are limited, the following were recorded: at a distance of 500 to 700 feet (150 to 200 meters), a 400-pound (180 kg) sea turtle was killed; at 1,200 feet (370 meters), a 200- to 300-pound (90 to 140 kg) sea turtle experienced “minor” injury; and at 2,000 feet (600 meters) a 200- to 300-pound (90 to 140 kg) sea turtle was not injured’(O’Keeffe and Young 1984).

In the unlikely event that UXO detonations are required, modeling indicates that <0.1 Kemp’s ridley sea turtles, leatherback sea turtles, or green sea turtles will be exposed to noises/blasts above PTS/mortality/slight lung injury/gastrointestinal injury thresholds. The potential for serious injury is minimized by the implementation of pre-clearance and shutdown zones that would facilitate a delay in detonations if sea turtles were observed approaching or within areas that could be ensonified above sound levels that could result in auditory and non-auditory injury. These measures also make it unlikely that any sea turtles will be exposed to UXO detonations that would result in mortality and slight lung injury as well as severe hearing impairment or serious injury and—if exposed —would more likely have the potential to result in slight PTS (i.e., minor degradation of hearing capabilities at some hearing thresholds). Furthermore, Ocean Wind has committed to the use of aircraft to monitor the clearance zone if needed. The potential for PTS/non-auditory injury is further minimized by the use of a dual noise-mitigation system during all UXO detonations. The proposed requirement that UXO detonations can only commence when the pre-clearance zones (Table 1-11) are fully visible to PSOs allows the potential for high turtle detection capability and enables a high rate of success in implementation of these zones to avoid serious injury. As the maximum zones for the mortality – impulse (severe lung injury) are relatively small (e.g., 1,056 feet [332 meters] for the largest charge weight) the ability for PSOs to detect sea turtles within this zone is considered high, thus the potential for PTS exposure to these sea turtle species is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project UXO detonations leading to PTS/mortality/slight lung injury/gastrointestinal injury **may affect, not likely to adversely affect** green, Kemp’s ridley, and leatherback sea turtles.

Modeling indicates that less than one individual loggerhead sea turtle may be exposed to underwater noise levels above PTS thresholds, less than one individual loggerhead sea turtle may be exposed– above mortality-impulse (severe lung injury) thresholds, and one individual loggerhead sea turtle may be exposed above injury-impulse (slight lung injury) thresholds from UXO detonations. As stated above, the modeling used to estimate potential exposures are based on a conservative approach under the assumption that the UXO could not be removed and had to be blown in place. While the scenario cannot be discounted, the likelihood of this scenario occurring is highly unlikely for the size charge that was modeled. Furthermore, the potential for serious injury would be minimized by the implementation of the mitigation and monitoring measures proposed (Table 1-11) that are expected to reduce the potential for serious injury to loggerhead sea turtles. Thus, the potential for exposure of sea turtles to UXO detonations leading to PTS and non-auditory injury (mortality and internal trauma) is extremely unlikely to occur and **discountable**. Therefore, the effects of blast exposure from Project UXO detonations leading to PTS and non-auditory injury (mortality and internal trauma) **may affect, not likely to adversely affect** loggerhead sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

Reaction of sea turtles to explosives is absent from the literature. U.S. Navy (2017) assumed that sea turtles are likely to exhibit no more than a brief startle response to any individual explosive. Avoidance of the area is only considered likely if the event includes multiple explosives events. Popper et al. (2014) suggest that in response to explosions, sea turtles have a high risk for behavioral disturbance in the near and intermediate fields (e.g., tens of meters and hundreds of meters respectively), and low risk in the far field (thousands of meters). The risk for TTS and other recoverable injuries were considered high in near and intermediate fields, and low in the far field (Popper et al. 2014).

Considering UXO detonations activities that modeled the largest explosive charge, estimates indicated that less than one Kemp’s ridley, less than one leatherback, and 13 loggerhead sea turtles may be exposed to noise levels that exceed behavioral thresholds (Table 3-33 and Table 3-34). No green turtle exposures are expected. As discussed, the highly unlikely occurrence of the event, and the mitigation measures in place to limit sea turtle exposures to UXO detonations are expected to reduce the potential effects on sea turtle behavior. Furthermore, the low number of potential UXOs identified in the Project area and Ocean Wind’s commitment to using a dual noise-mitigation system for all detonations would further reduce all potential underwater noise effects associated with UXO detonations.

Should an exposure occur, the potential effects would be brief (e.g., a single noise exposure and the sea turtle would divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project UXO detonations leading to behavioral disturbance **may affect, not likely to adversely affect** green, Kemp's ridley, and leatherback sea turtles.

Modeling suggests that 13 loggerhead sea turtles could be exposed to noise impacts from UXO exposure resulting in the potential for behavioral disturbance. If a detonation is required loggerhead sea turtles may be exposed to noise resulting in behavioral disturbance even with the application of mitigation measures and cannot be discounted. Therefore, the effects of noise exposure from Project UXO detonations leading to behavioral disturbance **may affect, likely to adversely affect** loggerhead sea turtles.

Non-impulsive Underwater Noise

Project-generated non-impulsive underwater noise activities are: vibratory pile driving associated with installation and removal of the cofferdam, some HRG surveys, vessel operations, aircraft operations, cable laying and trenching, dredging and WTG operations. Underwater noise modeling was conducted for HRG surveys and vibratory pile installation for marine mammals only and no modeling was conducted for vessel operations, aircraft operations, cable laying and trenching, dredging and WTG operations. Therefore, the discussion regarding potential effects to sea turtles is qualitative.

Vibratory Pile Driving (C)

Installation and removal of sheet piles would require the use of a vibratory hammer as described above under Section 3.2.6.2. A practical spreading loss model developed within the Greater Atlantic Regional Fisheries Office (GARFO) Acoustics Tool was used to estimate the extent of potential underwater noise effects from vibratory driving of sheet piles to fish thresholds. The model uses a Transmission Loss equation of TL = 15*log(R1/R0) and has been developed for open ocean environments (NOAA 2020). The tool provides proxy project information for vibratory pile driving project similar to the Proposed Action (Table 3-38). The resulting ranges to sea turtle behavioral thresholds are outlined in Table 3-39.

Table 3-38 Proxy Projects for Estimating Underwater Noise for Sea Turtles

Pile Type	Hammer Type	Water Depth (m)	Pile Size (inches)	Attenuation rate (dB/10m)	Estimated Peak Noise Level (dB L_{pk})	Estimated Pressure Level (dB L_{rms})	Estimated Single Strike Sound Exposure Level (dB $L_{E,24h}$)
AZ Steel Sheet	Vibratory	15	24	5	182	165	165

Source: NOAA 2020
Notes: Model was last updated September 14, 2020
dB = decibels; $L_{E,24h}$ = cumulative sound exposure level; L_{pk} = peak sound exposure level; L_{rms} = root mean squared sound pressure level; m = meters

Table 3-39 Estimated Distances to Sea Turtle Behavioral Thresholds

Type of Pile	Hammer Type	Distance (m) to Sea Turtle Behavioral Threshold 175 dB L_{rms}
24-inch AZ Steel Sheet	Vibratory	N/A

Source: NOAA 2020
dB = decibels; L_{rms} = root mean squared sound pressure level; m = meters; N/A = the threshold was not reached;

Effects of Exposure to Noise Above the PTS Thresholds

The GARFO Acoustics Tool does not consider non-impulsive thresholds for sea turtles. However, based on the model, the behavioral threshold for sea turtles will not be exceeded. With the added measures of the pre-clearance zones (e.g., 1,640 feet [500 meters]) and short duration of the activity (4-day period), The potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project vibratory pile driving leading to PTS **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

Based on the GARFO Acoustics Tool, the behavioral threshold for sea turtles will not be exceeded. With the added measures of the pre-clearance zones (e.g., 1,640 feet [500 meters]) and short duration of the activity (4-day period) the potential for behavioral exposure to these ESA-listed turtles is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project vibratory pile driving leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

<u>HRG Surveys (pre-C, C, O&M, D)</u>

Underwater noise modeling was conducted for marine mammals for the HRG surveys proposed for the Project (see Section 3.2.6.2). The largest PTS isopleth distance for HRG surveys for marine mammals was less than 6.5 feet (2 meters) for all ESA-listed marine mammal species and was 141 for behavioral effects (Table 3-19). Although underwater noise modeling was not conducted specifically for sea turtles for HRG surveys, it can be inferred that the PTS and behavioral zones would be smaller than those noted for marine mammals. This is because that even within their best hearing range, sea turtles have low sensitivity, with their lowest thresholds being almost 40 dB higher than those for MFCs and audiograms more similar to those of fishes without specialized auditory adaptations for higher-frequency hearing (Popper et al. 2014; U.S. Navy 2017).

The mitigation measures for HRG surveys include pre-clearance zones/shutdown zone of 328 feet (100 meters) for turtles as well as ramp-ups. Pre-start clearance surveys and ramp-ups would be conducted for non-impulsive, non-parametric sub-bottom profilers and impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kHz. Shutdowns would be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kHz.

Effects of Exposure to Noise Above the PTS Thresholds

The Applicant’s proposed mitigation for HRG surveys includes pre-clearance and shutdown zones, and ramp-up procedures (Table 1-11). Pre-clearance and shutdown zones for sea are 328 feet (100 meters) and would capture the PTS zone of influence. Monitoring of this zone for sea turtles is considered highly effective in mitigating PTS effects. With the application of Applicant-proposed mitigation, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project HRG surveys leading to PTS **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

As the source level assumed for HRG surveys (Table 3-18) could exceed the behavioral thresholds for sea turtles (e.g., 175 dB re 1 µPa) behavioral disturbance is considered possible. It is likely that the pre-clearance zone (e.g., 328 feet [100 meters]) would cover the behavioral disturbance zone of influence. In addition, the effects are transient and would dissipate as the vessel move away from the receiver (e.g., turtle). With the application of monitoring measures and the transient nature of the effect, the potential for behavioral exposure to ESA-listed turtles is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project HRG surveys leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

Vessel Noise (pre-C, C, O&M, D)

There are several types of vessels that would be required throughout the life of the Project. Table 1-4 and Table 1-5 outline the type of vessels that would be required for Project construction and operations as well as the maximum number of vessels required by vessel type. The size of these vessels range from 325 to 350 feet (99 to 107 meters) in length, from 60 to 100 feet (18 to 30 meters) in beam, and draft from 16 to 20 feet (5 to 6 meters). Source levels for large vessels range from 177 to 188 dB re 1 µPa-m L_{rms} with frequencies between less than 40 Hz and 100 Hz (McKenna et al. 2012). Smaller support vessels typically produce higher-frequency sound concentrated in the 1,000 to 5,000 Hz range, with source levels ranging from 150 to 180 dB re 1 µPa-m L_{rms} (Kipple 2002; Kipple and Gabriele 2003).

Effects of Exposure to Noise Above the PTS Thresholds

It is unlikely that received levels of underwater noise from vessel activities would exceed PTS thresholds for sea turtles, therefore, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project vessel operations leading to PTS **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

There is very little information regarding the behavioral responses of sea turtles to underwater noise. A recent study suggests that sea turtles may exhibit TTS effects even before they show any behavioral response (WHOI 2022). Hazel et al. 2007 demonstrated that sea turtles appear to respond behaviorally to vessels (avoidance behavior) at close range (approximately 32 feet [10 meters] or closer). Based on the source levels outlined above, the behavioral threshold for sea turtles is likely to be exceeded by Project vessels. Popper et al. (2014) suggest that in response to continuous shipping sounds, sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters).

Behavioral effects are considered possible but would be temporary with effects dissipating once the vessel or individual has left the area. With the implementation of vessel separation distances outlined in Table 1-11 (164 feet [50 meters] for sea turtles), potential behavioral effects are further reduced. In addition, the BOEM proposed measures to reduce vessel strikes on sea turtles which includes slowing to 4 knots (2 m/s) when sea turtle sighted within 328 feet (100 meters) of the forward path and avoiding transiting through areas of visible jellyfish aggregations or floating sargassum) will reduce the potential for behavioral disturbance effects. Based on the proposed mitigation measures, sea turtles are expected to have a low probability of exposure to underwater noises above behavioral thresholds from vessel operations. Should an exposure occur, the potential effects would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project vessel operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

Aircraft Noise (C, O&M, D)

Helicopter support would be required during several Project activities through construction, O&M, and decommissioning. The number of helicopter trips required for construction is provided in Table 1-5. Patenaude et al. (2002) showed that aircraft operations could result in temporary behavioral responses to marine mammals; however, similar studies on sea turtles is not available in the literature. Kuehne et al. (2020) demonstrated that underwater noise from large Boeing EA-18G Growler aircrafts and determined that sound signatures of aircraft at a depth of 98 feet (30 meters) below the sea surface had underwater noise levels of 134 (± 3) dB re 1 µPa L_{rms}. Noise from helicopters required for the Project are expected to be less than those generate by these larger aircrafts.

Popper et al. (2014) suggest that in response to continuous sounds (e.g., aircraft operations), sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). The potential risk for injury and TTS are considered low at all distances (Popper et al. 2014). BOEM expects that most aircraft operations would occur above 1,500 feet (457 meters) (NARW aircraft approach regulation) except under specific circumstances (e.g., helicopter landings on the service operation vessel or visual inspections of WTGs). Exposure of noises above PTS, TTS, and behavioral thresholds from Project aircrafts for all ESA-listed sea turtles is extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project aircraft activities leading to PTS/ behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

Cable Laying or Trenching Noise (C)

Cables would typically be laid, and post-lay burial would be performed using a jetting tool, if seabed conditions allow. Cables may remain on the seabed within the Wind Farm Area for up to 2 weeks. Possible installation methods for these options include jetting, vertical injection, controlled-flow excavation, trenching, and plowing. Boulder clearance would take place prior to construction to clear the cable corridor in preparation for trenching and burial operations. Noise generated by boulder clearance and controlled-flow excavation are discussed below under dredging.

The action of laying the cables on the seafloor itself is unlikely to generate high levels of underwater noise. Most of the noise energy would originate from the vessels themselves including propellor cavitation noise and noise generated by onboard thruster/stabilization systems and machinery (e.g., generators), including noise emitted by the tugs when moving the anchors.

There is limited information regarding underwater noise generated by cable-laying and burial activities in the literature. Johansson and Andersson (2012) recorded underwater noise levels generated during a comparable operation involving pipelaying and a fleet of nine vessels. Mean noise levels of 130.5 dB re 1 µPa were measured at 4,921 feet (1,500 meters) from the source. Reported noise levels generated during a jet trenching operation provided a source level estimate of 178 dB re 1 µPa-m (Nedwell et al. 2003).

Effects of Exposure to Noise Above the PTS Thresholds

Cable-laying noise sources associated with the Project were below the established PTS injury thresholds for all marine mammal hearing groups as outlined in Section 3.2.6.2 above. As turtles are less sensitive to underwater noise than marine mammals, it can be inferred that the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds from cable laying is extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project cable laying operations leading to PTS **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds and Masking

Cable-laying operations could exceed the disturbance threshold for sea turtles (175 dB re 1 µPa L_{rms}). As outlined above, there is very little information regarding the behavioral responses of sea turtles to underwater noise. Behavioral responses to vessel noise include avoidance behavior but only at very close range (32 feet [10 meters]; Hazel et al. 2007). Popper et al. (2014) suggests that in response to continuous sounds, sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). The potential risk for injury and TTS are considered low at all distances for continuous noise (Popper et al. 2014).

Behavioral effects are considered possible but would be temporary with effects dissipating once the activity has ceased or individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project cable-laying operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

Dredging Noise (C)

Dredging may be done in the Wind Farm Area and export cable corridors for sandwave clearance. Ocean Wind has indicated that sandwave clearance work could be undertaken by traditional dredging methods such as a mechanical clamshell dredge, as well as hydraulic trailing suction hopper or controlled-flow excavator. Dredging may be required at the HDD in-water exit pit at the Oyster Creek landfall site on the east side of Island Beach State Park and at the HDD in-water exit pit for the BL England site.

Dredging may also be required in the shallow areas of Barnegat Bay to allow vessel access for export cable installation. Locations include the prior channel (west side of Island Beach State Park/east side of Barnegat Bay), the west side of Barnegat Bay at the export cable landfall, and the Oyster Creek section of the federal channel in Barnegat Bay if USACE is unable to conduct dredging in this area as part of the federal channel dredging that is currently under contract.

Mechanical clamshell dredging refers to grabs used to remove seafloor material. Noise produced by mechanical dredges is emitted from winches and derrick movement, bucket contact with the substrate, digging into substrate, bucket closing, and emptying of material into a barge or scow (Dickerson et al. 2001). Reported sound levels of clamshell dredges include 176 dB re 1 µPa-m L_{rms} (BC MoTI 2016) and 107 to 124 dB re 1 µPa at 505 feet (154 meters) from the source with peak frequencies of 162.8 Hz (Dickerson et al. 2001; McQueen et al. 2019). Maximum levels occurred when the dredge bucket made contact with the channel bottom in mixed coarse sand or gravel (Dickerson et al. 2001; McQueen et al. 2019). Hydraulic trailing suction hopper dredging and controlled-flow excavation dredging involve the use of a suction to either remove sediment from the seabed or relocate sediment from a particular location on the seafloor. The sound produced by hydraulic dredging results from the combination of sounds generated by the impact and abrasion of the sediment passing through the draghead, suction pipe, and pump. The frequency of the sounds produced by hydraulic suction dredging ranges from approximately 1 to 2 kilohertz, with reported source levels of 172 to 190 dB re 1 µPa-m (Robinson et al. 2011; Todd et al. 2015; McQueen et al. 2019). Robinson et al. (2011) noted that the level of broadband noise generated by suction dredging is dependent on the aggregate type being extracted, with coarse gravel generating higher noise levels than sand.

Effects of Exposure to Noise Above the PTS Thresholds

Based on the available source level information presented above, dredging by mechanical or hydraulic dredges is unlikely to exceed turtle PTS (injury) thresholds for sea turtles. Exposure of noises above PTS, thresholds from Project dredging for all sea turtles is extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project dredging operations leading to PTS **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

If dredging occurs in one area for relatively long periods, behavioral thresholds are possible. As outlined above, there is very little information regarding the behavioral responses of sea turtles to underwater noise. Behavioral responses to vessel noise include avoidance behavior but only at very close range (32 feet [10 meters]; Hazel et al. 2007). Popper et al. (2014) suggest that in response to continuous sounds, sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). The potential risk for injury and TTS is considered low at all distances for continuous noise (Popper et al. 2014).

Behavioral effects are considered possible but would be temporary with effects dissipating once the activity has ceased or individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project dredging operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

WTG Operations (O&M)

Sound is generated by operating WTGs due to pressure differentials across the airfoils of moving turbine blades and from mechanical noise of bearings and the generator converting kinetic energy to electricity. Sound generated by the airfoils, like aircraft, is produced in the air and enters the water through the air-water interface. Mechanical noise associated with the operating WTG is transmitted into the water as vibration through the foundation and subsea cable. Both airfoil sound and mechanical vibration may result in long-term, continuous noise in the offshore environment. Measured underwater sound levels in the literature are limited to geared smaller wind turbines (less than 6.15 MW), as summarized by Tougaard et al. (2020). Underwater noise generated by these smaller-geared turbines is of a low frequency and at relatively low SPLs near the foundation, dissipating to ambient background levels within 0.6 miles (1 km) (Dow Piniak et al. 2012; Elliott et al. 2019; summarized in Tougaard et al. 2020). Tougaard et al. 2009 measured SPLs ranging between 109 and 127 dB re 1 µPa underwater 45 and 65 feet (14 and 20 meters) from the foundations at frequencies below 315 Hz up to 500 Hz. Wind turbine acoustic signals above ambient background noise were detected up to 2,066 feet (630 meters) from the source (Tougaard et al. 2009). Noise levels were shown to increase with higher wind speeds (Tougaard et al. 2009). Another study detected SPLs of 125 to 130 dB re 1 µPa up to 984 feet (300 meters) from operating turbines in frequencies between 875 and 1,500 Hz (Lindeboom et al. 2011). At 164 feet (50 meters) from a 3.6 MW monopile wind turbine, Pangerc et al. (2016) recorded maximum SPLs of 126 dB re 1 µPa with frequencies of 20 to 330 Hz, which also varied with wind speed. Kraus et al. (2016) measured ambient noise conditions at three locations adjacent to the proposed South Fork Wind Farm over a 3-year period and identified baseline levels of 102 to 110 dB re 1 µPa. They also found that maximum operational noise levels typically occurred at higher wind speeds when baseline noise levels are higher due to wave action.

Available data on large direct-drive turbines are sparse. Direct-drive turbine design eliminates the gears of a conventional wind turbine, which increases the speed at which the generator spins. Direct-drive generators are larger generators that produce the same amount of power at slower rotational speeds. Only one study of direct-drive turbines presented in Elliott et al. (2019) was available in the literature. The study measured SPLs of 114 to 121 dB re 1 µPa at 164 feet (50 meters) for a 6 MW direct-drive turbine.

Based on measurements from WTGs 6.15 MW and smaller, Stöber and Thomsen (2021) estimated that operational noise from larger (10 MW WTG), current-generation WTGs would generate higher source levels (177 dB re 1 μPa-m) than earlier research. Additionally, Stöber and Thomsen (2021) estimates that a shift from gear-driven wind turbines to direct drive turbines would decrease sound levels by 10 dB resulting in a range to the 120 dB re 1 µPa behavioral threshold of 1.4 km (0.9 miles). Using the least-squares fits from Tougaard et al. (2020), SPLs from 11.5 MW turbines (in 20 m/s, gale-force wind) would be expected to fall below the same behavioral threshold within 245 m (about 800 ft). In lighter, 10 m/s winds (~20 kts) the predicted range to threshold would be only 140 m (about 460 ft). Both models were based on small turbines and a small sample size, adding uncertainty to the modeling results. Stöber and Thomsen (2021) use only the loudest measurements from each study cited. While this is reasonable practice for most sound source studies, sound from an operating WTG can be expected to correlate with wind speed and therefore with higher environmental noise. Scaling the loudest sound measurements linearly with turbine power will scale environmental noise up along with it and can be expected to overestimate sound levels from larger turbines and is especially concerning as no correlation coefficient was provided to assess the goodness of fit. Tougaard et al. (2020) take wind speed into account for each of the measurements in their fit and scale the level with WTG power using a logarithmic measurement. Because of these factors, range estimates based on Tougaard et al. (2020) are considered more relevant to this assessment.

Effects of Exposure to Noise Above the PTS Thresholds

Based on the source levels presented above, it is unlikely that received levels of underwater noise from WTG operations would exceed PTS thresholds for sea turtles, therefore, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is **discountable**. The effects of noise exposure from Project WTG operations leading to PTS **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

Based on the available source levels and modeling information presented above, underwater noise from WTG operations could exceed behavioral thresholds and cause masking of communications. However, more acoustic research is warranted to characterize SLs originating from large direct-drive turbines, the potential for those turbines to cause TTS effects, and to what distance behavioral and masking effects are likely. Because of this BOEM has included a monitoring requirement that the Applicant conduct underwater noise monitoring during WTG operations, particularly during high wind events (Table 1-12). Popper et al. (2014) suggest that in response to continuous sounds, sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters).

Sea turtles may be exposed to noise levels that exceed behavioral thresholds during WTG operations, particularly during high wind events when ambient underwater noise levels are also elevated and behavioral reactions may include avoidance of the area (Hazel et al. 2007). However, given the interim definition for ESA harassment, the animals ability to avoid harmful noises, the potential for ESA-listed sea turtles to be exposed to underwater noise exceeding TTS or behavioral thresholds from WTG operations would not rise to the level of take under the ESA and is therefore considered **insignificant**. Therefore, the effects of noise exposure from Project WTG operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

3.3.5.1.1.4 Effects to Prey Organisms

The ESA-listed sea turtles outlined in this BA feed on a variety of prey items summarized in Table 3-40 including invertebrates like crabs, jellyfish, and mollusks and fish. As discussed above in Section 3.2.6.2, invertebrate sound sensitivity is restricted to particle motion, and affects are expected to dissipate rapidly such that any effects are highly localized from the noise source (Edmonds et al. 2016). This indicates that the invertebrate forage base for turtles is unlikely to be measurably affected by underwater noise resulting from the Project activities. Detonation of UXO, could temporarily reduce the abundance of invertebrates in proximity to the activity. However, in response to such an effect, turtles who feed on invertebrates would likely move to other foraging areas not affected by detonations.

Impact pile driving and UXO detonations may temporarily reduce the abundance of forage fish, eggs, and larvae in proximity to activity. Table 3-43 and Table 3-45 outline the potential distances in which physiological injury, recoverable injury, TTS and behavioral effects could occur to fish, eggs and larvae. However, impacts to these species is unlikely to result in an effect on the survival and fitness of sea turtles based on the minimal contribution of fish to their overall diet and the ability of turtles to adjust their diet to exploit other types of prey resources when available. The effects to turtles due to reduction in prey items from underwater noise generated by the Project would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, impacts from underwater noise sources due to the Proposed Action **may affect, not likely to adversely affect** prey organisms for ESA-listed sea turtles.

Table 3-40 Summary of Prey Items for ESA-listed Sea Turtles

ESA-Listed Turtles	Prey Items	Reference	Occurs in Project Area
N. A. DPS of Green Sea Turtles	Aquatic vegetation, invertebrates, including jellyfish, sponges, sea pens, and pelagic prey.	Heithaus et al. 2002; Seminoff et al. 2015	Y
Leatherback Sea Turtles	Feeding almost exclusively on jellyfish, siphonophores, and salps.	Eckert et al. 2012; NMFS and USFWS 2020	Y
NW. A. DPS of Loggerhead Sea Turtles	Mollusks, crabs, and sea pens.	Plotkin et al. 1993; Ruckdeschel and Shoop 1988; Burke et al. 1993; NMFS and USFWS 2008	Y
Kemp’s Ridley Sea Turtles	Crustaceans, mollusks, fish, jellyfish, and tunicates, crabs and aquatic vegetation.	Byles 1988; Carr and Caldwell 1956; Schmid 1998; NMFS et al. 2011	Y

DPS = distinct population segment; ESA = Endangered Species Act

3.3.5.2. Dredging Effects on Sea Turtles [C]

Impacts from dredging during construction, in addition to the noise discussed in Section 3.3.5.1, could affect ESA-listed sea turtles through impingement, entrainment, and capture associated with mechanical and hydraulic dredging techniques. As mentioned in Section 3.2.6.2, clamshell and suction dredging for the Project may occur both inshore and offshore within the Wind Farm Area and export cable corridors for sandwave clearance. Additionally, dredging may also be required in the HDD pits at landfall and in shallow areas of Barnegat Bay to allow vessel access for export cable installation. Approximately 18,000 yd^3 (13,762 m^3) of sediment would be removed from a 3.7-acre (0.01 km^2) area in order to maintain the Oyster Creek federal navigation channel to its authorized 200-foot width and 8-foot depth (61.0-meter width and 2.4-meter depth). However, since the environmental review for maintenance dredging to authorized depth and width is covered under the USACE federal permit as part of their Barnegat Inlet Federal Navigation Project, the effects of these actions are not considered in the following analysis.

Mechanical dredging would consist of lowering an open clamshell bucket through the water column and once the bucket contacts the seafloor, closing the bucket jaws to trap and scoop the sediment that is then brought to the surface. Hydraulic dredging uses dragheads that trail along the seafloor removing sediment.

The fact that a sea turtle would have to be directly below the clamshell bucket during dredging on the seafloor indicates that physical interactions between the mechanical dredge and sea turtles is extremely unlikely to occur. Further, the Project would employ controlled/continuous rate of descent and lift which would decrease the rate of speed and potential to surprise an unsuspecting sea turtle on the seafloor.

Sea turtles have been known to become entrained in trailing suction hopper dredge or trapped beneath the draghead as it moves across the seabed. Direct impacts, especially for entrainment, typically result in severe injury or mortality (Dickerson et al. 2004; USACE 2020). Sea turtles may be crushed during placement of the draghead on the seafloor, impinged if unable to escape the draghead suction and become stuck, or entrained if sucked through the draghead. Of the three direct impacts, entrainment most often results in mortality. About 69 projects have recorded sea turtle takes within channels in New Jersey, Delaware, and Virginia and there have likely been numerous other instances not officially recorded (Ramirez et al. 2017). However, the risk of interactions between hopper dredges and individual sea turtles is expected to be lower in the open ocean areas where dredging may occur compared to nearshore navigational channels where sea turtles are more concentrated in a constrained operating environment (Michel et al. 2013; USACE 2020). This may be due to the lower density of sea turtles in these areas (Sea Turtle Densities) as well as differences in behavior and other risk factors. Sea turtles are most often able to escape from the oncoming draghead of a hydraulic dredge due to the slow speed that the draghead advances (up to 3 miles per hour or 4.4 feet/second [1.4 m/s]; NMFS 2020). During swimming and surfacing, sea turtles are highly unlikely to interact with the draghead and are most vulnerable when foraging or resting on the seafloor. The potential capture of sea turtles in the dredging equipment could occur, but is more likely in channels and areas that otherwise have high densities of sea turtles. There are no known large aggregation areas or areas where turtles would be expected to spend large amounts of time stationary on the bottom where they could be entrained in a suction dredge.

Furthermore, the Project would employ PSOs on landfall dredges, inshore where sea turtles are known to be more vulnerable to dredging, further decreasing the risk of impingement or entrainment of sea turtles during suction dredging activities. Inshore dredging is proposed to span less than one month. Therefore, given the short duration of dredging where sea turtles are most vulnerable, PSOs, and available information, the risk of injury or mortality of individual sea turtles resulting from dredging necessary to support offshore wind Project construction would be low and population-level effects are unlikely to occur. Since there is a low risk of interactions with dredges and the mitigation and monitoring measures that will be implemented, the likelihood of a sea turtle becoming entrained in a dredge associated with the Proposed Action is considered extremely unlikely to occur and **discountable**. Therefore, the effects of entrainment from Project dredging leading to injury or mortality **may affect, not likely to adversely affect** ESA-listed turtles**.**

Dredging would increase turbidity and temporarily affect an overall very small area that may be used as foraging habitat by sea turtles. In areas such as the maintenance yard landfall, open cut trenching was chosen over HDD to avoid impacts to adjacent SAV beds. This method would limit the impacts to SAV to less than 1 acre (0.004 km^2) and make the likelihood of impacts to green sea turtle foraging from Project dredging activities so small it cannot be meaningfully measured, detected, or evaluated. Pelagic prey items are extremely unlikely to be affected due to the operation of both dredges on the seafloor, therefore leatherback sea turtle prey items are extremely unlikely to be affected (Table 3-40). The benthic organisms preyed upon by Kemp’s ridley and loggerhead sea turtles may survive entrainment and motile organisms, such as crabs, may avoid the dredge (Table 3-40). However, entrainment of crabs does occur (Reine et al. 1998) and we expect that most small benthic invertebrates in the path of the dredge would be entrained. Given the size of the area where dredging will occur and the short duration of dredging, the loss of benthic invertebrates will be small, temporary, and localized. Based on this analysis, we expect any impact of the loss of prey items to foraging for ESA-listed sea turtles due to dredging to be so small that they cannot be meaningfully measured, evaluated, or detected and considered **no effect**.

3.3.5.3. Habitat Disturbance Effects on Sea Turtles (C, O&M, D)

Effects from habitat disturbance to sea turtles are expected to be similar to the effects described for this stressor in marine mammals (Section 3.2.6.4). Habitat disturbance related to the Project would occur through all three phases of construction, O&M, and decommissioning. Potential effects to ESA-listed sea turtles and their prey from habitat disturbance are analyzed below and range from short- to long-term impacts. Individual stressors under habitat disturbance encompass displacement from physical disturbance of sediment; changes in oceanographic and hydrological conditions due to presence of structures; conversion of soft-bottom to hard-bottom habitat; concentration of prey species due to the reef effect; and secondary entanglement due to an increased presence of recreational fishing in response to the reef effect. These are discussed separately and organized by Project phase in the following paragraphs.

3.3.5.3.1 Displacement from Physical Disturbance of Sediment (C, D)

Construction effects to sea turtles from temporary physical disturbance of the seabed during offshore cable installation for the Project would be limited to short-term displacement of prey species residing on top of or within the top few feet of surface sediments particularly during the installation of the inter-array and offshore export cables. A total of 4,481 acres (18.1 km^2) is proposed for disturbance including boulder clearance along the inter-array, substation and export cables, and vessel anchoring (Table 1-3). Offshore export cable and inter-array cable installation is proposed to occur approximately from January 1, 2024, until March 31, 2025, spanning all seasons when ESA-listed sea turtles may be present in the Project area. Leatherback sea turtles are dietary specialists, feeding almost exclusively on pelagic jellyfish, salps, and siphonophores, which are unlikely to be affected by benthic habitat alteration (Table 3-40; NMFS and USFWS 2020). Adult green sea turtles primarily forage on seagrass and marine algae, but occasionally will consume marine invertebrates and juveniles (Table 3-40; Seminoff et al. 2015). Therefore, physical displacement of benthic prey items from offshore export and inter-array cable installation has greater potential to impact the loggerhead and Kemp's ridley sea turtles (Table 3-40). The restoration of marine soft-sediment habitats occurs through a range of physical (e.g., currents, wave action) and biological (e.g., bioturbation, tube building) processes (Dernie et al. 2003). Disturbed areas not replaced with hardened structures or scour protection (discussed later in this subsection) totaling 4,041.6 acres (16.4 km^2) would resettle and the benthic community returned to normal typically within 1 year (Dernie et al. 2003; Department for Business, Enterprise and Regulatory Reform 2008). The continental shelf off New Jersey is about 93 miles (150 km) wide and roughly 124 miles (200 km) long, yielding an area of approximately 7,413,161 acres (30,000 km^2) (Milliman 1972). Even in a worst-case scenario assuming that the reduction in the abundance of benthic infauna and epifauna in the Action Area is directly proportional to the amount of soft substrate disturbed, it would be expected to be an unmeasurable reduction in the benthic infauna and epifauna available for foraging for loggerhead sea turtles, Kemp's ridley sea turtles, and occasionally green sea turtles in the Action Area. Given this small, localized, short-term reduction in benthic infauna and epifauna are only one of the species groups the loggerhead sea turtles, Kemp's ridley sea turtles, and green sea turtles may feed on in the Action Area, any effects to these species are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

The offshore portion of the export cable is unlikely to cross any potential SAV as SAV growth is limited by water depth (light penetration) and wave/current energy (Long Island Sound Study 2003). Therefore, it is anticipated that any potential impacts to SAV may occur within inshore waters of the Project's offshore export cable corridor. However, SAV surveys have been conducted so impacts at the landfall locations can be avoided where practicable (Table 1-11). Cable emplacement activities would result in mortality, injury, or displacement of benthic fauna in the path of construction as well as possible damage to sensitive habitats such as SAV, which is present within the Oyster Creek export cable route (Figure 3-1). Under the Proposed Action, multiple landings on the western shore of Barnegat Bay and two export cable routes west of Island Beach State Park are under consideration for the Oyster Creek export cable route, with varying degrees of potential impacts on SAV. The seafloor could be disturbed by cable trenches, dredging (if required), anchoring, and cable protection. These activities may disturb a total of 20 acres (0.1 km^2) of SAV within the 61,440-acre (249 km^2) Barnegat Bay. Seagrasses have varying abilities to withstand at least small changes in their environment; therefore, short-term light reductions or thin smothering from dredging should have only short-term effects (Todd et al. 2015). Wisehart et al. (2007) demonstrated that eelgrass density and seedling recruitment 5 months following disturbance was also higher in dredged aquaculture beds than areas with longline aquaculture beds. Anchor placement and retrieval could cause short-term to permanent impacts to SAV beds in the Project area.

While anchor placement and chain sweep may damage seagrass blades, which could recover in the short term, anchor drag and retrieval are likely to damage or uproot seagrass rhizomes, which may take years to recover (Orth et al. 2017), resulting in long-term to permanent impacts to SAV. Neither leatherback sea turtles for their prey rely on SAV habitat (Table 3-40. However, SAV does provide important nursery habitat for Kemp's ridley, loggerhead, and green sea turtle prey and is a rich foraging ground for green sea turtles of the North Atlantic DPS and Kemp's ridley sea turtles. Both green and Kemp's ridley sea turtles are uncommon in New Jersey (NJDEP 2010). Loggerheads prey on the abundant shellfish found in SAV, especially horseshoe crabs and blue crabs (Table 3-40. The Project has committed to mitigation measures to minimize effects on SAV during construction (Table 1-11), including the use of BMPs to minimize seabed disturbance and sediment dispersion. However, it is unclear what the specific BMPs are and, therefore, this assessment cannot assume they would be effective. Additionally, the SAV growing season, when seagrasses are at their most vulnerable, is May through October in New Jersey (Colarusso and Verkade 2016). Landfall cable installation for the Project is proposed to occur from September 2023 to May 2024 and the offshore export cable installation is proposed to occur from January 2024 through October 2024, throughout the entire 2024 SAV growing season. In most locations, the affected areas are expected to recover naturally, and impacts would be short term because seabed scars associated with jet plow cable installation are expected to recover in a matter of weeks, allowing for rapid recolonization (MMS 2009). An additional Applicant-proposed mitigation measure is to avoid SAV where practicable and restore any damage if avoidance is not practicable (Table 1-11). However, once affected, SAV can be difficult to replace and such efforts are often deemed unsuccessful (Lefcheck et al. 2019). Abundant similar habitat and prey would be found in the adjacent areas, resulting in fewer impacts on Kemp's ridley, loggerhead, and green sea turtles. Given this small, localized reduction in SAV, any effects to ESA-listed sea turtles and their prey are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

3.3.5.3.2 Changes in Oceanographic and Hydrological Conditions due to Presence of Structures (O&M)

A detailed description of the potential long-term, O&M effects of the presence of structures on oceanic conditions is presented in Section 3.2.6.4. While green sea turtles, loggerhead sea turtles, and Kemp's ridley sea turtles consume prey not as closely affected by physical oceanographic features such as currents and upwelling, leatherback sea turtles consume planktonic prey not able to move independently of normal ocean currents (Table 3-40. The hydrologic alterations within a smaller wind installation were anticipated to result in an increase in or aggregation of leatherback sea turtle prey, but the effect was deemed likely to be so small that it cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant** (NMFS 2021a).

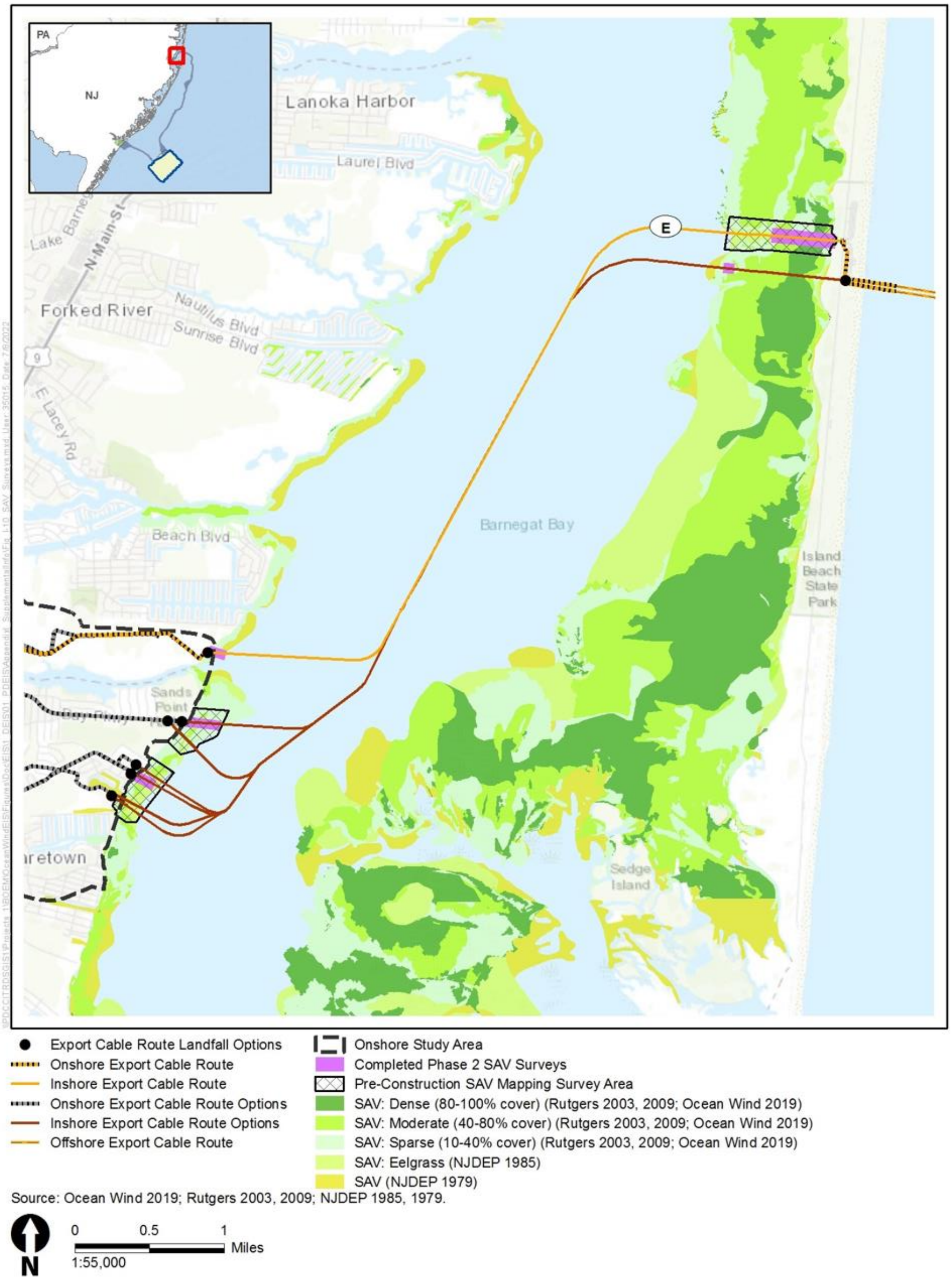

Figure 3-1 Map of Ocean Wind 1 Inshore Export Cable Route Options and Historical and Recent SAV Survey Mapping

3.3.5.3.3 Conversion of Soft-bottom Habitat to Hard-bottom Habitat (O&M)

Long-term O&M effects to ESA-listed sea turtles and their prey species from the loss of soft-bottom habitat and conversion of soft-bottom habitat to hard-bottom habitat may occur if this habitat shift resulted in changes in use of the area by listed species or in the availability, abundance, or distribution of forage species. The proposed installation of up to 101 WTG and OSS foundations would remain until decommissioning and constitute long-term obstacles in the water column that could alter the normal behavior and distribution of aquatic organisms in the Wind Farm Area. Up to 98 turbines and three substations are proposed for installation. The below surface parameters of the tubular WTG foundations are 37 feet (11 meters) in diameter at the seafloor and taper to 27 feet (8 meters) in diameter at the sea surface (Figure 1-3). The maximum case for conversion from soft to hardened substrate through scour protection for the Project is 439.4 acres (1.8 km^2; Table 1-2). Though this conversion would result in a loss of habitat for juvenile green sea turtles, and adult loggerhead and Kemp's ridley sea turtles, the loss is expected to be so small that it cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

3.3.5.3.4 Concentration of Prey Species due to the Reef Effect (O&M, D)

Another long-term O&M effect created by hardened structures is the reef effect. Foundations and cable armoring form are the biological hotspots that support species range shifts and expansions and changes in biological community structure resulting from a changing climate (Raoux et al. 2017; Methratta and Dardick 2019; Degraer et al. 2020). Around the base of the monopiles, colonizing organisms on the surface of the pile would likely enhance food availability and food web complexity through an accumulation of organic matter (Degraer et al. 2020; Mavraki et al. 2020). The accumulation could lead to an increased importance of the detritus-based food web but is unlikely to result in significant broad scale changes to the local trophic structure (Raoux et al. 2017). The available information suggests that the prey base for Kemp's ridley and loggerhead sea turtles may increase in the Action Area due to the reef effect of the WTGs and associated scour protection and an increase in crustaceans and other forage species (Table 3-40). However, given the small size of the area affected and any potential resulting increase in available forage, the Project would contribute a noticeable increment to the combined impacts on sea turtles. No effects to the forage base of adult green sea turtles are anticipated as no effects on marine vegetation are anticipated. Also based on the available information, there may be an increase in abundance of gelatinous organisms that leatherback sea turtles prey on but that this increase will be so small that the effects to leatherback sea turtles cannot be meaningfully measured, evaluated or detected and therefore **insignificant**.

3.3.5.3.5 Summary of Habitat Disturbance Effects

Given the limited amount of foraging habitat exposed to habitat disturbance, the temporary and localized nature of construction effects, the ability of turtles to adjust their diet in response to resource availability, the effects of habitat disturbance on turtle habitat availability and prey availability is expected to be so small they cannot be meaningfully measured, evaluated or detected and are therefore **insignificant**. Therefore, the effects of habitat disturbance from the Project construction and presence of structures leading to reductions in turtle habitat availability and prey availability **may affect, not likely to adversely affect** ESA-listed turtles**.**

3.3.5.4. Secondary Entanglement due to an Increased Presence of Recreational Fishing in Response to Reef Effect (O&M)

Another long-term impact of the presence of structures during O&M is the potential to concentrate recreational fishing around foundations, potentially increasing the risk of sea turtle entanglement in both vertical and horizontal fishing lines and increasing the risk of injury and mortality due to infection, starvation, or drowning. A majority of the recreational and commercial prime fishing areas and fishing activity occurs outside of the Project area (DNV-GL 2021). If there is an increase in recreational fishing in the Project area, it is likely that this will represent a shift in fishing effort from areas outside the wind farm area to within the wind farm area and/or an increase in overall effort. These structures could also result in fishing vessel displacement or gear shift. The potential impact on sea turtles from these changes is uncertain. However, if a shift from mobile gear (trolling) to fixed gear (hook and line) occurs due to inability of the fishermen to maneuver mobile gear, there would be a potential increase in the number of vertical lines, resulting in an increased risk of sea turtle interactions with fishing gear. Given vessel safety concerns regarding being too close to foundations and other vessels, the likelihood of recreational fishermen aggregating around the same turbine foundation at the same time is low. Due to foraging strategies, leatherback and loggerhead sea turtles are more likely to be exposed to recreational fishing lines in the pelagic WTG area (Table 3-40). Conversely, Kemp’s ridley and green sea turtles are less likely to be exposed to recreational fishing lines in the pelagic WTG area (Table 3-40).

Thus, exposure of Kemp’s ridley and green sea turtles to entanglement in fishing gear around WTGs is **discountable.** Therefore, potential entanglement due to increased presence of recreational fishing gear associated with WTGs during operations **may affect, not likely to adversely affect** Kemp’s ridley and green sea turtles.

Based on available information, secondary entanglement due to an increased presence of recreational fishing around the WTGs is possible and cannot be discounted for leatherback or loggerhead sea turtles. Therefore, the potential entanglement due to increased presence of recreational fishing gear associated with WTGs during operations **may affect**, **likely to adversely affect** leatherback and loggerhead sea turtles.

3.3.5.5. Turbidity Effects on Sea Turtles (C & D)

Physical or lethal effects are unlikely to occur because sea turtles are air-breathing and land-brooding, and therefore do not share the physiological sensitivities of susceptible organisms like fish and invertebrates. Sea turtles may alter their behavior in response to elevated TSS levels (e.g., moving away from an affected area). They may also experience behavioral stressors, like reduced ability to forage and avoid predators. However, sea turtles are migratory species that forage over wide areas and would likely be able to avoid short-term TSS impacts that are limited in severity and extent without consequence. Additionally, APMs to minimize and reduce the potential for adverse effects from water quality changes on sea turtles resulting from the Project have been proposed (COP Vol II, Table 1.1-2; Ocean Wind 2022).

Moreover, many sea turtle species routinely forage in nearshore and estuarine environments with periodically high natural turbidity levels. Therefore, short-term exposure to elevated TSS levels is unlikely to measurably inhibit foraging (Michel et al. 2013). However, elevated levels of turbidity may negatively affect sea turtle forage items, including benthic mollusks, crustaceans, sponges, and sea pens by clogging respiratory apparatuses. The more mobile prey items like crabs may also be negatively affected by turbidity by clogging their gills, but likely to a lesser extent due to their ability to leave the turbid area (BOEM 2021a).

In Barnegat Bay and Great Egg Harbor Bay, where sediments are predominantly fine grain, potential temporary impacts due to resuspension of sediments may occur. Seafloor affected by dredging prior to cable installation would result in turbidity effects that have the potential to have temporary impacts on some sea turtle foraging habitat, including about 20 acres (0.08 km^2) of SAV in proximity to Island Beach State Park, Sabol et al. (2005) documented the impacts of dredging to SAV and found the distribution of eelgrass to be highly variable based on season and year. This suggests that potential impacts to SAV habitat are short-term and localized. Any effects from increased turbidity levels from construction activities on turtles, their habitat or their prey would be isolated and temporary and are so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of increased turbidity levels from Project construction activities **may affect, not likely to adversely affect** ESA-listed turtles.

3.3.5.6. Vessel Traffic Effects on Sea Turtles (pre-C, C, O&M, D)

Vessel traffic for the Project would occur during pre-construction, construction, O&M, and decommissioning phases. Based on information provided by Ocean Wind, construction activities would require several types of vessels transiting between the various ports and the Project area, totaling an estimated 2,859 vessel trips over the 20-month construction period, or approximately 143 trips per month (Table 1-6; Ocean Wind 2022). The construction vessels that would be used for Project construction are described Table 1-4 and the maximum number of vessels required by vessel type is shown in Table 1-5 and Table 1-4. Vessel parameters of those used for O&M are listed in Table 1-7 and trips details of O&M vessel types as well as their approximate drafts are detailed in Table 1-8. Vessels used for decommissioning would be similar to those used in construction. Construction vessels would travel between the Wind Farm Area and the following ports that are expected to be used during construction: Atlantic City, New Jersey, as a construction management base; Paulsboro, New Jersey, or from Europe directly for foundation fabrication and load out; Norfolk, Virginia, or Hope Creek, New Jersey, for WTG pre-assembly and load out; and Port Elizabeth, New Jersey, or Charleston, South Carolina, or directly from Europe for cable staging. All O&M transits would occur from Atlantic City, New Jersey, to the Project area. Construction would generate between 20 and 65 vessels operating in the Wind Farm Area or over the offshore export cable route at any given time (Table 1-5).

Vessel interactions are a significant source of sea turtle injury and mortality and injury, via trauma and propeller wounds. Fifty to 500 loggerhead sea turtles and five to 50 Kemp’s ridley sea turtles are estimated to be killed by vessel traffic per year in the United States (NRC 1990). This report is dated and also indicates that this estimate is highly uncertain and could be a large overestimate or underestimate. The Recovery Plan for loggerhead sea turtles (NMFS and USFWS 2008) notes that, from 1997 to 2005, 14.9% of all stranded loggerheads in the U.S. Atlantic and Gulf of Mexico were documented as having some type of propeller or collision injuries although it is not known what proportion of these injuries occurred before or after the turtle died. Therefore, increased vessel traffic associated with the proposed action may increase the potential for impacts from vessel strikes.

The regions of greatest risk to sea turtles from vessel strike are outside the Action Area and include areas with high concentrations of recreational-boat traffic (e.g., eastern Florida coast, Florida Keys, and the shallow coastal bays in the Gulf of Mexico) (NRC 1990). In general, the risk of strike for sea turtles is considered to be greatest in areas with high densities of sea turtles and small, fast-moving vessels such as recreational vessels or speed boats (NRC 1990). The lack of nesting beaches in the project area where vessels may be close to shore makes this factor irrelevant for this analysis, with the exception of boats transiting from Charleston, South Carolina. However, these would be large, slow moving cargo vessels that will be operating offshore where sea turtles are more dispersed. Also, due to the small number of proposed vessel transits in otherwise heavily trafficked waters, Project vessel transiting south of the Project Area will not result in a measurable increase risk to sea turtles.

It is possible that some vessels will transit from Europe, although the number and port locations are unknown. These vessels will be specialized construction vessels and cargo vessels that may travel up to around 12 knots (6.1 m/s). They would represent an extremely small portion of the vessel traffic to and from ports in western Europe along the Atlantic coast. It is extremely unlikely that any sea turtles would occur along the vessel transit route at the same time one of these project vessels moving through the area due to the dispersed nature of sea turtles in the open ocean and the intermittent presence of such vessels. Together, these factors make it extremely unlikely that any sea turtle would be struck by a Project vessel transiting from Europe.

As discussed in Section 3.2.6.7 for marine mammals, several factors contribute to the probability of vessel strikes, including the sea turtle density, time of year, sea turtle submergence rates, vessel type and speed, vessel trip numbers, and vessel trip distances. While not available for this analysis, a risk model was developed by BOEM (2021) for assessing strike risk associated with offshore wind development, which incorporates information from databases and reports to obtain sea turtle density, distribution, and swim depth data. Information about sea turtle density considerations are discussed in the next paragraph. Sea turtles, with the exception of hatchlings and pre-recruitment juveniles, spend a majority of their time submerged, during which time they may not be susceptible to vessel strikes. Sea turtles spend at least 20 to 30 percent of their time at the ocean surface (Lutcavage et al. 1997) during which they would be vulnerable to being struck by vessels or struck by vessel propellers. However, with the exception of leatherbacks, sea turtles prefer to stay within the first few meters of the water's surface. Information on swim depth are provided in the U.S. Navy Undersea Warfare Center's dive distribution and group size parameter reports (Watwood and Buonantony 2012; Borcuk et al. 2017); these data suggest that loggerhead and green sea turtles spend 60% to 75% of the time within 32 feet (10 meters) of the surface; leatherback sea turtles spend about 20% of the time within 32 feet (10 meters) of the water surface, and there is insufficient data to quantify Kemp's ridley sea turtle activity. Any sea turtle found in the Action Area could thus occur at or near the surface, whether resting, feeding or periodically surfacing to breathe.

Sea turtle density estimates are provided by the results from New York State Energy Research and Development Authority's (NYSERDA) surveys across the New York offshore planning area by Normandeau Associates and APEM (2018a, 2018b, 2019a, 2019b, 2020). These density estimates are provided in Appendix A. The estimated leatherback sea turtle density is highest during the fall, at 0.789 turtle per 38.6 mi^2 (100 km^2; Table A-3), which translates to approximately three leatherback sea turtles within the 68,450-acre Wind Farm Area. Another density estimate is available from the U.S. Navy Operating Area Density Estimates (NODE) for the Atlantic Ocean (U.S. Navy 2007), available through the Duke University SERDP SDSS Marine Animal Model Mapper. This NODE data indicates that the leatherback sea turtle density in the Project vicinity during fall ranges from 2.675 to 3.745 turtles per 38.6 mi^2 (100 km^2), which translates to higher density estimate of approximately 7 to 11 leatherback sea turtles within the Wind Farm Area at a given time. For loggerhead sea turtles, based on the NYSERDA surveys, the estimated density in the Project vicinity is greatest during summer at 26.779 turtles per 38.6 mi^2 (100 km^2; Table A-3); this equates to approximately 74 loggerhead sea turtles within the Wind Farm Area at a given time. The NODEs data estimates a lower summer density of loggerhead sea turtles, ranging from 3.61 to 7.95 turtles per 38.6 mi^2 (100 km^2), which equates to approximately 10 to 22 loggerhead sea turtles within the Wind Farm Area at a given time. For Kemp's ridley sea turtles, the estimated density based on the NYSERDA surveys was greatest during the summer, at 0.99 turtles per 38.6 mi^2 (100 km^2; Table A-3), which equates to approximately 3 Kemp's ridley sea turtles within the Wind Farm Area at a given time. The NODE data indicates that the summer density of Kemp's ridley sea turtles in the Project vicinity during ranges from 0 to 0.02 turtles per 38.6 mi^2 (100 km^2), which equates to approximately 0 to 1 Kemp's ridley sea turtle within the Wind Farm Area at a given time. Lastly, green sea turtle density estimates based on NYSERDA surveys were greatest during the summer, at 0.38 turtle per 38.6 mi^2 (100 km^2; Table A-3), which equates to less than one turtle within the Wind Farm Area at a given time. However, the NODEs data modeled estimates that the density of green sea turtles in the Project vicinity during summer ranges from 0 to 2.34 turtles per 38.6 mi^2 (100 km^2), which translates to approximately 0 to 6 green sea turtles within the Wind Farm Area at a given time. Sea turtle densities in the Action Area are mainly driven by forage availability and measures to avoid transiting through areas of visible jellyfish aggregations or floating sargassum lines or mats would effectively reduce collision risk.

Vessels traveling at higher speeds pose a higher risk to sea turtles. Relative to marine mammals, as discussed above in Section 3.2.6.7, sea turtles require more stringent speed reductions before lethal injury probabilities are reduced. To reduce the risk of lethal injury to loggerhead sea turtles from vessel strikes by 50%, Sapp (2010) found that small vessels (10 to 30 feet [3 to 6 meters] in length) had to slow down to approximately 7.5 knots (3.9 m/s); the probability of lethal injury decreased by 60% for vessels idling at 4 knots (2.1 m/s). The most informative study of the relationship between ship speed and collision risk was conducted on green sea turtles (Hazel et al. 2007). Green sea turtles often failed to flee approaching vessels. Hazel et al. (2007) concluded that green sea turtles rarely fled when encountering fast vessels (>10 knots [5.1 m/s]), infrequently fled when encountering vessels at moderate speeds of around 6 knots (3.1 m/s), and frequently fled when encountering vessels at slow speeds of approximately 2 knots (1 m/s). Based on the observed responses of green sea turtles to approaching boats, Hazel et al. (2007) further concluded that sea turtles rely primarily on vision rather than hearing to avoid vessels; although both may play a role in eliciting responses, sea turtles may habituate to vessel sound and be more likely to respond to the sight of a vessel rather than the sound of a vessel. The potential for collisions between vessels and sea turtles thus increases at night and during inclement weather. Based on these findings, vessel speed restrictions may be inconsequential to reducing strike risk at anything but the slowest speeds (< 2 knots [1 m/s]) due to the relatively low rate of flee responses of sea turtles.

Increased vessel traffic associated with construction and installation will be relatively short-term and localized and is anticipated to represent a minor addition to normal traffic in the area from commercial shipping, personal recreational vessels, passenger vessels, military vessels, and commercial/recreational fishing vessels. As detailed in Section 3.2.6.7, over 80% of the vessels and vessel trips would transit between the WDA and Atlantic City, New Jersey (Table 3-24). For this transit, vessels would traverse waters with sea turtle densities similar to those described above, with the highest approximate density being estimated for loggerhead sea turtles at around 0.15 turtle per mi^2 (2.59 km^2). At this relatively low density, vessel collisions would be statistically unlikely. Vessels transiting from Norfolk and Charleston could potentially traverse waters where sea turtle abundance may be almost 3 times higher, at densities up to around 0.42 loggerhead sea turtles per mi^2 (2.59 km^2). Within these potential vessel transit corridors, the highest densities of sea turtles are predicted to occur for loggerheads near the mouth of the Chesapeake Bay, approximately 20 to 30 miles (32 to 48 km) offshore (U.S. Navy 2007). Based on the density of sea turtles and a maximum of 2,859 vessel trips over 2 years during construction and installation, considered relative to existing vessel traffic, there is a low risk of vessel collision with a sea turtle due to Project vessel traffic (Figure 3-2).

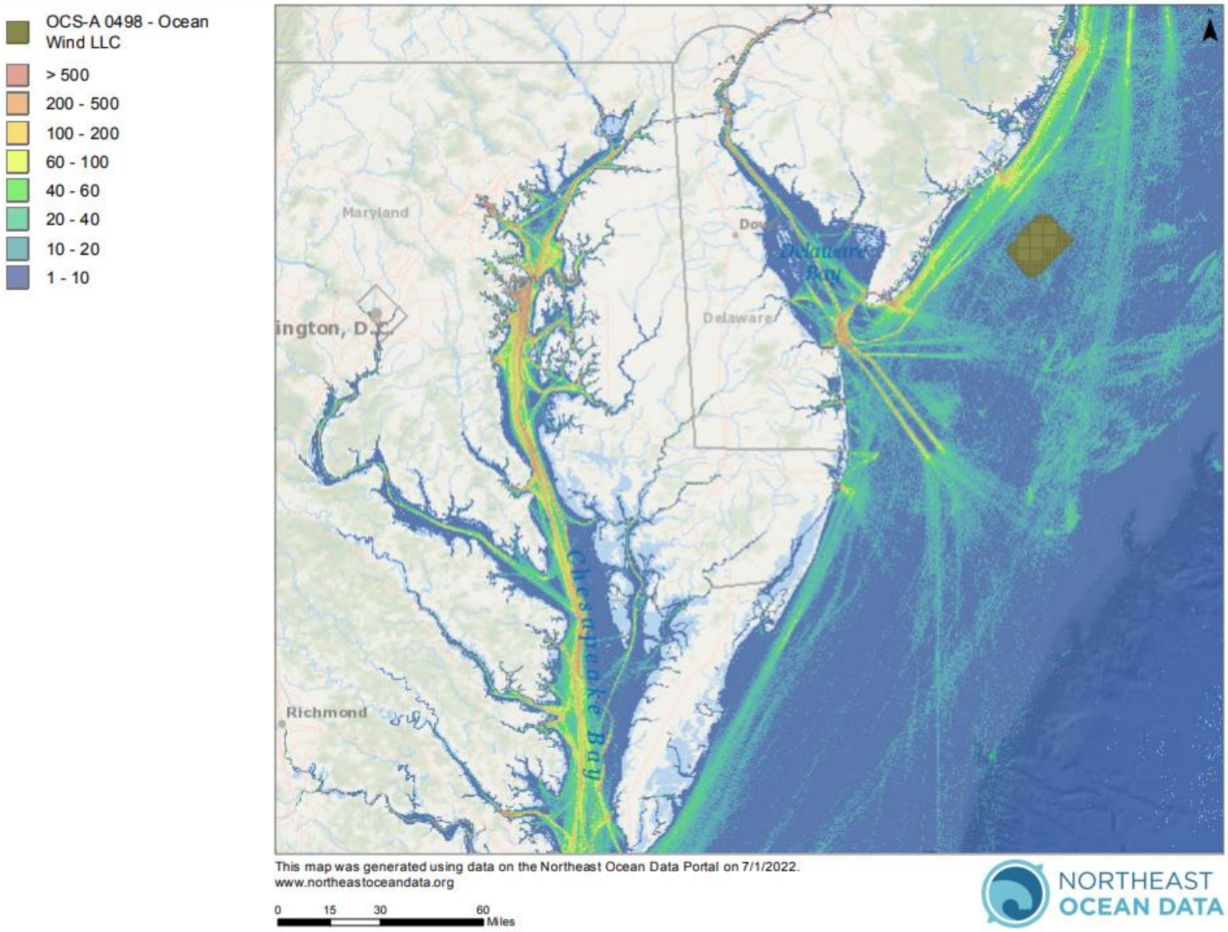

Figure 3-2 Map of All 2021 Vessel Traffic in the Project Area

There are limited measures that have been proven to be effective at reducing collisions between sea turtles and vessels (Schoeman et al. 2020). Also, the relatively small size of turtles and the significant time spent below the surface makes their observation by vessel operators extremely difficult. Nevertheless, the use of PSOs and other measures detailed in Table 1-12 under “Look out for sea turtles and reporting” would serve to reduce potential collisions. For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, Ocean Wind would have a trained lookout posted on all vessel transits during all phases of the project to observe for sea turtles. For all vessels operating south of the Virginia/North Carolina border, where sea turtles are present year-round, Ocean Wind would have a trained lookout posted year-round on all vessel transits during all phases of the project to observe for sea turtles. The trained lookout would monitor https://seaturtlesightings.org/ prior to each trip and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators/captains and lookouts on duty that day. The trained lookout would maintain a vigilant watch and monitor a Vessel Strike Avoidance Zone (1,640 feet [500 meters]) at all times to maintain minimum separation distances from ESA-listed species. Alternative monitoring technology (e.g., night vision, thermal cameras, etc.) would be available to ensure effective watch at night and in any other low visibility conditions. If a sea turtle is sighted within 328 feet (100 meters) or less of the operating vessel’s forward path, the vessel operator would slow down to 4 knots (2 m/s) (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 knots (2 m/s) or less until there is a separation distance of at least 328 feet (100 meters) at which time the vessel may resume normal operations. If a sea turtle is sighted within 164 feet (50 meters) of the forward path of the operating vessel, the vessel operator would shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots (2 m/s). The vessel may resume normal operations once it has passed the turtle. Also, sea turtle collisions would be reduced because vessel operators would avoid transiting through areas of visible jellyfish aggregations or floating sargassum lines or mats. In the event that operational safety prevents avoidance of such areas, vessels would slow to 4 knots (2 m/s) while transiting through such areas. All vessel crew members would be briefed in the identification of sea turtles and in regulations and best practices for avoiding vessel collisions. Reference materials would be available aboard all project vessels for identification of sea turtles. The expectation and process for reporting of sea turtles (including live, entangled, and dead individuals) would be clearly communicated and posted in highly visible locations aboard all project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to do so.

Although the 10-knot (5.1 m/s) speed restrictions in certain areas would reduce potential impacts, sea turtle collisions may still occur at slow speeds. Therefore, BOEM has proposed reporting requirements to document the amount or extent of sea turtle take that occurs during all phases of the Proposed Action. During the construction phase and for the first year of operations, monthly reports would detail all project activities carried out in the previous month, including vessel transits (number, type of vessel, and route), and piles installed, and all observations of ESA-listed species. Beginning in year 2 of operations, Ocean Wind would compile and submit annual reports that include a summary of all project activities carried out in the previous year, including the same information as noted above. Additionally, BOEM and NMFS would meet twice during the first year of project operation to review sea turtle observation records, in September (to review observations through August of that year) and December (to review observations from September to November). The best available information on sea turtle presence, distribution, and abundance, project vessel activity, and observations would be used to estimate the total number of sea turtle vessel strikes in the action area that are attributable to project operations. These meetings would continue on an annual basis following year 1 of operations. Upon mutual agreement of NMFS and BOEM, the frequency of these meetings could be changed. BOEM proposed measures are designed to avoid vessel strikes on sea turtles by reducing vessel speed within important habitat areas or in situations when collision risk may be greatest (Table 1-12). Additionally, vessels traveling at higher speeds equipped with PSOs would be required to maintain speed commensurate with weather conditions and effectively detecting sea turtles prior to reaching the 328 foot (100 meter) avoidance measure (Table 1-12). For example, Hazel et al. (2007) suggested that there are two situations where speed restrictions may be particularly valuable in protecting sea turtles: (1) where vessels travel across shallow turtle foraging habitat, and (2) where vessels use deeper channels between shoal banks that offer foraging opportunities for turtles. Although not yet proposed by Ocean Wind or BOEM, additional speed reduction measures may be considered in the future for vessel transits through loggerhead sea turtle critical habitat.

Ocean Wind has estimated that Project O&M would involve daily trips of CTV or SES (i.e., high speed crew transfer air-cushion catamarans) trips except in severe weather, or approximately 115,150 vessel trips over the lifetime of the Project, originating from the Atlantic City O&M facility. The vessels that would be used for Project O&M are described in Section 6.1.3.5 and Tables 6.1.2-1 to 6.1.2-4 in the COP, Volume I (Ocean Wind 2022). While the lack of in-water hull reduces the likelihood of a subsurface collision, sea turtles resting or breathing on the surface could be affected. Additionally, the high rate of speed of these vessels allows less reaction time from the sea turtles and for the vessel operator conducting a maneuver to avoid the sea turtle. The contribution of the proposed Project would represent only a small portion of the overall annual increases in vessel traffic in the region (Figure 3-3; DNV-GL 2021). As described in Section 1.3.5 of this BA, Ocean Wind has voluntarily committed to specific APMs, including vessel timing and speed restrictions to avoid and minimize vessel-related risks to marine mammals (Table 1-11 and Table 1-12). Based on the density of sea turtles in the Project area and a maximum of 283 monthly round trips during O&M, there is a moderate risk of encountering a sea turtle.

Based on this analysis, the effects of Project vessel traffic leading to collisions with sea turtles are unlikely given the relatively small increase in vessel traffic and because sea turtles only seasonally occur in typically small numbers with a dispersed distribution. The species and age classes most likely to be affected are adults, sub-adults, and juveniles of leatherback sea turtles, Northwest Atlantic Ocean DPS of loggerhead sea turtles, and the North Atlantic DPS of green sea turtles. Due to their low density in the Action Area, vessel collisions with Kemp's ridley sea turtles would be extremely unlikely. While the effect of adding the vessels to the baseline cannot be meaningfully measured, detected, or evaluated, the effects are also **discountable**. Therefore, the effects of vessel traffic resulting in vessel strike due to the Proposed Action **may affect, not likely to adversely affect** ESA-listed sea turtles.

An additional potential impact of vessel traffic on sea turtles is spills from refueling or collisions. Impacts on individual sea turtles, including decreased fitness, health effects, and mortality, may occur if individuals are present in the vicinity of a spill, but accidental releases are expected to be rare and injury or mortality are not expected to occur. Furthermore, all vessels associated with the proposed Project would comply with the USCG requirements for the prevention and control of oil and fuel spills, and Ocean Wind would not allow any refueling of vessels while at sea (Ocean Wind 2022). Proper vessel regulations and operating procedures would minimize effects on sea turtles and their prey resulting from the release of debris, fuel, hazardous materials, or waste (BOEM 2012). With adherence to vessel regulations, the potential for a spill to occur is considered extremely unlikely to occur and **discountable**. Therefore, the effects of spills from Project vessel activities **may affect, not likely to adversely affect** ESA-listed turtles**.**

3.3.5.7. Monitoring Surveys Effects on Sea Turtles [pre-C, C, O&M]

As mentioned in Section 3.2.6.8 for marine mammals, monitoring surveys are for the Project are proposed during the initial three phases of pre-construction, construction, and operations and maintenance. Monitoring surveys during decommissioning are possible; however, the proposed plans do not extend to that phase. The details of each survey type can be found in Section 1.3.4. Potential impacts to ESA-listed sea turtles arising from monitoring surveys during pre-construction, construction, and operations and maintenance assessed elsewhere in this document are related to underwater vessel noise, increased vessel traffic, and increased for potential for vessel strikes. These stressors are discussed in Sections 3.3.5.1 and 3.3.5.6 respectively. Additional effects of survey methods discussed below include; habitat disturbance during trawling, dredging, and pot setting, and potential for entrapment or entanglement in monitoring gear.

Impacts to ESA-listed sea turtles specific to each survey type and equipment are described below in this section. The underwater noise effects generated by the survey methods used in the benthic monitoring plan (multibeam echosounder and side-scan sonar methods) used for habitat monitoring are similar to, but of lower magnitude than, the HRG survey methods described in Section 1.3.4.1. As these effects have already been considered, they are not addressed further in this assessment.

3.3.5.7.1 Trawl Survey

The capture and mortality of sea turtles in bottom trawl fisheries is well documented (Henwood and Stuntz 1987; NRC 1990; NMFS and USFWS 1991, 1992, 2008). As discussed in recovery plans and 5-year status reviews for all sea turtle species, reduction of sea turtle interactions with fisheries is a priority where these species occur (NMFS and USFWS 1991, 1992, 2015a, 2015b, 2019, 2020; Conant et al. 2009; NMFS et al. 2011). Finkbeiner et al. (2011) compiled sea turtle bycatch in U.S. fisheries and found that in the Atlantic, a mean estimate of 137,700 interactions, of which 4,500 were lethal, occurred annually since the implementation of bycatch mitigation measures. However, a vast majority of the interactions (98%) and mortalities (80%) occurred in the Southeast/Gulf of Mexico shrimp trawl fishery, although sampling inconsistencies and limitations should be considered when interpreting this data (NMFS 2016b).

While sea turtles are capable of remaining submerged for long periods of time, they appear to rapidly consume oxygen stores when entangled and forcibly submerged in fishing gear (Lutcavage and Lutz 1997). However, the preponderance of available research (Epperly et al. 2002; Sasso and Epperly 2006) and anecdotal information from past trawl surveys indicates that limiting tow times to less than 30 minutes will likely eliminate the risk of death for incidentally captured sea turtles. The bottom time for proposed trawls would be limited to 20 minutes, indicating that this activity poses a negligible risk of mortality. The proposed mitigation measures would be expected to eliminate the risk of serious injury and mortality from forced submergence for sea turtles caught in the bottom otter trawl survey gear. While no mortality is expected from either proposed otter trawl surveys, incidentally captured individuals would suffer stress and potential injury. Metabolic changes that impair a sea turtle's ability to function can occur within minutes of forced submergence. In the unlikely event that forced submergence occurs, oxygen stores are rapidly consumed, anaerobic glycolysis is activated, and acid-base balance is disturbed, sometimes on lethal levels (NMFS 2012b). Table 3-41 provides quantitative estimates of sea turtle captures and mortalities under the proposed actions, including the four major recurring surveys noted above as well as other short-term cooperative research projects, based on gear types used and deployment details such as tow times and soak durations. The risk analysis is organized by gear type as described below. As mentioned in Section 3.2.6.8, while the equipment and vessel used are the same as the NEAMAP survey, the effort of monitoring trawls for the Project is roughly one sixth or 17% of the NEAMAP.

Table 3-41 Estimated Future Takes of Sea Turtles under the NEFSC Trawl

Gear type	NEFSC Trawl		Extrapolation to Project Trawl[b]	
Sea Turtle Species	**Captures per Year[a]**	**Serious Injuries/ Mortalities per Year[a]**	**Captures per Year**	**Serious Injuries/ Mortalities per Year**
Loggerhead	(14.7) 15 turtles	(0.19) 1 turtle	(2.5) 3 turtles	(0.03) 1 turtle
Kemp's ridley	(13.1) 14 turtles	(0.2) 1 turtle	(2.3) 3 turtles	(0.04) 1 turtle
Green	(0.1) 1 turtle	0	(0.02) 1 turtle	0
Leatherback	(0.1) 1 turtle	0	(0.02) 1 turtle	0
Totals	31 turtles	2 turtles	8 turtles	2 turtles

Notes:
[a] Source: NMFS 2016b. Original take calculations were first presented in NMFS (2014). Parenthetical numbers are estimated takes and the number of potential takes are rounded up to a whole number to represent potential turtle takes.
[b] Extrapolation from NMFS (2016b) to the project was accomplished by multiplying the estimated take per species by 0.1777 (amount of yearly effort of Project trawl surveys compared to yearly effort of NMFS 2016b trawl) and rounded up to a whole number to represent potential turtle takes.
NEFSC = Northeast Fisheries Science Center

However, the leading cause for injury and mortalities in sea turtles with respect to trawl surveys are assessed within two separate time ranges. As mentioned above, sea turtles show an increase of 70% mortality between 50 minutes, 90 minutes and beyond. Trawl surveys from previous studies indicate that the gear types used for the proposed Project have not been subject to significant adverse interactions or impacts to listed turtles (NMFS 2012b, 2016b). In the event of a sea turtle capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures (Table 1-12). Given the estimated takes based on the NEFSC trawl surveys, trawl surveys from Project monitoring activities leading to potential capture and/or minor injury are

discountable and therefore **may affect, not likely to adversely affect** green and leatherback sea turtles. Furthermore, the estimated takes based on the NEFSC trawl surveys, trawl surveys from Project monitoring activities leading to potential capture and/or minor injury **may affect, likely to adversely affect** small numbers of loggerhead and Kemp's ridley sea turtles.

Sea turtle prey items such as horseshoe crabs, other crabs, whelks, and fish are removed from the marine environment as bycatch in bottom trawls. None of these are typical prey species of leatherback sea turtles or of neritic juvenile or adult green sea turtles. Therefore, the Ocean Wind trawl surveys would not affect the availability of prey for leatherback and green sea turtles in the Action Area. Neritic juveniles and adults of both loggerhead and Kemp's ridley sea turtles are known to feed on these species that may be caught as bycatch in the bottom trawls. However, all bycatch is expected to be returned to the water alive, dead, or injured to the extent that the organisms would shortly die. Injured or deceased bycatch would still be available as prey for sea turtles, particularly loggerhead sea turtles, which are known to eat a variety of live prey as well as scavenge dead organisms. Given this information, any effects on sea turtles from collection of potential sea turtle prey in the trawl gear will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, effects are considered **insignificant**.

3.3.5.7.2 Structure-Associated Fisheries Surveys

Chevron traps and BRUVs are stationary gear that pose a risk of entanglement for listed sea turtle species due to buoy and anchor lines. Of all the Atlantic sea turtles, the leatherback seems to be the most vulnerable to entanglement in trap/pot fishing gear, possibly due to its physical characteristics, diving and foraging behaviors; distributional overlap with the gear; and the potential attraction to prey items that collect on buoys and buoy lines at or near the surface (NMFS 2016b). Individuals entangled in pot gear generally have a reduced ability to forage, dive, surface, breathe, or perform other behaviors essential for survival (Balazs 1985). In addition to mortality, gear entanglement can restrict blood flow to extremities and result in tissue necrosis and death from infection. Individuals that survive may lose limbs or limb function, decreasing their ability to avoid predators and vessel strikes (NMFS 2016b). There is a risk of sea turtle entanglement, particularly for leatherbacks in trap or pot gear. In the event of a sea turtle capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures (Table 1-12).

Sea turtle prey items such as horseshoe crabs, other crabs, whelks, and fish may be removed from the marine environment as bycatch in trap gear. None of these are typical prey species of leatherback sea turtles or of neritic juvenile or adult green sea turtles. Therefore, the Ocean Wind structure-associated fishes surveys will not affect the availability of prey for leatherback and green sea turtles in the Action Area. Neritic juveniles and adults of both loggerhead and Kemp's ridley sea turtles are known to feed on these species that may be caught as bycatch in the trap/pot gear. However, all bycatch is expected to be returned to the water alive, dead, or injured to the extent that the organisms will shortly die. Injured or deceased bycatch would still be available as prey for sea turtles, particularly loggerhead sea turtles, which are known to eat a variety of live prey as well as scavenge dead organisms. Given this information, any effects on sea turtles from collection of potential sea turtle prey in the trap gear will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, effects are **insignificant**.

3.3.5.7.3 Clam, Oceanography, and Pelagic Fisheries Surveys

The equipment used in the clam, oceanography, and pelagic fish surveys pose minimal risk to sea turtles. Tows for the clam survey have a very short duration of 120 seconds. Given the short soak time and the extremely unlikely possibility for mortality or serious injury to sea turtles, the clam surveys pose minimal risk to sea turtles in the Project area. In the event of a sea turtle capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures (Table 1-12). Based on the above analysis, the potential for entanglement of ESA-listed sea turtles in clam, oceanography, and pelagic fish survey equipment is considered extremely unlikely to occur and is **discountable**. Both the oceanography and pelagic fish surveys are non-extractive and subject to the same mitigation as the structure-associated fish surveys (Table 1-11).

Dredge equipment would be towed along the bottom for 120 seconds. Leatherback sea turtles feed on pelagic plankton and therefore clam surveys do not pose a risk to leatherback sea turtle prey (Table 3-40). Under the currently proposed clam survey design, the vessel will pull the dredge approximately 607 feet (185 meters) per tow, totaling 12,140 feet (3,700 meters) during a sampling event. While Kemp's ridley and loggerhead sea turtle prey may be captured in the clam dredge, the relatively small area covered and the fact that samples will be returned to the water result in an unlikely effect on Kemp's ridley and loggerhead sea turtle prey (Table 3-40. Clam dredging would likely remove SAV foraged for by green sea turtles (Table 3-40). However, the tows are expected to occur in the Lease Area away from primary green sea turtle foraging areas in nearshore and inshore waters. Therefore, clam dredging is extremely unlikely to impact green sea turtle prey. In the unlikely event that pelagic fish are taken during a survey event, indirect impacts on sea turtle prey-predator interactions could occur. However, both the oceanography and pelagic fish surveys are non-extractive and also subject to the mitigation measures as the structure-associated fish surveys. Therefore, the risks of entrapment and entanglement from the equipment used in clam, oceanography, and pelagic fish surveys on sea turtles are considered extremely unlikely to occur and **discountable**.

3.3.5.7.4 Acoustic Telemetry Surveys

Acoustic telemetry to monitor for tagged fish, elasmobranchs, and invertebrates would be conducted during pre-construction, construction, and O&M phases of the Project. Surveys would employ a combination of fixed hydrophone receivers attached to piers, bulkheads, and floating docks, deployed from a vessel during the structure-associated fishes survey, and attached to a glider during the pelagic fish surveys. The fixed hydrophones would be attached to existing inshore structures and do not pose a risk to sea turtles. The mobile hydrophone deployed during the structure-associated fishes survey will be subject to the same pre- and continuous protected species observational periods and, therefore, present a discountable amount of risk to sea turtles (Table 1-12). Additionally, the hydrophone attached to the glider is non-extractive and would average 0.45 knots (0.23 m/s). The potential for entanglement of sea turtles in acoustic telemetry survey equipment is considered extremely unlikely to occur and is **discountable**.

3.3.5.7.5 Passive Acoustic Monitoring Surveys

Impacts arising from vessel noise and the potential for vessel strike could occur during system deployment and are discussed in Sections 3.3.5.1 and 3.3.5.6. Sources of impacts from PAM technologies to sea turtles are limited to mooring lines for moored PAM systems, in which poses a theoretical entanglement risk to sea turtles, and encounters with ASVs and AUVs could also occur.

Mitigation measures to reduce risk of entanglement to sea turtles were developed by referencing BOEM's BA on data collection activities (BOEM 2021b). As stated in measure #2 in Table 1-11, a PAM plan will be submitted to NMFS and BOEM for review and concurrence 120 days prior to start of activities. Additionally, as stated in measure #57 in Table 1-12, PAM systems will use the best available technology to reduce any potential risks of entanglement. Buoys attached to the seafloor use buoys, lines (chains, cables, or coated rope systems), swivels, shackles, and anchor designs that prevent any potential entanglement of listed species while ensuring the safety and integrity of the structure or device. All mooring lines and ancillary attachment lines must use one or more of the following measures to reduce entanglement risk: shortest practicable line length, rubber sleeves, weak links, chains, cables, or similar equipment types that prevent lines from looping, wrapping, or entrapping protected species. Any equipment must be attached by a line within a rubber sleeve for rigidity. The length of the line must be as short as necessary to meet its intended purpose. All buoys must be properly labeled with lessee and contact information. With the following mitigation measures, the potential for entanglement of ESA-listed species in PAM survey equipment is considered extremely unlikely to occur and is **discountable**.

Autonomous PAM systems such as ASVs and AUVs could have hydrophone equipment attached that operate autonomously in a defined area. In very shallow water, these devices can be operated remotely from a vessel or by line of sight from shore either by an operator or in an unmanned mode. ASVs and AUVs are typically lightweight and small vessels that travel at slow speeds of less than 3 knots (1.5 m/s). ASVs and AUVs produce virtually no self-generated noise and are not expected to pose a risk of injury to turtles from collisions due to their low mass, small size, and slow operational speeds (Work et al. 2010). The potential for injury of ESA-listed cetaceans from ASVs and AUVs is considered extremely unlikely to occur and is **discountable.**

3.3.5.7.6 Summary of Monitoring Survey Effects

As described in the sections above, any effects from monitoring surveys (e.g., entanglement, reductions in prey or strikes) on turtles are considered extremely unlikely to occur and **discountable** or are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the effects of monitoring surveys (excluding trawl surveys) from the Project **may affect, not likely to adversely affect** ESA-listed turtles. The effects of trawl surveys can be discounted and therefore **may affect, not likely to adversely affect** green and leatherback sea turtles. Furthermore, the effects of trawl surveys cannot be discounted and therefore **may affect, likely to adversely affect** small numbers of loggerhead and Kemp’s ridley sea turtles.

3.3.5.8. Effects of Electromagnetic Fields on Sea Turtles [O&M]

Similar to the review conducted by the same author on marine mammals, Normandeau (2011) conducted a review of sea turtle sensitivity to human-made EMF in the scientific literature. The available evidence indicates that sea turtles are magnetosensitive and orient to the earth’s magnetic field for navigation, but they are unlikely to detect magnetic fields below 50 mG (5 µT). Normandeau (2011) summarized theoretical concerns in the literature that human-created EMF could disrupt adult migration to and juvenile migration from nesting beaches. Nesting beaches are not present within the Action Area. Although the Proposed Action would produce magnetic field effects above the 50-mG (µT) threshold at selected locations where transmission cables lie on the bed surface, the affected areas would be localized around unburied cable segments and limited to within 3.3 feet (1 meter) of the cable surface. Given the lack of sensitive sea turtle life stages to be present, the limited field strength involved, and limited potential for highly mobile species like sea turtles to encounter field levels above detectable thresholds, any EMF effects on turtles are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the effects of EMF from the Project **may affect, not likely to adversely affect** ESA-listed turtles**.**

Magnetic fields associated with the operation of the transmission line could impact benthic organisms that serve as sea turtle prey. Effects to forage fish, jellyfish, copepods, and krill are extremely unlikely to occur given the limited distance into the water column that any magnetic field associated with the transmission line is detectable. The survival and reproduction of benthic organisms are not thought to be affected by long-term exposure to static magnetic fields (Bochert and Zettler 2006; Normandeau 2011). Results from the 30-month post-installation monitoring for the Cross Sound Cable Project in Long Island Sound indicated that the benthos within the transmission line corridor for this Project continues to return to pre-installation conditions. The presence of amphipod and worm tube mats at a number of stations within the transmission line corridor suggest construction and operation of the transmission line did not have a long-term negative effect on the potential for benthic recruitment to surface sediments (NMFS 2021). Based on the analysis above, EMF effects on turtle prey are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the effects of EMF from the Project leading to reduction in prey **may affect, not likely to adversely affect** ESA-listed turtles**.**

3.3.5.9. Air Emissions (Vessel Discharges and Offshore Equipment) (C, O&M, D)

As mentioned in Section 3.2.6.10, sources of air pollutant emissions are limited to construction, O&M, and decommissioning phases of the proposed Project. The proposed Project's WTGs, substations, and offshore and onshore cable corridors would not themselves generate air pollutant emissions during normal operations. The following summarizes the estimated air pollutant emissions during construction, O&M and decommissioning phases.

As presented in Section 3.2.6.10, a summary of estimated emissions during construction of the Project is provided in Table 3-25. During construction, most emissions would occur in the Wind Farm Area, along the offshore and onshore export cable routes, construction staging areas. Other emissions are anticipated near ports that will be used to transport construction materials and personnel to and from the Wind Farm Area and cable corridors. Offshore emissions would occur during pile and scour protection installation, offshore cable laying, turbine installation, substation installation and diesel-fueled generators used temporarily to supply power to various lighting and equipment prior to cable installment. There also would be emissions from engines used to power pile-driving hammers and air compressors used to supply compressed air to noise-mitigation devices during pile driving (if used). Emissions from vessels used to transport workers, supplies, and equipment to and from the construction areas would result in additional air quality impacts.

The impact from air pollutant emissions is anticipated to be minor and temporary. Since construction and decommissioning activities will likely require similar equipment such as vessels for transportation, driving and removing piles and laying and removing cable, it's assumed that air quality impacts would be similar. Although sea turtles are capable of diving for long periods and have different diving patterns, these animals respire air with very little cutaneous exchange (Jackson 1985; Hays et al. 2000). Not many studies have been conducted to assess air quality impacts to sea turtles; however, the NAAQS are designed to ensure that air quality does not significantly deteriorate from baseline levels. Additionally, the Project's use of SES or CTVs for crew transport have the potential to employ technology that reduces emissions compared to standard in-water hull and propeller vessels. It is reasonable to conclude that any effects to listed sea turtles from these emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are **insignificant**. Therefore, the effects of air emissions from the Project **may affect, not likely to adversely affect** ESA-listed turtles**.**

3.3.5.10. Lighting and Marking of Structures (C, O&M, D)

As mentioned in Section 3.2.6.11, the Project would introduce artificial light sources to the Project area over the short-term on construction and decommissioning vessels and long-term installation stationary light sources over O&M. Artificial light has the potential to affect sea turtles directly and indirectly through changes in predatory-prey or foraging dynamics. Different species have been reported to act differently to artificial light. It has been documented that juvenile loggerhead sea turtles orient toward glowing light sticks of the colors green blue, yellow chemical lights and LED orange (Wang et al 2007). Although leatherback sea turtles feed on jellyfish and gelatinous zooplankton (Table 3-40) that have the potential to emit light wavelengths, results from Gless et al. (2008) indicated that juveniles do not respond to artificial light. A field study was conducted on green sea turtle hatchlings and discovered that over 80% of individuals oriented toward a light source (Thums et al. 2016). Additionally, as discussed in Section 3.2.6.11, artificial light has the potential to aggregate and alter community composition of fish and invertebrates (Nightingale et al. 2006; McConnell et al. 2010; Davies et al. 2016). Zooplankton also respond to artificial light, effecting their vertical distribution within the water column (Orr et al. 2013).

However, light sources from the proposed project involves intermittent flashes of red hues and do not present a continuous light source. Orr et al. (2013) conducted a study on the effects of navigational lights on sea turtles and the results indicate that no effects on juvenile or adult sea turtles.

Lighting-related BMPs committed to by the Applicant include red wavelength-emitting diode obstruction lighting; lighting that flashes 30 flashes per minute; use of an aircraft detection lighting system that turns on lights in response to an aircraft in proximity of the wind farm to reduce total time lights are on; and directional shielding of aeronautical obstruction lights to prevent visibility below the horizontal plane. Therefore, continuous light sources or long-term exposure to sea turtles is not anticipated. Based on the available literature, sea turtles do not appear to be affected by navigational lights (Orr et al. 2013). With the application of mitigation measures the potential effects to turtles and their prey from lighting are likely so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are **insignificant**. Therefore, the effects of lighting of structures from the Project **may affect, not likely to adversely affect** ESA-listed turtles**.**

3.3.5.11. Unexpected/Unanticipated Events (C, O&M, D)

Unexpected and unanticipated events are not part of the Proposed Action but have a low potential to occur and are considered in the Draft EIS. As introduced in Section 3.2.6.12, these unlikely events have the potential to impact sea turtles and include vessel collision and allision with foundations, failure of WTGs due to a weather event, oil spill, or chemical release.

In the event of a vessel collision/allision with a WTG, fluids contained within the turbine may be released or a catastrophic failure or collapse of the turbine may occur. Measures in place to minimize the risk of vessel collision/allision include turbine depiction on navigation charts, compliant lighting and marking of turbines detailed in Section 3.3.5.10, and proper spacing of the turbines in consideration of navigational safety. In the extremely unlikely event that a vessel was to collide with a turbine, equipment that would collapse would be limited to the footprint or immediately outside the footprint of the Wind Farm Area. Impacts to sea turtles would only occur if collision and collapse of turbine or turbine equipment occur while sea turtles are present. Based on this information, any effects to listed sea turtles that could theoretically result from a vessel collision/allision are extremely unlikely and not reasonably certain to occur.

Oil and chemical release could also occur from collision or extreme weather events. Most hurricane events within the Atlantic generally occur from mid-August to late October, and the majority of all events occur in September (Donnelly et al. 2004). On average, hurricanes occur every 3 to 4 years within 90 to 170 miles (144 to 273 km) of the New Jersey coast (NJDEP 2010). Most historical cyclones affecting the Project area are tropical storms, and storms as powerful as Category 3 hurricanes have affected the area. Hurricane Sandy occurred in 2012 and caused the highest storm surges and greatest inundation on land in New Jersey.

Sea turtles may be exposed to oil or chemical spills through the skin and mucous membranes or shells of the eggs, ingestion from contaminated good or water as well as inhaling polycyclic aromatic compounds (PAHs) or oil slicks at the surface are all potential exposure sources to sea turtles. Female sea turtles may also pass on PAHs or other chemicals to their eggs during development. Impacts on individual sea turtles, include decreased fitness, health effects, and mortality, may occur if individuals are present in the vicinity of a spill (NOAA 2010).

However, accidental releases are expected to be rare and injury or mortality are not expected to occur. The predicted frequency of such events is no more than three WTG fluid spills over the 25-year life of the WTGs and no more than one diesel spill over the life of the Project. Modeling presented by BOEM in the BA (from Bejarano et al. 2013) indicates that there is a 0.01% chance of a “catastrophic release” of oil from the wind facility in any given year. Given the 25-year life of this Project, the modeling supports the determination that such a release is not reasonably certain to occur. Therefore, any fuel or WTG fluid spill is extremely unlikely and not reasonably certain to occur. In the unlikely event of a spill, if a response was required by the EPA or the USCG, there would be an opportunity for the NMFS to conduct a consultation with the lead federal agency on the oil spill response which would allow the NMFS to consider the effects of any oil spill response on listed sea turtles in the Action Area.

Furthermore, all vessels associated with the proposed Project would comply with the USCG requirements for the prevention and control of oil and fuel spills, and Ocean Wind would not allow any refueling of vessels while at sea (Ocean Wind 2022). Proper vessel regulations and operating procedures would minimize effects on sea turtles and their prey resulting from the release of debris, fuel, hazardous materials, or waste (BOEM 2012).

The potential for unexpected and unanticipated events to occur are considered extremely unlikely to occur and are therefore **discountable**. Therefore, the effects of unexpected and unanticipated events from the Project **may affect, not likely to adversely affect** ESA-listed turtles**.**

3.4. MARINE FISH

The only ESA-listed fish species considered for analysis in this BA is the Atlantic sturgeon. There are five DPSs of Atlantic sturgeon present or likely to be present in the Action Area.

3.4.1 Atlantic Sturgeon

The Atlantic sturgeon is a large bottom-feeding fish that grows up to 14 feet (4.2 meters), reaches weights up to 600 pounds (270 kg), and lives up to 60 years. The species is anadromous and spawns in medium to large rivers on the U.S. Atlantic coast. It is known to inhabit 38 major estuarine and associated riverine systems in the eastern United States and Canada (ASSRT 2007) from Labrador Inlet, Labrador, Canada, to Cape Canaveral, Florida (77 FR 5879). The species hatches in freshwaters and migrates to the ocean as juveniles. Once reaching maturity, Atlantic sturgeons migrate back up rivers to spawn in the spring, with males spawning almost every year and females every 2 to 3 years. Distribution and abundance vary by season as they are found in shallow coastal waters during the summer months and move to deeper waters in winter and early spring (Dunton et al. 2010).

Adult and subadult Atlantic sturgeon range widely across the Atlantic OCS, feeding primarily on benthic invertebrates and small fish on or near the seabed. They appear to congregate in areas providing favorable foraging conditions (Stein et al. 2004a, 2004b), exhibit dietary flexibility, and can adapt to changing prey availability (Johnson et al. 1997; Guilbard et al. 2007). During migrations along the eastern seaboard, Atlantic sturgeon are thought to travel north in the spring and south in the fall (Erickson et al. 2011). During this migration period, Atlantic sturgeon may pass through the Project area, but this has not been confirmed. In a modeled study, Breece et al. (2018) discovered that spring migration takes place in shallower nearshore waters and, conversely, in deeper offshore waters for fall migration.

Male Atlantic sturgeon generally do not reach maturity until at least 12 years and females as late as 19 years (Dovel and Berggren 1983). Their interannual spawning period can range from 3 to 5 years, and adults inhabit marine waters either all year during non-spawning years or seasonally during spawning years (Bain 1997). Tagging data show that while at sea, adults intermix with populations from other rivers (ASSRT 2007). Despite their ability to range widely along the Atlantic coast, tagging and genetic studies indicate high site fidelity in natal rivers and very low gene flow among populations (Dovel and Berggren 1983; Savoy and Pacileo 2003; Grunwald et al. 2008).

Atlantic sturgeon are opportunistic predators that feed primarily on benthic invertebrates but will adjust their diet to exploit other types of prey resources when available. For example, Johnson et al. (1997) found that polychaetes composed approximately 86% of the diet of adult Atlantic sturgeon captured in the New York Bight. Isopods, amphipods, clams, and fish larvae composed the remainder of the diet, with the latter accounting for up to 3.6% of diet in some years. In contrast, Guilbard et al. (2007) observed that small fish accounted for up to 38% of subadult Atlantic sturgeon diet in the St. Lawrence River estuarine transition zone during summer, but less than 1% in fall. The remainder of the species' diet consisted primarily of amphipods, oligochaetes, chironomids, and nematodes, with the relative importance of each varying by season.

There is no available information on the hearing capabilities of Atlantic sturgeon specifically, although the hearing of other species of sturgeon have been studied. Meyer et al. (2010) and Lovell et al. (2005) studied the auditory system morphology and hearing ability of lake sturgeon (*Acipenser fulvescens*), a closely related species. The Acipenseridae (sturgeon family) have a well-developed inner ear that is independent of the swim bladder and therefore it appears as though sturgeon rely directly on their ears to hear. The results of these studies indicate a generalized hearing range from 50 to approximately 700 Hz, with greatest sensitivity between 100 and 300 Hz. Popper (2005) summarized studies measuring the physiological responses of the ear of European sturgeon (*Acipenser sturio*). These results suggest that sturgeon are likely capable of detecting sounds from below 100 Hz to about 1 kHz.

3.4.1.1. Current Status

Five separate DPSs of Atlantic sturgeon were listed under the ESA in 2012 (77 FR 5880, 77 FR 5914): Chesapeake Bay (endangered), Carolina (endangered), New York Bight (endangered), South Atlantic (endangered), and Gulf of Maine (threatened). Final determinations listing the Atlantic sturgeon New York Bight and Chesapeake Bay DPSs as endangered, Gulf of Maine DPS as threatened (77 FR 5880), and Carolina and South Atlantic DPSs as endangered (77 FR 5914) were issued in February 2012, and the rulings became effective on April 6, 2012. Atlantic sturgeon originating from rivers in Canada are not currently listed. The listing rule from 2012 included the following threats to recovery of Atlantic sturgeon: destruction of habitat or range, dams and tidal turbines, dredging and blasting, and degradation of water quality (77 FR 5880).

In 2017, critical habitat was designated for all five DPSs of Atlantic sturgeon (82 FR 39160); these critical habitat designations are riverine, and a majority of the Action Area is not located within designated critical habitat. The exception is the critical habitat within the Delaware River, which would overlap with vessel transits to Paulsboro, New Jersey, for foundation scope during construction.

The species has suffered significant population declines across its range as a result of historical overfishing and degradation of freshwater and estuarine habitats by human development (ASSRT 2007). Bycatch mortality, water quality degradation, and dredging activities remain persistent threats. Some populations are affected by unique stressors, such as habitat impediments and apparent ship strikes (ASSRT 2007).

3.4.1.2. Potential Habitat Surrounding and within Project Area

The Atlantic sturgeon demonstrates strong spawning habitat fidelity and extensive migratory behavior (Savoy et al. 2017). Adults and subadults migrate extensively along the Atlantic coastal shelf (Erickson et al. 2011; Savoy et al. 2017), and all life stages use the coastal nearshore zone as a migratory corridor between river systems (Eyler et al. 2004; ASSRT 2007). Erickson et al. (2011) found that adults remain in nearshore and shelf habitats ranging from 6 to 125 feet (2 to 38 meters) in depth, preferring shallower waters in the summer and autumn and deeper waters in the winter and spring.

Individuals from every Atlantic sturgeon DPS have been captured in the Virginian marine ecoregion (Cook and Auster 2007; Wirgin et al. 2015a, 2015b), which extends from Cape Cod, Massachusetts, to Cape Lookout, North Carolina. Eyler et al. (2009) reported that Atlantic sturgeon tagged off New Jersey have been recaptured in Long Island Sound, off Maryland, Delaware, New Hampshire, and North Carolina. Atlantic sturgeon have been captured in several sampling programs off the New Jersey coast (Stein et al. 2004b; Eyler et al. 2009; Dunton et al. 2010; Erickson et al. 2011). Dunton et al. (2010)

analyzed data from surveys covering the northwest Atlantic Ocean from Cape Hatteras (North Carolina) to the Gulf of Maine conducted by five agencies. The catch per unit of effort for Atlantic sturgeon off New Jersey, from New York Harbor south to the entrance of Delaware Bay (Delaware), was second only to catch per unit of effort from the entrance of New York Harbor to Montauk Point, New York. About 95% of all Atlantic sturgeon captured in the sampling off New Jersey occurred in depths less than 66 feet (20 meters) with the highest catch per unit of effort at depths of 33 to 49 feet (10 to 15 meters) (Dunton et al. 2010).

Ingram et al. (2019) tagged Atlantic sturgeon off the New York wind energy area using acoustic tags to track the movement of fish seasonal from November 2016 through February 2018. Their study showed that offshore migrations peaked from November through January and were uncommon or entirely absent during July to September.

Critical habitat has been designated for the New York Bight DPS in the Delaware River that begins where the main stem of the river discharges into Delaware Bay at approximately river mile 48.5 (river km 78) and stretches upriver to the Trenton-Morrisville Route 1 Toll Bridge at approximately river mile 132.5 (river km 213.5) (BOEM 2021b). The essential features of the Delaware River critical habitat were identified (Section 2.3.9).

3.4.2 Effects Analysis for Marine Fish

3.4.2.1. Underwater Noise Effects on Marine Fish

Potential adverse auditory effects to fish from Project-generated underwater noise includes physiological effects, TTS, masking, and behavioral disruption. The underwater noise modeling that was conducted for marine mammals for impact pile driving and UXO detonations also considered fish and are summarized in Section 3.2.6.2. The section below outlines the thresholds applied, the results of the underwater noise modeling conducted, and the impact consequences for each potential activity.

3.4.2.1.1 Acoustic Criteria

Acoustic criteria to assess the potential effects to fish were developed by FHWG (2008) and are presented in Table 3-42. These criteria include thresholds for impulsive sources (e.g., impact pile driving) and specific thresholds for explosive events (e.g., UXO detonations). Impulsive criteria include dual metrics which are used to assess the effects to fish exposed to high levels of accumulated energy (SEL or $L_{E,24h}$) for repeated impulsive sounds and a single strike at high L_{pk}. The criteria include a maximum accumulated SEL for lower-level signals and a maximum L_{pk} for a single pile-driving strike or explosive event (FHWG 2008). Non-impulsive criteria include a single metric to assess the effects of accumulated energy ($L_{E,24h}$) to fish from a non-impulsive or continuous source. NMFS has not established a formal threshold for behavioral disturbance, however, the 150 dB re 1 µPa L_{rms} threshold is typically used and was applied to all noise sources to assess the behavioral response of fish (Andersson et al. 2007; Wysocki et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011).

The Fisheries Hydroacoustic Working Group (FHWG) was formed in 2004 and consists of biologists from NMFS, USFWS, Federal Highway Administration, USACE, and the California, Washington, and Oregon Departments of Transportation, supported by national experts on underwater sound producing activities that affect fish and wildlife species of concern. In June 2008, the agencies signed a memorandum of agreement documenting criterion for assessing physiological effects of impact pile driving on fish. The criteria were developed for the acoustic levels at which physiological effects to fish could be expected. The FHWG outlines thresholds for fish greater and less than 2 grams in weight for the onset of physiological effects (Stadler and Woodbury 2009), and not necessarily levels at which fish are mortally damaged. These criteria were developed to apply to all fish species.

Table 3-42 Thresholds for Onset of Physiological Effects, Mortality, and Behavioral Disturbance for Fish

Marine Fish Type	Physiological Effects[a]		Mortality[b]	Behavioral Disturbance[c]
	L_{pk} (dB re 1 μPa)	$L_{E,24h}$ (dB re 1 μPa^{2}s)		
	Impulsive	Impulsive	Explosions	Impulsive/Non-Impulsive
Fish (≥ 2 grams) – Atlantic Sturgeon	206	187	229	150
Fish (< 2 grams)	206	183	229	150

Notes:
[a] FHWG 2008;
[b] Minimum threshold from Popper et al. 2014;
[c] Andersson et al. 2007; Wysocki et al. 2007; Mueller-Blenke et al. 2010; Purser and Radford 2011.
> = greater than; < less than; dB re 1 μPa = decibels relative to 1 micropascal; dB re 1 μPa^{2}s = decibels relative to 1 micropascal squared second; L_{pk} = peak level

3.4.2.1.2 Assessment of Effects

3.4.2.1.2.1 Impulsive Underwater Noise

Project-generated impulsive underwater noise includes impact pile driving associated with the installation of the WTGs and OSS, some HRG surveys, and the potential detonation of UXOs. Acoustic propagation modeling of impact pile driving and UXO detonations was undertaken by JASCO Applied Sciences to determine distances to injury and behavioral disturbance thresholds for fish (Hannay and Zykov 2022; Küsel et al. 2022). Details regarding the modeling are presented above under Section 3.2.6.2. The following section summarizes the results of the modeling. For fish, animal movement was not used to determine acoustic ranges and the number of sturgeon (or other fish) potentially exposed to noises above thresholds was not undertaken.

Impact Pile Driving (C)

Noise from impact pile driving for the installation of WTGs and OSS foundations would occur intermittently during the installation of offshore structures. Table 3-43 summarizes the maximum ranges for injury and behavioral disturbance for the installation of WTGs and OSSs.

The Applicant-proposed mitigation to be applied for fish during impact pile driving, which includes the use of a noise mitigation system, and ramp-up procedure (see Table 1-11). In addition, the Applicant plans to implement a sound verification plan to confirm the sound source characteristics predicted by the modeling are reflective of the actual sound propagation in the field. In the event that sound source verification indicates that characteristics in the field are such that the model is invalid or is determined to underestimate exposure of listed species or extent of potential effects, reinitiation of this consultation may be necessary. The noise mitigation system employed with be either a DBBC or a single BBC in combination with a hydrodamper to achieve a minimum of 10 dB noise reduction.

Table 3-43 Acoustic Ranges to Fish Thresholds for Monopile Foundation Installation – 10 dB Attenuation (Two Monopiles/24 Hours)

Faunal Group	Metric	Threshold	$R_{95\%}$ (km)[b]
Fish ≥ 2 grams (includes sturgeon)	$L_{E,24h}$	187	8.66[a]
	L_{pk}	206	0.07[a]
	L_{rms}	150	7.54[a]
Fish < 2 grams[c]	$L_{E,24h}$	183	11.59[a]
	L_{pk}	206	0.07[a]
	L_{rms}	150	7.54[a]

Source: Küsel et al. 2022.
Notes:
[a] Hammer Energy 4000kJ, pen depth 50 meters, winter.
[b] Highest $R_{95\%}$ values for L_{pk} and Lrms were selected from various hammer (IHC S-4000) energies, penetration depths and summer/winter scenarios. Monopile foundations have 8- to 11-meter diameter. Assumes one monopile per 24 hours. Results presented are for location G10 (Küsel et al. 2022).
[c] Included for prey items of ESA-listed marine mammals, turtles and fish
$L_{E,24h}$ = cumulative sound exposure level over 24 hours, PTS threshold
L_{pk} = peak sound pressure level, PTS threshold
L_{rms} = sound pressure level root mean squared, behavior threshold
dB = decibels; kJ = kilojoules; km = kilometers; $R_{95\%}$ = maximum acoustic range at which the sound level was encountered after the 5% farthest points were excluded

Table 3-44 Acoustic Ranges to Fish Thresholds for Pin Piles -10 dB Attenuation (3 Pin Piles/24 Hours)

Faunal Group	Metric	Threshold	$R_{95\%}$ (km)[b]
Fish ≥ 2 grams (includes sturgeon)	$L_{E,24h}$	187	4.05[a]
	L_{pk}	206	0.06[a]
	L_{rms}	150	5.32[a]
Fish < 2 grams[c]	$L_{E,24h}$	183	5.69[a]
	L_{pk}	206	0.06[a]
	L_{rms}	150	5.32[a]

Sources: Küsel et al 2022.
Notes:
[a] Hammer Energy 2,500 kJ, pen depth 60 meters, winter.
[b] Highest $R_{95\%}$ values for L_{pk} and L_{rms} were selected from various hammer (IHC S-2500) energies, penetration depths and summer/winter scenarios. Jacket foundations have 2.44-meter diameter. Assumes 3 pin piles per 24 hours.
[c] Included for prey items of ESA-listed marine mammals, turtles and fish
$L_{E,24h}$ = cumulative sound exposure level over 24 hours, PTS threshold
L_{pk} = peak sound pressure level, PTS threshold
L_{rms} = sound pressure level root mean squared, behavior threshold
dB = decibels; kJ = kilojoules; km = kilometers; $R_{95\%}$ = maximum acoustic range at which the sound level was encountered after the 5% farthest points were excluded

Effects of Exposure to Noise Above the Physiological Thresholds

Modeling indicates that for a single pile strike to result in physiological injury, Atlantic sturgeon would need to be within 229 feet (70 meters) of a monopile and 196 feet (60 meters) of a pin pile (based on the 206 dB peak threshold). As described in Section 3.4.1.2, the Offshore Wind Area has not been systematically surveyed for Atlantic sturgeon; however, based on the best available information on use of the Offshore Wind Area by Atlantic sturgeon, including the capture of Atlantic sturgeon during surveys conducted at similar water depths (Dunton et al. 2010), we expect Atlantic sturgeon to occur at least occasionally in the Offshore Wind Area, where they could be exposed to pile driving noise. Individuals present in the area will likely occur intermittently, moving through the Offshore Wind Area throughout their spring and fall migrations and may be forage opportunistically in areas where benthic invertebrates are present. The area is not known to be a preferred foraging area and has not been identified as an aggregation area which reduced the potential for impact to this species from impact pile-driving noise. Given the dispersed distribution of Atlantic sturgeon in the Lease Area, the potential for co-occurrence in time and space is considered extremely unlikely to occur given the small area where exposure to peak noise could occur (extending 229 feet [70 meters] from the pile) and is therefore **discountable**.

Considering cumulative thresholds, modeling indicates that physiological effects to Atlantic sturgeon may be possible up to 5.38 miles (8.66 km) from impact pile driving of WTG monopile foundations and 2.52 miles (4.05 km) from OSS pin pile foundations (Table 3-43 and Table 3-44). For injury to occur, however, sturgeon would need to remain within these distances for the duration of the activity. With the implementation of ramp-ups, the potential for serious injury is minimized. Ramp-up would facilitate a gradual increase of hammer blow energy to allow marine life to leave the area prior to the start of operations at full energy that could result in injury. Ramp-ups could be effective in deterring Atlantic sturgeon from impact pile driving activities prior to exposure resulting in a serious injury. The potential for serious injury is also minimized by using a noise mitigation system during all impact pile-driving operations. Based on this analysis, the potential for Atlantic sturgeon to be exposed to cumulative noise that could result in physiological injury is considered extremely unlikely occur and is therefore **discountable**.

The effects of noise exposure from Project impact pile driving leading to physiological injury **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Effects of Exposure to Noise Above the Behavioral Thresholds

Modeling indicates that behavioral disturbance to Atlantic sturgeon may be possible up to 4.69 miles (7.54 km) from impact pile driving of WTG monopile foundations and 3.31 miles (5.32 km) from OSS pin pile foundations (Table 3-43 and Table 3-44). Several studies have been conducted on the behavioral response of fish to impulsive noise sources. Those that have been published show varying results, ranging from avoidance (moving out of the affected area or into deeper water; Dalen and Knutsen 1987; Slotte et al. 2004) to minor changes in behavior (Wardle et al. 2001; Hassel et al. 2004) or no reaction at all (Peña et al. 2013).

As stated above, the potential for Atlantic sturgeon to be present in the Offshore Wind Area is considered possible but would occur intermittently, and no preferred foraging areas or aggregation areas have been identified in the Offshore Wind Area. Therefore, Atlantic sturgeon could be exposed to noises above behavioral threshold and may avoid the area; however, avoidance of preferred foraging areas and accessing of spawning or overwintering areas would not occur, and only cessation of opportunistic foraging areas during migration period is expected. Should an exposure occur, it would be temporary with effects dissipating once the activity had ceased or the individual had left the area. Potential effects would be brief (e.g., Atlantic sturgeon may approach the noisy area and divert away from it), and any effects from this brief exposure would be so small that they could not be measured, detected, or evaluated and would therefore be **insignificant**. Therefore, the effects of noise exposure from Project impact pile driving leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

3.4.2.1.2.2 UXO Detonations (C)

As outlined above for marine mammals (Section 3.2.6.2), Ocean Wind may encounter UXOs on the seabed in the Lease Area and along export cable routes. While non-explosive methods may be employed to lift and move these objects, some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could kill, injure, or disturb Atlantic sturgeon.

Ocean Wind conducted modeling of acoustic fields for UXO detonations which is described in detail in Section 3.2.6.2). Mitigated (10 dB) ranges to physiological injury and behavioral thresholds were calculated. Additionally, a BOEM proposed measure extends the APM seasonal restriction of UXO detonations in the offshore wind area (January to April) to include the months of November and December to avoid greater concentrations of Atlantic sturgeon in the offshore (Table 1-12). Under this measure no UXOs can be detonated from November to April in offshore areas greater than 3 nm (state waters). UXO survey results are expected in Fall of 2022 which defines the exact location and size of UXO. Table 3-45 summarizes the maximum ranges to physiological injury per charge weight bin for Atlantic sturgeon.

Table 3-45 Maximum Ranges to Onset of Mortality for Fish – Mitigated (with 10 dB)

Fish Hearing Group	Onset of Mortality	All sites: Maximum (m)				
		E4 (2.3 kg)	E6 (9.1 kg)	E8 (45.5 kg)	E10 (227 kg)	E12 (454 kg)
All Fish Hearing Groups	$L_{p,\ 0\text{-pk},\ flat}$: 229 dB	49	80	135	230	290

Source: Hannay and Zykov 2022.
Note: Water Depth 50 m.
dB = decibels; dB re 1 μPa = decibels relative to 1 micropascal; kg = kilograms; L_{pk} = peak sound pressure level; m = meters

Fish mitigation and monitoring measures during UXO detonations will include the use of a dual noise-mitigation system with a 10 dB attenuation, seasonal restrictions, and post-detonation monitoring for injured and/or dead fish. It is not possible to maintain pre-start clearance zones or conduct visual monitoring for fish prior to UXO detonations. Any fish kills involving protected species will be reported to the appropriate agencies as outlined in Table 1-11 and Table 1-12.

Effects of Exposure to Noise Above the Mortality Thresholds

Modeling indicates that the distance for a UXO detonation to result in physiological injury resulting in mortality for Atlantic sturgeon ranges between 160 feet (49 meters) and 951 feet (290 meters) (depending on the charge weight). As described in Section 3.4.1.2, Atlantic sturgeon could occur in the Offshore Wind Area, where they could be exposed to UXO detonations. Individuals present in the area will likely occur intermittently, moving through the Offshore Wind Area throughout their spring and fall migrations and may forage opportunistically in areas where benthic invertebrates are present. The area is not known to be a preferred foraging area and has not been identified as an aggregation area which further reduces the potential for impact to this species from UXO detonations. Given the dispersed distribution of Atlantic sturgeon in the Lease Area, the potential for co-occurrence in time and space is considered unlikely but possible with greater exposures during the colder months. The Applicant is not planning to monitor for Atlantic sturgeon prior to detonations but has committed to the implementation of a dual noise-mitigation systems during all detonation events. This, coupled with the unlikely detonation of UXO, the conservative approach to modeling distances, the low number of potential detonations required for the Project (unknown, but modeled for no more than 10), and the commitment to a dual noise-mitigation system with 10 dB attenuation, further reduces the potential for exposure to Atlantic sturgeon. The full extent of the potential for injuries is not known and if they occur, they could result in physiological impacts that lead to injury or mortality of small numbers of Atlantic sturgeon if they are present within the areas outlined in Table 3-45. However, the seasonal restriction of UXO detonations from November through April would effectively eliminate the likelihood of any exposures for Atlantic sturgeon and would be **discountable**. Therefore, the effects of noise and blast exposure from Project

UXO detonations leading to mortality **may affect, not likely to adversely affect** small numbers of Atlantic sturgeon.

Effects of Exposure to Noise Above the Behavioral Thresholds

Reaction of fish to explosives is absent from the literature. Fish are likely to react in a similar way to sea turtles. U.S. Navy (2017) assumed that sea turtles would exhibit no more than a brief startle response to any individual explosive. Prolonged avoidance of the area is only considered likely if the event includes multiple explosives events, which is not part of the Proposed Action.

The low number of potential UXOs identified in the Project area and Ocean Wind's commitment to using a dual noise-mitigation system for all detonations and the BOEM proposed seasonal restriction would further reduce all potential underwater noise effects associated with UXO detonations. Should a sturgeon be exposed to noises above behavioral thresholds the effects would likely be brief (e.g., Atlantic sturgeon may be startled and divert away from the area), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project UXO detonations leading to TTS/behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

3.4.2.1.2.3 Non-impulsive Underwater Noise

Project-generated non-impulsive underwater noise activities are: vibratory pile driving associated with installation and removal of the cofferdam, some HRG surveys, vessel operations, aircraft operations, cable laying and trenching, dredging and WTG operations. To support the analysis the GARFO Acoustics Tool: *Analyzing the effects of pile driving in riverine/inshore waters on ESA-listed species in the Greater Atlantic Region* (NOAA 2020) was used to determine the extent of behavioral effects to Atlantic sturgeon for vibratory pile driving activities. In addition, the HRG programmatic was used to determine potential extent of effects of Project HRG surveys on Atlantic sturgeon (NMFS 2021c). However, there are no tools specific for vessel operations, aircraft operations, cable laying and trenching, dredging, or WTG operations, and therefore, the discussion regarding potential effects from these activities to Atlantic sturgeon is qualitative.

Vibratory Pile Driving (C)

Installation and removal of sheet piles will require the use of a vibratory hammer as described above under Section 3.2.6.2. A practical spreading loss model developed within the GARFO Acoustics Tool was used to estimate the extent of potential underwater noise effects from vibratory driving of sheet piles to fish thresholds. The model uses a Transmission Loss equation of TL = 15*log(R1/R0) and has been developed for open ocean environments (NOAA 2020). The tool provides proxy project information for vibratory pile driving project similar to the Proposed Action (Table 3-46). The resulting ranges to sturgeon behavioral thresholds are outlined in Table 3-47.

Table 3-46 Proxy Projects for Estimating Underwater Noise for Atlantic Sturgeon

Pile Type	Hammer Type	Water Depth (m)	Pile Size (inches)	Attenuation rate (dB/10m)	Estimated Peak Noise Level (dB_{Peak})	Estimated Pressure Level (dB_{RMS})	Estimated Single Strike Sound Exposure Level (dB_{SEL})
AZ Steel Sheet	Vibratory	15	24	5	182	165	165

Source: NOAA 2020
Notes: Model was last updated September 14, 2020

dB = decibels; dB_{Peak} = peak decibels; dB_{RMS} = decibels root mean squared; dB_{SEL} = decibels sound equivalent level; m = meters

Table 3-47 Estimated Distances to Sturgeon Behavioral Thresholds

Type of Pile	Hammer Type	Distance (m) to Behavioral Disturbance Threshold (150 dB_{RMS})
24-inch AZ Steel Sheet	Vibratory	100

Source: NOAA 2020
m = meters; dB_{RMS} = decibels root mean squared

Effects of Exposure to Noise Above the Physiological Injury Thresholds

Based on the GARFO modeling conducted, peak injury threshold for physiological injury would be exceeded at < 3.3 feet (1 meter) from the source. Due to the small distance in which these effects could occur, they are considered extremely unlikely to occur and **discountable**. Cumulative injury thresholds are not expected to be exceeded, therefore there is **no effect**. The effects of noise exposure from Project vibratory pile driving leading to physiological injury **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Effects of Exposure to Noise Above the Behavioral Thresholds

Based on the GARFO Acoustics Tool (NOAA 2020) used to determine the extent of potential behavioral effects, behavioral thresholds for fish would be exceeded up to 328 feet (100 meters) from the source. Vibratory pile driving is only expected to occur over a 4-day period. With the relatively small areas in which behavioral disturbance is expected to occur and the short duration of the activity, the potential for behavioral exposure to the ESA-listed Atlantic sturgeon is reduced. Should a sturgeon be exposed to noises above behavioral thresholds the effects would likely be brief (e.g., Atlantic sturgeon may divert away from the area), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project vibratory pile driving leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

HRG Surveys (pre-C, C, O&M, D)

A total of 3,797 miles (6,110 km) of HRG surveys are estimated to be required in the Offshore Project area and export cable route area. Further details on the scope of the HRG surveys are presented above in Section 1.3.4.1. Several HRG survey sources not likely to be detectable by Atlantic sturgeon as they operate above the hearing sensitivity of this species (above 1 kHz; Table 3-18).

BOEM completed a desktop analysis of nineteen HRG sources in Crocker and Fratantonio (2016) to evaluate the distance to thresholds of concern for listed species. To provide the maximum impact scenario for these calculations, the highest power levels and most sensitive frequency setting for each species were used when the equipment had the option for multiple user settings and a worst-case exposure scenario of 60 continuous minutes for fish. All sources were analyzed at a tow speed of 4.5 knots (2.3 m/s), the expected speed of project HRG vessels while conducting surveys. Distances to potential onset of physiological injury using the FHWG (2008) thresholds were calculated. Using a spherical spreading model (20 log(r)), BOEM also calculated the distances to the behavioral threshold for fish (e.g., 150 dB re 1 μPa SPL). Result of the analysis are presented below in Table 3-48.

Table 3-48 Summary of Physiological Injury and Behavioral Disturbance Distances from Mobile HRG Sources for Fish

HRG Source	Highest Source Level (dB re 1 μPa)	Distance (in meters) to Physiological Injury		Distance (in meters) to Behavioral Disturbance
		L_{pk}	$L_{E,24h}$	L_{rms}
Mobile, Impulsive, Intermittent Sources				
Boomers, Bubble Guns	176 dB $L_{E,24h}$ 207 dB L_{rms} 216 L_{pk}	3.2	0	708
Sparkers	188 dB $L_{E,24h}$ 214 dB L_{rms} 225 L_{pk}	9	0	1,996[a]
Chirp Sub-Bottom Profilers	193 dB $L_{E,24h}$ 209 dB RMS 214 L_{pk}	N/A	N/A	32
Mobile, Non-impulsive, Intermittent Sources				
Multi-beam echosounder (100 kHz)	185 dB $L_{E,24h}$ 224 dB L_{rms} 228 L_{pk}	N/A	N/A	N/A
Multi-beam echosounder (>200 kHz) (mobile, non-impulsive, intermittent)	182 dB $L_{E,24h}$ 218 dB L_{rms} 223 L_{pk}	N/A	N/A	N/A
Side-scan sonar (>200 kHz) (mobile, non-impulsive, intermittent)	184 dB $L_{E,24h}$ 220 dB L_{rms} 226 L_{pk}	N/A	N/A	N/A

Source: NMFS 2021c
Notes: Assumed vessel moving at speeds of 4.5 knots; fish thresholds were taken from FHWG (2008); Spreadsheet and geometric spreading models do not consider the tow depth and directionality of the sources; therefore, these are likely overestimates of actual disturbance distances.
[a] The calculated distance to the 150 dB rms threshold for the Applied Acoustics Dura-Spark is 1,996 m; however, the distances for other equipment in this category is significantly smaller.
L_{pk} = peak sound pressure level, PTS threshold
$L_{E,24h}$ = cumulative sound exposure level over 24 hours, PTS threshold
L_{rms} = sound pressure level root mean squared, behavior threshold
dB = decibels; kHz = kilohertz m = meters; HRG = high-resolution geophysical; N/A = not applicable due to the sound source being out of the hearing range for the group $R_{95\%}$ = maximum acoustic range at which the sound level was encountered after the 5% farthest points were excluded

Effects of Exposure to Noise Above the Physiological Injury Thresholds

As noted above, several of the HRG survey sources are not likely to be detectable by Atlantic sturgeon as they operate above the hearing sensitivity of this species (above 1 kHz; Table 3-18) and are shown in Table 3-48 as not applicable (N/A). Therefore, physiological injury thresholds are not expected to be exceeded for non-parametric shallow penetration SBPs (non-impulsive) HRG surveys (e.g., ET 216 (2000DS or 3200 top unit), ET 424, ET 512, GeoPulse 5430A, and Teledyne Benthos Chirp I–I - TTV170; Table 3-18); therefore, there is **no effect** to Atlantic sturgeon from these HRG surveys.

The Applicant has indicated they will use boomers and sparkers during their HRG surveys (e.g., AA, Dura-spark UHD [400 tips, 500 joules (J)] AA, triple plate S-Boom [700 to 1,000 J]; Table 3-18). The analysis conducted by BOEM in NMFS 2021c indicates that boomers and sparkers could exceed peak physiological injury thresholds for Atlantic sturgeon at 10.4 feet (3.2 meters) and 29.5 feet (9 meters) respectively. Cumulative physiological injury thresholds are not anticipated to be exceeded. With the implementation of ramp-ups, the potential for serious injury is minimized. Ramp-up would facilitate a gradual increase of equipment energy to allow marine life to leave the area prior to the start of operations at full energy that could result in injury. Ramp-ups could be effective in deterring Atlantic sturgeon from HRG survey equipment prior to exposure resulting in serious injury. In addition, as the survey equipment is secured to the survey vessel or towed behind a survey vessel and is only turned on when the vessel is traveling along survey transect, the potential effects are transient and intermittent. Considering the relatively small injury zones, the implementation of ramp-up procedures and the transient nature of the effect the potential for Atlantic sturgeon to be exposed to noise sources above physiological thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project HRG surveys leading to physiological injury **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Effects of Exposure to Noise Above the Behavioral Thresholds

The analysis conducted by BOEM in NMFS 2021c indicates that boomers, sparkers and chirps could exceed behavioral thresholds for Atlantic sturgeon at 2,322 feet (708 meters), 6,548 feet (1,996 meters), and 105 feet (32 meters), respectively. However, as the survey equipment is secured to the survey vessel or towed behind a survey vessel and is only turned on when the vessel is traveling along survey transect, the potential effects are transient and intermittent. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the equipment and divert away from it), and no avoidance of preferred foraging area or known aggregation areas is considered likely. Effects of this brief exposure could result in displacement of opportunistic feeding areas; however, any impacts associated with this avoidance would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project HRG surveys leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Vessel Noise (pre-C, C, O&M, D)

There are several types of vessels that would be required throughout the life of the Project. Table 1-4 and Table 1-5 outline the type of vessels that would be required for Project construction and operations as well as the maximum number of vessels required by vessel type. The size of these vessels range from 325 to 350 feet (99 to 107 meters) in length, from 60 to 100 feet (18 to 30 meters) in beam, and draft from 16 to 20 feet (5 to 6 meters). SPL source levels for large vessels range from 177 to 188 dB re 1 μPa-m with frequencies between less than 40 Hz and 100 Hz (McKenna et al. 2012). Smaller support vessels typically produce higher-frequency sound concentrated in the 1,000 Hz to 5,000 Hz range, with source levels ranging from 150 to 180 dB re 1 μPa-m (Kipple 2002; Kipple and Gabriele 2003).

Effects of Exposure to Noise Above the PTS Thresholds

It is unlikely that received levels of underwater noise from vessel activities would exceed physiological injury thresholds for Atlantic sturgeon, therefore, the potential for ESA-listed Atlantic sturgeon to be exposed to noise above physiological injury thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project vessel operations leading to physiological injury **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Effects of Exposure to Noise Above the Behavioral Thresholds and Masking

Potential masking effects to fish from vessel noise has been reported (Vasconcelos et al. 2007), as well as behavioral effect from similar sources. Continuous sounds produced by marine vessels have been reported to change fish behavior, causing fish to change speed, direction, or depth; induce avoidance of affected areas by fish; or alter fish schooling behavior (Engås et al. 1995, 1998; Mitson and Knudsen 2003; Sarà et al. 2007; De Robertis and Handegard 2013). It was observed that high levels of low-frequency noise (from 10 to 1,000 Hz) may be responsible for inducing an avoidance reaction (Sand et al. 2008).

Behavioral effects are considered possible but would be temporary with effects dissipating once the vessel or individual has left the area. In addition, Atlantic sturgeon are benthic feeders and therefore, are unlikely to be affected while foraging by a transient vessel noise source. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the vessel and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project vessel operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Aircraft Noise (C, O&M, D)

Helicopter support would be required during several Project activities through construction, O&M, and decommissioning. The number of helicopter trips required for construction is provided in Table 1-5. Patenaude et al. (2002) showed that aircraft operations could result in temporary behavioral responses to marine mammals; however, similar studies on fish are not available in the literature. Kuehne et al. (2020) demonstrated that underwater noise from large Boeing EA-18G Growler aircrafts and determined that sound signatures of aircraft at a depth of 98 feet **(**30 meters) below the sea surface had underwater noise levels of 134 (± 3) dB re 1 µPa SPL. Noise from helicopters required for the Project are expected to be less than those generate by these larger aircrafts.

BOEM expects that most aircraft operations would occur above 1,500 feet (457 meters) (NARW aircraft approach regulation) except under specific circumstances (e.g., helicopter landings on the service operation vessel or visual inspections of WTGs). Exposure of noises above physiological injury, TTS, and behavioral thresholds from Project aircraft for Atlantic sturgeon is extremely unlikely to occur and is **discountable** for physiological injury and **insignificant** for behavioral thresholds. Therefore, the effects of noise exposure from Project aircraft activities leading to physiological injury/ behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Cable Laying or Trenching Noise (C)

Cables would typically be laid, and post-lay burial would be performed using a jetting tool, if seabed conditions allow. Cables may remain on the seabed within the Wind Farm Area for up to 2 weeks. Possible installation methods for these options include jetting, vertical injection, controlled-flow excavation, trenching, and plowing. Boulder clearance would take place prior to construction to clear the cable corridor in preparation for trenching and burial operations. Noise generated by boulder clearance and controlled-flow excavation are discussed below under dredging.

The action of laying the cables on the seafloor itself is unlikely to generate high levels of underwater noise. Most of the noise energy would originate from the vessels themselves including propellor cavitation noise and noise generated by onboard thruster/stabilization systems and machinery (e.g., generators), including noise emitted by the tugs when moving the anchors.

There is limited information regarding underwater noise generated by cable-laying and burial activities in the literature. Johansson and Andersson (2012) recorded underwater noise levels generated during a comparable operation involving pipelaying and a fleet of nine vessels. Mean noise levels of 130.5 dB re 1 µPa were measured at 4,921 feet (1,500 meters) from the source. Reported noise levels generated during a jet trenching operation provided a source level estimate of 178 dB re 1 µPa-m measured at 3.3 feet (1 meter) from the source (Nedwell et al. 2003).

Effects of Exposure to Noise Above the PTS Thresholds

It is unlikely that received levels of underwater noise from cable-laying operations would exceed physiological injury thresholds for Atlantic sturgeon since the animals would move away from any noise that could result in injury. Thus, the potential for ESA-listed Atlantic sturgeon to be exposed to noise above physiological injury thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project cable-laying operations leading to physiological injury **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Effects of Exposure to Noise Above the Behavioral Thresholds

Behavioral effects are considered possible but would be temporary with effects dissipating once the activity or individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the noisy area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project vessel operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Dredging Noise (C)

Dredging may occur in the Wind Farm Area and export cable corridors for sandwave clearance. Ocean Wind has indicated that sandwave clearance work could be undertaken by traditional dredging methods such as a mechanical clamshell dredge, as well as hydraulic trailing suction hopper or controlled-flow excavator. Dredging may be required at the HDD in-water exit pit at the Oyster Creek landfall site on the east side of Island Beach State Park and at the HDD in-water exit pit for the BL England site.

Dredging may also be required in the shallow areas of Barnegat Bay to allow vessel access for export cable installation. Locations include the prior channel (west side of Island Beach State Park/east side of Barnegat Bay), the west side of Barnegat Bay at the export cable landfall, and the Oyster Creek section of the federal channel in Barnegat Bay if USACE is unable to conduct dredging in this area as part of the federal channel dredging that is currently under contract.

Mechanical clamshell dredging refers to grabs used to remove seafloor material. Noise produced by mechanical dredges is emitted from winches and derrick movement, bucket contact with the substrate, digging into substrate, bucket closing, and emptying of material into a barge or scow (Dickerson et al. 2001). Reported sound levels of clamshell dredges include 176 dB re 1 μPa-m (BC Moti 2016) and 107 to 124 dB re 1 μPa at 505 feet (154 meters) from the source with peak frequencies of 162.8 Hz (Dickerson et al. 2001; McQueen et al. 2019). Maximum levels occurred when the dredge bucket made contact with the channel bottom in mixed coarse sand or gravel (Dickerson et al. 2001; McQueen et al. 2019). Hydraulic trailing suction hopper dredging and controlled-flow excavation dredging involve the use of a suction to either remove sediment from the seabed or relocate sediment from a particular location on the seafloor. The sound produced by hydraulic dredging results from the combination of sounds generated by the impact and abrasion of the sediment passing through the draghead, suction pipe, and pump. The frequency of the sounds produced by hydraulic suction dredging ranges from approximately 1 to 2 kilohertz, with reported source levels of 172 to 190 dB re 1 μPa-m (Robinson et al. 2011; Todd et al. 2015; McQueen et al. 2019). Robinson et al. (2011) noted that the level of broadband noise generated by suction dredging is dependent on the aggregate type being extracted, with coarse gravel generating higher noise levels than sand.

Effects of Exposure to Noise Above the PTS Thresholds

It is unlikely that received levels of underwater noise from dredging operations would exceed physiological injury thresholds for Atlantic sturgeon since the animals would move away from any noise that could result in injury. Thus, the potential for ESA-listed Atlantic sturgeon to be exposed to noise above physiological injury thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure from Project dredging leading to physiological injury **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Effects of Exposure to Noise Above the Behavioral Thresholds

If dredging occurs in one area for relatively long periods, behavioral thresholds are possible. As outlined above. Behavioral responses of fish to vessel noises include changes swim speeds, direction, or depth, avoidance and alterations of schooling behaviors.

Behavioral effects are considered possible but would be temporary with effects dissipating once the activity has ceased or individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project dredging operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

WTG Operations (O&M)

Sound is generated by operating WTGs due to pressure differentials across the airfoils of moving turbine blades and from mechanical noise of bearings and the generator converting kinetic energy to electricity. Sound generated by the airfoils, like aircraft, is produced in the air and enters the water through the air-water interface. Mechanical noise associated with the operating WTG is transmitted into the water as vibration through the foundation and subsea cable. Both airfoil sound and mechanical vibration may result in long-term, continuous noise in the offshore environment. Measured underwater sound levels in the literature are limited to geared smaller wind turbines (less than 6.15 MW), as summarized by Tougaard et al. (2020).

Underwater noise generated by these smaller-geared turbines is of a low frequency and at relatively low SPLs near the foundation, dissipating to ambient background levels within 0.6 miles (1 km) (Dow Piniak et al. 2012; Elliott et al. 2019; summarized in Tougaard et al. 2020). Tougaard et al. 2009 measured SPLs ranging between 109 and 127 dB re 1 μPa underwater 45 and 65 feet (14 and 20 meters) from the foundations at frequencies below 315 Hz up to 500 Hz. Wind turbine acoustic signals above ambient background noise were detected up to 2,066 feet (630 meters) from the source (Tougaard et al. 2009). Noise levels were shown to increase with higher wind speeds (Tougaard et al. 2009). Another study detected SPLs of 125 to 130 dB re 1 μPa up to 984 feet (300 meters) from operating turbines in frequencies between 875 and 1,500 Hz (Lindeboom et al. 2011). At 164 feet (50 meters) from a 3.6 MW monopile wind turbine, Pangerc et al. (2016) recorded maximum SPLs of 126 dB re 1 μPa with frequencies of 20 to 330 Hz, which also varied with wind speed. Kraus et al. (2016) measured ambient noise conditions at three locations adjacent to the proposed South Fork Wind Farm over a 3-year period and identified baseline levels of 102 to 110 dB re 1 μPa. They also found that maximum operational noise levels typically occurred at higher wind speeds when baseline noise levels are higher due to wave action. Tougaard et al. (2020) concluded that operational noise from multiple WTGs could elevate noise levels within a few kilometers of large windfarm operations under very low ambient noise conditions.

Available data on large direct-drive turbines are sparse. Direct-drive turbine design eliminates the gears of a conventional wind turbine, which increases the speed at which the generator spins. Direct-drive generators are larger generators that produce the same amount of power at slower rotational speeds. Only one study of direct-drive turbines presented in Elliott et al. (2019) was available in the literature. The study measured SPLs of 114 to 121 dB re 1 μPa L_{rms} at 164 feet (50 meters) for a 6 MW direct-drive turbine.

Based on measurements from WTGs 6.15 MW and smaller, Stöber and Thomsen (2021) estimated that operational noise from larger (10 MW WTG), current-generation WTGs would generate higher source levels (177 dB re 1 µPa-m) than earlier research. Additionally, Stöber and Thomsen (2021) estimates that a shift from gear-driven wind turbines to direct drive turbines would decrease sound levels by 10 dB resulting in a range to the 120 dB re 1 µPa behavioral threshold of 1.4 km (0.9 miles). Using the least-squares fits from Tougaard et al. (2020), SPLs from 11.5 MW turbines (in 20 m/s, gale-force wind) would be expected to fall below the same behavioral threshold within 245 m (about 800 ft). In lighter, 10 m/s winds (~20 kts) the predicted range to threshold would be only 140 m (about 460 ft). Both models were based on small turbines and a small sample size, adding uncertainty to the modeling results. Stöber and Thomsen (2021) use only the loudest measurements from each study cited. While this is reasonable practice for most sound source studies, sound from an operating WTG can be expected to correlate with wind speed and therefore with higher environmental noise. Scaling the loudest sound measurements linearly with turbine power will scale environmental noise up along with it and can be expected to overestimate sound levels from larger turbines and is especially concerning as no correlation coefficient was provided to assess the goodness of fit. Tougaard et al. (2020) take wind speed into account for each of the measurements in their fit and scale the level with WTG power using a logarithmic measurement. Because of these factors, range estimates based on Tougaard et al. (2020) are considered more relevant to this assessment.

Effects of Exposure to Noise Above the PTS Thresholds

Based on the source levels presented above, it is unlikely that received levels of underwater noise from WTG operations would exceed physiological injury thresholds for Atlantic sturgeon, therefore, the potential for ESA-listed Atlantic sturgeon to be exposed to noise above physiological injury thresholds is considered extremely unlikely to occur and is **discountable**. The effects of noise exposure from Project WTG operations leading to PTS **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Effects of Exposure to Noise Above the Behavioral Thresholds

Based on the available source levels and modeling information presented above, underwater noise from WTG operations could exceed behavioral thresholds and cause masking of communications. However, more acoustic research is warranted to characterize SLs originating from large direct-drive turbines, the potential for those turbines to cause behavioral effects, and to what distance behavioral and masking effects are likely. Because of this BOEM has included a monitoring requirement that the Applicant conduct underwater noise monitoring during WTG operations, particularly during high wind events (Table 1-12).

Atlantic sturgeon may be exposed to noise levels that exceed behavioral thresholds during WTG operations, particularly during high wind events when ambient underwater noise levels are also elevated and behavioral reactions may include avoidance of the area. As described above, it is expected that Atlantic would occur intermittently in the Offshore Wind Area throughout their spring and fall migrations and may be forage opportunistically in areas where benthic invertebrates are present. The area is not known to be a preferred foraging area and has not been identified as an aggregation area which reduced the potential for impact to this species from long-term operation noise. Given the interim definition for ESA harassment, the animals ability to avoid harmful noises, the lack of preferred foraging area and known aggregations in the Offshore Wind Area, the potential for ESA-listed Atlantic sturgeon to be exposed to underwater noise exceeding behavioral thresholds or masking effects from WTG operations would not rise to the level of take under the ESA and is therefore considered **insignificant**. Therefore, the effects of noise exposure from Project WTG operations leading to behavioral disturbance and masking **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

3.4.2.1.2.4 Effects to Prey Organisms

Atlantic sturgeon are opportunistic predators that feed primarily on benthic invertebrates but will adjust their diet to exploit other types of prey resources when available. They have been documented to feed on polychaetes, isopods, amphipods, clams, fish larvae (Johnson et al. 1997), small fish, amphipods, oligochaetes, chironomids, and nematodes (Guilbard et al. 2007).

Invertebrate sound sensitivity is restricted to particle motion, and affects are expected to dissipate rapidly such that any effects are highly localized from the noise source (Edmonds et al. 2016). This indicates that the invertebrate forage base for Atlantic sturgeon is unlikely to be measurably affected by underwater noise resulting from the Project activities Action. Detonation of UXO, however, could temporarily reduce the abundance of invertebrates in proximity to the activity. However, the area is not known to be a preferred foraging area for Atlantic sturgeon and therefore, they would likely move to other benthic areas not affected by detonations to feed opportunistically.

Impact pile driving and UXO detonations may temporarily reduce the abundance of forage fish, eggs, and larvae in proximity to activity. Table 3-43 and Table 3-44 outline the potential distances in which physiological injury, recoverable injury and behavioral effects could occur to small forage fish (<2 grams) and eggs and larvae. However, impacts to these species is unlikely to result in an effect on the survival and fitness of Atlantic sturgeon based on the minimal contribution of fish to their overall diet and the ability of the species to adjust their diet to exploit other types of prey resources when available. The effects to Atlantic sturgeon due to reduction in prey items from underwater noise generated by the Project would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, impacts from underwater noise sources due to the Proposed Action **may affect, not likely to adversely affect** prey organisms for Atlantic sturgeon.

3.4.2.2. Dredging Effects on Marine Fish [C]

Impacts from dredging during construction, in addition to the noise discussed in Section 3.4.2.1, could affect ESA-listed marine fish through impingement, entrainment, and capture associated with mechanical and hydraulic dredging techniques. As mentioned in Section 3.2.6.2, clamshell and suction dredging for the Project may occur both inshore and offshore within the Wind Farm Area and export cable corridors for sandwave clearance. Additionally, dredging may also be required in the HDD pits at landfall and in shallow areas of Barnegat Bay to allow vessel access for export cable installation. Approximately 18,000 yd^3 (13,762 m^3) of sediment would be removed from a 3.7-acre (0.01 km^2) area in order to maintain the Oyster Creek federal navigation channel to its authorized 200-foot width and 8-foot depth (61-meter width and 2.4-meter depth). However, since the environmental review for maintenance dredging to authorized depth and width is covered under the USACE federal permit as part of their Barnegat Inlet Federal Navigation Project, the effects of these actions are not considered in the following analysis. Mechanical dredging would consist of lowering an open clamshell bucket through the water column and once the bucket contacts the seafloor, closing the bucket jaws to trap and scoop the sediment that is then brought to the surface. Hydraulic dredging uses dragheads that trail along the seafloor removing sediment.

Dredging during construction could carry a variety of impacts on Atlantic sturgeon related to injury and mortality associated with dredging techniques as well as impacts to prey. Adult Atlantic sturgeon are expected to be well distributed throughout the Project area (Dunton et al. 2010). The risk of interactions between sturgeon and mechanical dredges is thought to be highest in areas where large numbers of sturgeon are known to aggregate. There are no known areas of sturgeon aggregations within the proposed areas for dredging for the Project. The risk of capture may also be related to the behavior of the sturgeon in the area. While foraging, sturgeon are at the bottom interacting with the sediment (Dadswell 2006). This behavior may increase the susceptibility of capture with a dredge bucket. For entrapment to occur, an individual sturgeon would have to be present directly below the dredge bucket at the time of operation. Given the rarity of sturgeon in the area to be dredged, the co-occurrence of an Atlantic sturgeon and the dredge bucket is extremely unlikely. As such, entrapment of sturgeon during the temporary performance of mechanical dredging operations is also extremely unlikely. Due to their bottom foraging and swimming behavior adult Atlantic sturgeon have been known to become entrained in hydraulic-cutterhead dredges they move across the seabed (Novak et al. 2017; Balazik et al. 2020; NMFS 2022b). Given the need for a sturgeon to approach within 1 meter of the dredge head to become entrained and the lack of attraction or deterrence relationship observed between Atlantic sturgeon and dredges, the likelihood of effects to Atlantic sturgeon from Project dredging is low (Balazik et al. 2020; NMFS 2022b). Thus, the likelihood of an Atlantic sturgeon becoming entrained in a mechanical dredge associated with the Proposed Action is considered extremely unlikely to occur and **discountable**.

Juvenile Atlantic sturgeon are known to inhabit estuarine environments for up to a year before migrating out into the ocean (ASMFC 2012). Though the presence of SAV has been recorded in Barnegat Bay, no known strong association has been documented between juvenile Atlantic sturgeon and SAV (ASMFC 1997). Additionally, no juvenile or adult Atlantic sturgeon were recorded during a 3-year trawl survey of Barnegat Bay that spanned all four seasons (Valenti et al. 2017). It is not anticipated that dredging in Barnegat Bay due to inshore export cable installation would impact juvenile Atlantic sturgeon.

Atlantic sturgeon prey upon small bottom-oriented fish such as the sand lance, mollusks, polychaete worms, amphipods, isopods, and shrimp, with polychaetes and isopods being the primary and important groups consumed in the Project area (Smith 1985; Johnson et al. 1997; Dadswell 2006). Sand lance could become entrained in a hydraulic dredge due to their bottom orientation and burrowing within sandy sediments that require clearing by the Project. Reine and Clarke (1998) found that not all fish entrained in a hydraulic dredge are expected to die. Studies summarized in Reine and Clarke (1998) indicate a mortality rate of 37.6% for entrained fish. It is expected that dredging in sandwaves to allow for cable installation will result in the entrainment and mortality of some sand lance. Given the size of the area where dredging will occur and the short duration of dredging, benthic infauna and epifauna will likely experience 100% mortality. However, given the size of the area where dredging will occur, the short duration of dredging, the loss of benthic invertebrates and sand lance will be small, temporary, and localized, and the opportunistic feeding nature of Atlantic sturgeon, it is expected any impact of the loss of Atlantic sturgeon prey items to be so small that it cannot be meaningfully measured, evaluated, or detected.

Therefore, the effects of entrainment from the Project dredging leading to injury or mortality **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon**.**

3.4.2.3. Habitat Disturbance Effects on Marine Fish (C, O&M, D)

Similar to the effects described for this stressor in marine mammals Section 3.2.6.4 and sea turtles Section 3.3.5.3, habitat disturbance related to the Project would occur throughout all three phases of construction, operations and maintenance, and decommissioning. Potential effects to ESA-listed Atlantic sturgeon and their prey from habitat disturbance are analyzed below and range from short- to long-term impacts. Individual stressors under habitat disturbance encompass displacement from physical disturbance of sediment; changes in oceanographic and hydrological conditions due to presence of structures; conversion of soft- to hard-bottom habitat; concentration of prey species due to the reef effect; and secondary entanglement due to an increased presence of recreational fishing in response to the reef effect. These are discussed separately and organized by Project phase below.

3.4.2.3.1 Displacement from Physical Disturbance of Sediment (C, D)

Construction of the proposed Project would result in direct temporary disturbance of the seabed within the wind farm area and along the offshore export cable corridors resulting in short-term displacement of prey species residing on top of or within the top few feet of surface sediments. A total of 4,481 acres (18.1 km^2) is proposed for disturbance including boulder clearance along the inter-array, substation and export cables, and vessel anchoring. Areas of temporary disturbance to the seabed are detailed by each Project component in Table 1-3 and are described further below.

After construction activities are completed, these areas should return to the baseline state. The restoration of marine soft-sediment habitats occurs through a range of physical (e.g., currents, wave action) and biological (e.g., bioturbation, tube building) processes (Dernie et al. 2003). Disturbed areas not replaced with hardened structures or scour protection (discussed later in this subsection) totaling 4,041.6 acres (16.4 km^2) would resettle and the benthic community returned to normal typically within 1 year (Dernie et al. 2003; Department for Business, Enterprise and Regulatory Reform 2008). The continental shelf off New Jersey is about 93 miles (150 km) wide and roughly 124 miles (200 km) long, yielding an area of approximately 7,413,161 acres (30,000 km^2) (Milliman 1972). Atlantic sturgeon are known to eat a variety of benthic organisms and are believed to be opportunistic feeders with stomach contents ranging from mollusks, worms, amphipods, isopods, shrimp, and small benthic fish (e.g., sand lance; Smith 1985; Johnson et al. 1997; Dadswell 2006; Novak et al. 2017). Generally, the disturbance of benthic habitat would be short-term and localized, with an abundance of similar foraging habitat and prey available in adjacent areas for Atlantic sturgeon. Additionally, since Atlantic sturgeon would rarely occur within the Offshore Project Area (Stein et al. 2004; Eyler et al. 2009; Dunton et al. 2010; Erickson et al. 2011), they are also unlikely to be affected by seabed disturbance. Therefore, the effects of displacement of Atlantic sturgeon and their prey from physical disturbance of sediment are expected to be so small they cannot be meaningfully measured, evaluated or detected and are therefore **insignificant**.

3.4.2.3.2 Changes in Oceanographic and Hydrological Conditions due to Presence of Structures (O&M)

A detailed description of the potential long-term, O&M effects of the presence of structures on oceanic conditions is presented in Section 3.2.6.4. The greatest concern for Atlantic sturgeon and changes in oceanographic and hydrologic conditions resulting from structures in the open ocean would be potential impacts to prey sources. However, Atlantic sturgeon consume prey not as closely affected by physical oceanographic features, such as the sand lance, mollusks, polychaete worms, amphipods, isopods, and shrimp, as other species discussed in this BA. Potential impacts to larval dispersion and survival of Atlantic sturgeon prey species from changes hydrologic conditions but the effect was deemed likely to be so small that it is extremely unlikely to occur and are, therefore, **discountable**.

3.4.2.3.3 Conversion of Soft-bottom to Hard-bottom Habitat (O&M)

Long-term habitat alterations from soft bottom to hard bottom during O&M of the Project through placement of monopiles and jacketed piles, scour protection, and cable protection. Scour protection would only be added in areas where boulders or other hard substrates are present on or immediately below the bed surface. The maximum case for conversion from soft to hardened substrate through scour protection for the Project is 439.4 acres (1.8 km^2) (Table 1-2). Although these effects would be long term, the placement of additional rock on existing mixed-boulder substrate would not substantially alter the character of the current habitat. Further, the continental shelf off New Jersey is about 93 miles (150 km) wide and roughly 124 miles (200 km) long, yielding an area of approximately 7,413,161 acres (30,000 km^2) (Milliman 1972). Given the opportunistic nature of the Atlantic sturgeon diet and the relatively small area of habitat conversion compared to the wider New Jersey shelf, long-term habitat conversion from soft to hard-bottom habitat is expected to be so small that it cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant effects to ESA-listed marine fish. Other long-term O&M effects such as the reef effects and potential to concentrate recreational fishing or displace commercial fishing effort are not expected to impact Atlantic sturgeon. Recreational fishing is not a concern for mortality and commercial trawl and gillnet operations (fisheries most likely to result in Atlantic sturgeon takes) mostly occur outside the Project area (DNV-GL 2021; NMFS 2022b).

Overall, construction of the WTGs, OSSs, and scour protection would transform 152 acres (0.61 km^2) of potential foraging habitat for Atlantic sturgeon into coarse, hard-bottom habitat. The addition of the WTGs and OSSs is expected to result in a habitat shift in the area immediately surrounding each monopile from soft-sediment, open-water habitat system to a structure-oriented system, including an increase in fouling organisms. Over time (weeks to months), the areas with scour protection are likely to be colonized by sessile or mobile organisms (e.g., sponges, hydroids, and crustaceans). This results in a modification of the benthic community in these areas from primarily infaunal organisms (e.g., amphipods, polychaetes, and bivalves). Hard-bottom habitat and vertical structures in a soft-bottom habitat can create artificial reefs, thus inducing the "reef" effect (Taormina et al. 2018). The reef effect is usually considered a beneficial impact, associated with higher densities and biomass of fish and decapod crustaceans (Taormina et al. 2018), which may provide a potential increase in available forage items for sturgeon compared to the surrounding soft-bottom habitat. Studies have demonstrated that WTG foundations and scour protection acted as artificial reefs with high species diversity and abundance of epibenthic species, comparable to that of a natural rocky reef (Coolen et al. 2018). The only forage fish anticipated to be affected by these habitat alterations would be sand lance. As sand lance are strongly associated with sandy substrate, and the Project would result in a loss of such soft bottom, there would be a reduction in availability of habitat for sand lance that, theoretically, could result in a localized reduction in the abundance of sand lance in the Action Area. However, considering the size of the Action Area, which is dominated by sandy substrate, the loss or conversion of soft-bottom habitat would be very small compared to the surrounding habitat area. Given this small, localized reduction in sand lance and that sand lance is only one of many species the Atlantic sturgeon may feed on in the Action Area, any effects to these species are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant.

Atlantic sturgeon may also experience a reduction in infaunal benthic organisms, such as polychaete worms, in areas where soft substrate is lost or converted to hard substrate. This represents a small portion of the soft-bottom habitat available in this region. However, it is expected that, due to the large foraging areas over which sturgeon search and forage for food, there will be no detectable impacts on the foraging success of sturgeon. Therefore, the effects of conversion of soft-bottom habitat to hard-bottom habitat on Atlantic sturgeon and their prey are expected to be so small they cannot be meaningfully measured, evaluated or detected and are therefore **insignificant**.

3.4.2.3.4 Summary of Habitat Disturbance Effects

As described in the sections above, any effects from habitat disturbance on Atlantic sturgeon are considered so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of habitat disturbance from Project structures **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

3.4.2.4. Secondary Entanglement due to an Increased Presence of Recreational Fishing in Response to Reef Effect (O&M)

Another long-term impact of the presence of structures during O&M is the potential to concentrate recreational fishing around foundations, potentially increasing the risk of Atlantic sturgeon entanglement in both vertical and horizontal fishing lines and increasing the risk of injury and mortality due to infection and starvation. A majority of the recreational and commercial prime fishing areas and fishing activity occurs outside of the Project area (DNV-GL 2021). If there is an increase in recreational fishing in the Project area, it is likely that this will represent a shift in fishing effort from areas outside the wind farm area to within the wind farm area and/or an increase in overall effort. These structures could also result in fishing vessel displacement or gear shift. The potential impact on Atlantic sturgeon from these changes is uncertain. However, if a shift from mobile gear (trolling) to fixed gear (hook and line) occurs due to inability of the fishermen to maneuver mobile gear, there would be a potential increase in the number of vertical lines, resulting in an increased risk of sturgeon interactions with fishing gear. Given vessel safety concerns regarding being too close to foundations and other vessels, the likelihood of recreational fishermen aggregating around the same turbine foundation at the same time is low. Due to their benthic foraging strategy, Atlantic sturgeon have a reduced chance of being exposed to recreational fishing lines in the pelagic WTG area. Thus, exposure of Atlantic sturgeon to entanglement in fishing gear around WTGs is **discountable**. Therefore, potential entanglement due to increased presence of recreational fishing gear associated with WTGs during operations **may affect, not likely to adversely affect** Atlantic sturgeon.

3.4.2.5. Turbidity Effects on Marine Fish (C & D)

Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute reaction is expected (Wilber and Clarke 2001). Directed studies of sturgeon TSS tolerance are currently lacking, but sturgeons, as a whole, are adapted to living in naturally turbid environments like large rivers and estuaries (Johnson 2018). Adult and subadult sturgeon that would be expected to occur in the Project area are tolerant of elevated suspended sediment levels, and as such, Johnson (2018) recommends that sturgeon should not be exposed to TSS levels of 1,000 mg/L above ambient levels for longer than 14 days at a time to avoid behavioral and physiological effects. Tolerance of juvenile Atlantic sturgeon to suspended sediments has been evaluated in a laboratory setting and exposed individuals to TSS concentrations of 100, 250, and 500 mg/L for a 3-day period (Wilkens et al. 2015). Of the fish exposed, 96% survived the test and the authors suggested that the absence of any significant effects on survival or swimming performance indicates that the impacts of sediment plumes in natural settings are minimal where fish have the ability to move or escape. Additionally, APMs to minimize and reduce the potential for adverse effects from water quality changes on Atlantic sturgeon resulting from the Project have been proposed (COP Vol II, Table 1.1-2; Ocean Wind 2022).

Atlantic sturgeon are opportunistic benthivores that feed primarily on mollusks, polychaete worms, amphipods, isopods, shrimps and small bottom-dwelling fishes (Smith 1985; Dadswell 2006).

There would also be increased vessel anchoring during the construction of offshore components of the proposed Project. Anchoring would cause increased turbidity levels, which would be localized, short term, and minor during construction. During installation of array and substation interconnection cables, Ocean Wind anticipates a maximum of 20 vessels operating during a typical workday in the Wind Farm Area. For offshore export cable installation, Ocean Wind anticipates a maximum of 26 vessels operating during a typical workday. The number of vessels is anticipated to result in 14 acres (0.05 km^2) of impact from anchoring.

Atlantic sturgeon would likely depart or avoid unfavorable water quality conditions they may encounter. Suspended sediment and turbidity could result in some temporary avoidance of turbid areas. Any effects from elevated level of turbidity from the project on Atlantic sturgeon or their prey are considered so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of elevated level of turbidity from Project construction and anchoring activities **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

3.4.2.6. Vessel Traffic Effects on Marine Fish (pre-C, C, O&M, D)

Project-related vessels, including those used in pre-construction, construction, O&M, and decommissioning, may pose a potential collision risk to Atlantic sturgeon. Based on information provided by Ocean Wind, construction activities (including offshore installation of WTGs, OSSs, array cables, interconnection cable, and export cable) would require several types of vessels (Table 1-5; Ocean Wind 2022), transiting between the various ports and the Project area an estimated total of 2,859 vessel trips over the 20-month construction period, or approximately 143 trips per month (COP Volume I, Section 6.1; Ocean Wind 2022). Specifications for construction vessels that would be used for Project construction are described Table 1-4. Vessel parameters of those used for O&M are listed in Table 1-7, and trips details of O&M vessel types as well as their approximate drafts are detailed in Table 1-8. Vessels used and number of trips for decommissioning would be similar to those used in construction. Construction vessels would travel between the Wind Farm Area and the following ports that are expected to be used during construction: Atlantic City, New Jersey, as a construction management base; Paulsboro, New Jersey, or from Europe directly for foundation fabrication and load out; Norfolk, Virginia, or Hope Creek, New Jersey, for WTG pre-assembly and load out; and Port Elizabeth, New Jersey, or Charleston, South Carolina, or directly from Europe for cable staging. All O&M transits would occur from Atlantic City, New Jersey, to the Project area.

While Atlantic sturgeon are known to be struck and killed by vessels in rivers and estuaries, there are no reports of vessel strikes in the marine environment, likely due to the space between bottom-oriented sturgeon and the propellers and hull of vessels (BOEM 2021c). Dunton et al. (2010) reported that approximately 95% of all Atlantic sturgeon captured in sampling off New Jersey occurred in depths less than 66 feet (20 meters) with the highest catch per unit of effort at depths of 33 to 49 feet (10 to 15 meters). At these depths in open coastal and marine environments, which would not constrain the distribution or movement of Atlantic sturgeon, they are not likely to be struck by Project-related vessels. Furthermore, the dispersed nature of vessel traffic and individual sturgeon reduces the potential for co-occurrence of individual sturgeon and individual vessels throughout most of the Project area, with the exception of vessels transiting between Paulsboro Marine Terminal and the New Jersey Wind Port in Hope Creek. Over a year and a half, one study detected 181 unique Atlantic sturgeon in an acoustic telemetry array placed in the New York Wind Energy Area (Ingram et al. 2019). Atlantic sturgeon presence peaked from November through January and sturgeon presence and behavior are expected to be similar in the Wind Farm Area. Decreased Atlantic sturgeon presence was noted from July to September, likely due to fish staging near spawning habitat (Ingram et al. 2019). Silber at al. (2010) examined models of whale positioning and potential ship strike for a vessel draft of 26 feet (8 meters), which is the same approximate depth as the deeper draft vessels used by the Project during construction, except for the foundation installation vessel, which has an approximate draft of 44 feet (13.5 meters); Table 1-5). They discovered that the hydrodynamic influence of a ship can extend as far as 79 feet (24 meters) if a whale is directly beneath the passing 26-foot (8-meter) ship. Depths in the Wind Farm area and offshore areas of the export cable route reach approximately 100 feet (30 meters). Therefore, in the offshore areas of the Project area where distance between the seafloor where Atlantic sturgeon tend to be found and the surface are greater than inshore or riverine environments, vessel-related mortalities are expected to be very low.

The downstream boundary of New York Bight Unit 4 are the markers that separate the Delaware River from Delaware Bay at river mile 48.2 (river km 77.6), while the upstream boundary is the Trenton-Morrisville Route 1 Toll Bridge at river mile 133.4 (river km 214.6; 89 FR 39248). Project vessels would transit through New York Bight Unit 4 from the Paulsboro Marine Terminal in Paulsboro, New Jersey (approximately river mile 86.3 [river km 139]) and the New Jersey Wind Port in Hope Creek, New Jersey (approximately river mile 51 [river km 82]) to the Wind Farm Area. Project vessels passing between Paulsboro and the Project area would transit approximately 38 miles (61 km) through the critical Atlantic sturgeon habitat of Unit 4. Only 2.8 miles (4.5 km) of Unit 4 would be transited by those vessels passing between the New Jersey Wind Port and the Project area. A total of 149 trips are proposed by the Project for construction vessels to potentially transit from Paulsboro (Table 3-24). However, these vessels have some of the deepest drafts in the construction vessel fleet. Depths of Delaware Bay average 26.2 feet (8 meters) and reach a maximum of 147.6 feet (45 meters) (Aristizábal and Chant 2013). O&M vessels port in Atlantic City and would not transit through Unit 4 where water body size and aggregations are of greater concern. Propeller boats and barges can pose a risk to fish that swim near the water surface and are a potential source of mortality for Atlantic sturgeon as a result of direct collisions with the hull or propeller (Brown and Murphy 2010). The majority of vessel-related Atlantic sturgeon mortality is likely caused by large transoceanic vessels in river channels (Brown and Murphy 2010; Balazik et al. 2012). Large vessels have been implicated because of their deep draft (up to 40 to 45 feet [12.2 to 13.7 meters]) relative to smaller vessels (15 feet [<4.5 meters]), which increases the probability of vessel collision with demersal fishes like Atlantic sturgeon, even in deep water (Brown and Murphy 2010). A majority of the Project vessel fleet for construction activities have draft between that of the most dangerous large vessels and small vessels examined by Balazik et al. (2012; Table 1-5). Further, O&M vessels are smaller draft vessels (Table 1-7). Although smaller vessels and those with relatively shallow drafts provide more clearance from the river bottom to reduce the probability of vessel strikes, they can operate at a higher speed, which is expected to limit sturgeons' ability to avoid being struck.

Atlantic sturgeon strikes are most likely to occur in areas with abundant boat traffic such as large ports or areas with relatively narrow waterways (ASSRT 2007). Vessel transits for the Project through the critical habitat of the Delaware River during spawning periods when sturgeon aggregate in the spring, pose an increased risk of vessel strikes with Atlantic sturgeon. Breece et al. (2013) discovered that the occupancy of Atlantic sturgeon in the Delaware River during spawning peaked just below the salt front with inhabitance occurring ± 18.6 miles (30 km) 84% of the time with a majority of observations occurring above the salt front. As mentioned in Section 2.3.9, the salt front for the Delaware River varies on a short- and long-term basis, but the long-term median location is recorded at river mile 67 (river km 107.8) in the spring when sturgeon aggregate (Breece et al. 2013; DRBC 2021). Therefore, the greatest risk of Atlantic sturgeon vessel strikes would occur in the spring in a 37-mile (60 km) stretch from river mile 48.3 (river km 77.8) to river mile 85.6 (river km 137.8). Project vessels transiting from the WDA to Paulsboro would transit through the entire high density portion of river; however, only a total of 149 trips during construction would travel this route. Foundation installation is proposed to occur during Q2 through Q4 of 2024 (Table 1-6). Assuming an even distribution of Project vessel trips to Paulsboro during those three quarters, approximately 50 trips would occur per quarter and therefore only 50 Project-related transits through areas of high sturgeon occupancy during spring spawning. Half of the 28 Atlantic sturgeon carcasses collected from 2005 to 2008 exhibited signed of vessel interaction (Brown and Murphy 2010). It is important to note that tissue analyses were not conducted on observed wound margins of salvaged Atlantic sturgeon carcasses to determine whether impact occurred pre- or post-mortem (Brown and Murphy 2010). However, due to the infrequent nature of these transits and the existing amount of vessel traffic, vessel transits in the Delaware River resulting from the Project are not expected to have a significant or measurable effects on Atlantic sturgeon in the Delaware River (NMFS 2021a). In offshore areas, the risk of a vessel strike is likely to be minimal due to overall lower densities of sturgeon and available space for sturgeon to avoid vessels in these areas. The risk of vessel strikes is assumed to be extremely low, as outlined, thus the potential for vessel strikes to ESA-listed Atlantic sturgeon is considered extremely unlikely to occur and **discountable**. Therefore, the effects of vessel strikes from Project vessel activities leading to injury or mortality **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

3.4.2.7. Monitoring Survey Effects on Marine Fish [pre-C, C, O&M]

As mentioned in Section 3.2.6.8 for marine mammals, monitoring surveys are for the Project are proposed during the initial three phases of pre-construction, construction, and operations and maintenance. Monitoring surveys during decommissioning are possible; however, the proposed plans do not extend to that phase. The details of each survey type can be found in Section 1.3.4. Many of the potential impacts to ESA-listed marine fish arising from monitoring surveys during pre-construction, construction, and operations and maintenance are related to increased vessel traffic, underwater vessel noise, and increased for potential for vessel strikes. These stressors are discussed in Sections 3.4.2.6 and 3.4.2.1, respectively. Effects of survey methods include habitat disturbance during trawling, dredging, and pot setting, and potential for entrapment or entanglement in monitoring gear.

Impacts to ESA-listed marine fish specific to each survey type and equipment are described below in this section. The underwater noise effects generated by the survey methods used in the benthic monitoring plan (multibeam echosounder and side-scan sonar methods) used for habitat monitoring are similar to, but of lower magnitude than, the HRG survey methods described in Section 1.3.4.1. As these effects have already been considered, they are not addressed further in this assessment.

3.4.2.7.1 Trawl Survey

Capture of Atlantic sturgeon in trawl gear has the potential to result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations (Moser and Ross 1995; Collins et al. 2000; Moser et al. 2000). However, the use of trawl gear has been employed as a safe and reliable method to capture sturgeon, provided that the tow time is limited (NMFS 2014).

Negative impacts to sturgeon resulting from trawling capture are related to tow speed and duration (Moser et al. 2000). Northeast Fisheries Observer Program data from Miller and Shepherd (2011) indicate that mortality rates of Atlantic sturgeon caught in otter trawl gear is approximately 5%. Short tow durations and careful handling of individuals once on deck are likely to result in a very low risk of mortality to captured individuals (NMFS 2014, 2016b). The equipment and methods used for the Project’s trawl surveys are the same as are used for NEAMAP surveys. Northeast Fisheries Observer Program (NEFOP) data calculates mortality rates of Atlantic sturgeon caught in otter trawl gear as approximately 5% (Miller and Shepherd 2011).

Atlantic sturgeon are captured incidentally in trawls used for scientific studies, including the standard Northeast Fisheries Science Center bottom trawl surveys and both the spring and fall NEAMAP bottom trawl surveys. However, the shorter tow durations and careful handling of any sturgeon once on deck during fisheries research surveys are likely to result in lower potential for mortality to captured individuals, as commercial fishing trawls tend to be significantly longer in duration. None of the hundreds of Atlantic and shortnose sturgeon captured in past state ocean, estuary, and inshore trawl surveys have had any evidence of serious injury and there have been no recorded mortalities. Both the NEFSC and NEAMAP surveys have recorded the capture of hundreds of Atlantic sturgeon since the inception of each. To date, there have been no recorded serious injuries or mortalities. In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s (NMFS 2016b). To date, no serious injuries or mortalities of any sturgeon have been recorded in those surveys. A single capture of Atlantic sturgeon has occurred in trawl surveys currently being conducted for the South Fork Wind offshore wind project.

Given the dispersed nature of Atlantic sturgeon, the limited number of trawl tows that will be conducted and the short tow times of 20 minutes for this Project, and evidence that fisheries research surveys are associated with a low risk of mortality, BOEM does not anticipate serious injury or mortality of Atlantic sturgeon captured during Project trawl surveys. Therefore, the effects of trawl surveys from Project monitoring activities leading to potential capture and/or minor injury **may affect, likely to adversely affect** small numbers of ESA-listed Atlantic sturgeon.

3.4.2.7.2 Structure-Associated Fisheries Surveys

BRUVs are composed of an anchor and camera attached to a line and buoy. There is no evidence that suggests Atlantic sturgeon would be affected or become entangled in the BRUV equipment. Chevron traps are stationary gear that pose a risk of capture for Atlantic sturgeon due to the baited trap. However, fish traps and pots were not recorded as potential sources for capture of Atlantic sturgeon in NEFOP data (Dunton et al. 2015). Atlantic sturgeon prey items such as mollusks and fish may be removed from the marine environment as bycatch in trap gear. However, the survey is non-extractive and any caught prey items will be returned to the site. Therefore, the Ocean Wind structure-associated fishes surveys will not affect the availability of prey for Atlantic sturgeon in the Action Area. Atlantic sturgeon have occasionally been caught via rod and reel; however, BOEM is proposing training of crew conducting fisheries surveys in the safe handling of Atlantic sturgeon in the unlikely event that one were to be captured (Table 1-12). Therefore, serious injury or mortality is extremely unlikely in the even further unlikely event that an Atlantic sturgeon is captured during rod and reel surveys. Given this information, any effects on sea turtles from collection of potential sea turtle prey in the trap gear will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, effects are **insignificant**.

3.4.2.7.3 Clam, Oceanography, and Pelagic Fish Surveys

Tows for the clam survey have a very short duration of 120 seconds, and the vessel is subject to similar mitigation measures as the trawl survey (Table 1-11). Both the oceanography and pelagic fish surveys are non-extractive and also subject to the mitigation measures as the structure-associated fish surveys. Clam and scallop dredges have not been shown to capture Atlantic sturgeon (Dunton et al. 2015). However, prior to deployment of any gear used for surveys, a 15-minute monitoring period would be conducted. If ESA-listed species are sighted during the survey and are at risk of interaction with the research gear, then the sampling station is either moved or canceled or the activity is suspended until there are no sightings of any ESA-listed species for 15 minutes within 0.5 nm (926 meters) of sampling location (Table 1-12). Tows for the clam survey have a very short duration of 120 seconds, and the vessel is subject to similar mitigation measures as the trawl survey (Table 1-11). Additionally, BOEM is proposing training of crew conducting fisheries surveys in the safe handling of Atlantic sturgeon in the unlikely event that one was to be captured (Table 1-12). Therefore, serious injury or mortality is extremely unlikely in the even further unlikely event that an Atlantic sturgeon is captured during Project-related clam surveys. The oceanography and pelagic fish surveys would employ equipment towed at or near the surface that is not expected to have any effect on Atlantic sturgeon. As mentioned above, due to the non-extractive nature of the clam, oceanography, and pelagic fish surveys, impacts to Atlantic sturgeon prey are **discountable**.

Based on the above analysis, the potential for capture of ESA-listed Atlantic sturgeon in clam, oceanography, and pelagic fish survey equipment is considered extremely unlikely to occur and is **discountable**.

3.4.2.7.4 Acoustic Telemetry Surveys

Acoustic telemetry to monitor for tagged fish, elasmobranchs, and invertebrates would be conducted during pre-construction, construction, and O&M phases of the Project. Surveys would employ a combination of fixed hydrophone receivers attached to piers, bulkheads, and floating docks, deployed from a vessel during the structure-associated fishes survey, and attached to a glider during the pelagic fish surveys. The fixed hydrophones would be attached to existing inshore structures and do not pose a risk to Atlantic sturgeon. The mobile hydrophone deployed during the structure-associated fishes survey will be subject to the same pre- and continuous protected species observational periods and, therefore, present a discountable amount of risk to sea turtles (Table 1-12). Additionally, the hydrophone attached to the glider is non-extractive and would average 0.45 knots (0.23 m/s). The potential for effect to Atlantic sturgeon from acoustic telemetry survey equipment is considered extremely unlikely to occur and is **discountable**.

3.4.2.7.5 Passive Acoustic Monitoring Surveys

The use of PAM buoys or autonomous PAM devices to monitor noise, marine mammals, and passive acoustic telemetry tags, and the use of sound attenuation devices placed on the seafloor for mitigation during pile driving have been proposed by Ocean Wind (HDR, Inc. 2022a). The use of sound attenuation devices and PAM for mitigation and monitoring were considered as part of the Proposed Action in the LOA under the MMPA (HDR, Inc. 2022a). As stated in Table 1-11, PAM monitoring surveys for the proposed project will be conducted at pre-construction, construction, O&M and decommissioning phases. These surveys will be used in order to monitor underwater noise and limit potential risk of strikes. Little information is known on the direct impacts of PAM monitoring to the Atlantic sturgeon and pelagic fish. However, no effects to Atlantic sturgeon resulting from moored PAM devices are expected to occur. As stated in measure #2 in Table 1-12, a PAM plan will be submitted to NMFS and BOEM for review and concurrence 120 days prior to start of activities. The PAM plan will identify proposed activities, equipment used, training requirements, mitigation measures and BMPs to be used during PAM monitoring. Additionally, as stated in measure #57 in Table 1-12, all PAM systems will use the best available technology to reduce risk of impacts such as entanglement. As such PAM buoys lines and anchors will be designed to reduce entanglement. All PAM equipment will be properly labeled with lessee and contact information. The potential for effect to Atlantic sturgeon from passive acoustic monitoring survey equipment is considered extremely unlikely to occur and is **discountable**.

Therefore, monitoring survey effects (excluding trawl surveys) due to the Proposed Action are considered **insignificant** or **discountable** and **may affect, not likely to adversely affect** Atlantic sturgeon. The potential effects of trawl surveys cannot be discounted and therefore, **may affect, likely to adversely affect** small numbers of Atlantic sturgeon.

3.4.2.8. Electromagnetic Field Effects on Marine Fish [O&M]

Atlantic sturgeon are electrosensitive but appear to have relatively low sensitivity to magnetic fields based on studies of other sturgeon species. Bevelhimer et al. (2013) studied behavioral responses of lake sturgeon, a species closely related to Atlantic sturgeon, to artificial EMFs and identified a detection threshold between 10,000 and 20,000 mG (1,000 to 2,000 µT), well above the levels likely to result from the proposed Project (i.e., 9.1 to 76.6 mG; 0.91 to 7.66 µT). This indicates that Atlantic sturgeon are likely insensitive to magnetic field effects resulting from the proposed Project. However, sturgeon may be sensitive to the induced electrical field generated by the cable.

Atlantic sturgeon have specialized electrosensory organs capable of detecting electrical fields on the order of 0.5 mV/m (Normandeau 2011; Gill et al. 2012). Exponent Engineering (2018) calculated that the maximum induced electrical field strength in Atlantic surgeon from the Project inter-array cable and the offshore export cable would be 0.43 mV/m or less, slightly below the detection threshold for the species. However, this analysis only considered the field associated with buried cable segments. Based on magnetic field strength, the induced electrical field in sturgeon in proximity to exposed cable segments is likely to exceed the 0.5-mV/m threshold. This suggests that Atlantic sturgeon would likely be able to detect the induced electrical fields in immediate proximity to exposed cable segments. Sturgeon species have been reported to respond to low-frequency AC electric signals. For example, migrating Danube sturgeon (*Acipenser gueldenstaedtii*) have been reported to slow down when crossing beneath overhead high voltage cables and speed up once past them (Gill et al. 2012). This is not a useful comparison, however, because overhead power cables are unshielded and generate relatively powerful induced electrical fields compared to shielded subsea cables. Insufficient information is available to associate exposure with induced electrical fields generated by subsea cables with behavioral or physiological effects (Gill et al. 2012). However, it is important to note that natural electrical field effects generated by wave and current actions are on the order of 10 to 100 mV/m, many times stronger than the induced field generated by buried cable segments. Given the range of baseline variability and limited area of detectable effects relative to available habitat on the OCS, EMF effects on Atlantic sturgeon are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

As mentioned in Section 3.3.5.8, magnetic fields associated with the operation of the transmission line could impact benthic organisms that serve as sturgeon prey. Effects to forage fish, jellyfish, copepods, and krill are extremely unlikely to occur given the limited distance into the water column that any magnetic field associated with the transmission line is detectable. The survival and reproduction of benthic organisms are not thought to be affected by long-term exposure to static magnetic fields (Bochert and Zettler 2004; Normandeau 2011). Results from the 30-month post-installation monitoring for the Cross Sound Cable Project in Long Island Sound indicated that the benthos within the transmission line corridor for this Project continues to return to pre-installation conditions. The presence of amphipod and worm tube mats at several stations within the transmission line corridor suggest construction and operation of the transmission line did not have a long-term negative effect on the potential for benthic recruitment to surface sediments (NMFS 2020, 2021). EMF effects on Atlantic sturgeon prey are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

Therefore, the effects of EMF from the Project **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

3.4.2.9. Air Emissions (Vessels and Offshore Equipment) (C, O&M, D)

As mentioned in Section 3.2.6.10, sources of air pollutant emissions are limited to construction, O&M, and decommissioning phases of the proposed Project. The proposed Project's WTGs, substations, and offshore and onshore cable corridors would not themselves generate air pollutant emissions during normal operations. The following summarizes the estimated air pollutant emissions during construction, O&M, and decommissioning phases.

As presented in Section 3.2.6.10, a summary of estimated emissions during construction of the Project is provided in Table 3-25. During construction, most emissions would occur in the Wind Farm Area from pile and scour protection installation, along the offshore and onshore export cable routes, construction staging areas. Offshore emissions sources would include, but are not limited to:

- Emissions from diesel-fueled generators used temporarily to supply power to various equipment prior to cable installment,
- Emissions from engines used to power pile-driving hammers and air compressors used to supply compressed air to noise-mitigation devices during pile driving, and
- Emissions from vessels used to transport workers, supplies, and equipment to and from the construction areas would result in additional air quality impacts. The Project's use of SES or CTVs for crew transport have the potential to employ technology that reduces emissions compared to standard in-water hull and propeller vessels.

Air emissions from the proposed project would cumulatively add to the carbon dioxide (CO_2) and fossil fuel emissions. Impacts to CO^2 exposure to marine fish is limited. In lab-controlled settings, higher partial pressure of carbon dioxide (pCO^2) (> 30,000 units of microatmospheres; µatm), has been demonstrated to be lethal to many freshwater and marine fish. However, these levels far exceed the potential cumulative air emission resulting from project. Elevations of pCO^2 have demonstrated stress and increased energy spent on acid-base regulation and cardiorespiratory control. (Ishimatsu et al. 2008)

As the NAAQS are designed to ensure that air quality does not significantly deteriorate from baseline levels, it is reasonable to conclude that any effects to listed Atlantic sturgeon from these emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are **insignificant**. Therefore, the effects of air emissions from the Project **may affect, not likely to adversely affect** ESA-listed listed Atlantic sturgeon.

3.4.2.10. Lighting and Marking of Structures (C, O&M, D)

As introduced in Section 3.2.6.11, the Project would introduce artificial light sources to the Project area over the short-term with construction and decommissioning vessels and long-term with the installation stationary light sources over O&M. Light sources from the Project would involve navigational lights which are characterized by intermittent flashes of red hues and do not present a continuous light source. Lighting-related BMPs committed by the Project include red wavelength-emitting diode obstruction lighting; lighting that flashes 30 flashes per minute; use of an aircraft detection lighting system that turns on lights in response to an aircraft in proximity of the wind farm to reduce total time lights are on; and directional shielding of aeronautical obstruction lights to prevent visibility below the horizontal plane, particularly for the demersal Atlantic sturgeon who generally feed on benthic invertebrates.

With the application of mitigation measures the potential effects to turtles and their prey from lighting are likely so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are **insignificant**. Therefore, the effects of lighting of structures from the Project **may affect, not likely to adversely affect** ESA-listed turtles.

3.4.2.11. Unexpected/Unanticipated Events (C, O&M, D)

As introduced in Section 3.2.6.12, unexpected and unanticipated events are not part of the Proposed Action but have a low potential to occur and are considered in the Draft EIS. These unlikely events have the potential to impact ESA-listed marine fish and include vessel collision and allision with foundations, failure of WTGs due to a weather event, oil spill, or chemical release.

In the event of a vessel collision/allision with a turbine, fluids contained within the turbine may be released or a catastrophic failure or collapse of the turbine may occur. Measures in place to minimize the risk of vessel collision/allision include turbine depiction on navigation charts, compliant lighting and marking of turbines detailed in Section 3.4.2.10, and proper spacing of the turbines in consideration of navigational safety. In the extremely unlikely event that a vessel was to collide with a turbine, equipment that would collapse would be limited to the footprint or immediately outside the footprint of the Wind Farm Area. Impacts to ESA-listed marine fish would only occur in the event that collision and collapse of turbine or turbine equipment occur while Atlantic sturgeon are present. Based on this information, any effects to ESA-listed marine fish that could theoretically result from a vessel collision/allision are extremely unlikely and not reasonably certain to occur.

Oil and chemical release could also occur from collision or extreme weather events. Most hurricane events within the Atlantic generally occur from mid-August to late October, and the majority of all events occur in September (Donnelly et al. 2004). On average, hurricanes occur every 3 to 4 years within 90 to 170 miles (145 to 274 km) of the New Jersey coast (NJDEP 2010). Most historical cyclones affecting the Project area are tropical storms, and storms as powerful as Category 3 hurricanes have affected the area. Hurricane Sandy occurred in 2012 and caused the highest storm surges and greatest inundation on land in New Jersey.

Direct effects of hydrocarbon exposure to fish can occur on individual, population or community levels. Ingestion of toxins and other polycyclic hydrocarbons can cause stress on ion-exchange mechanisms, loss of epithelial mucus and can also impair metabolism and swimming. Juveniles and embryos exposed to oil have shown increased mortality, premature hatching and morphological deformities. Indirect impacts to fishery stocks can also include food web food alterations from increased stress (Fordie et al. 2014; Langangen et al. 2017).

However, accidental releases are expected to be rare and injury or mortality are not expected to occur. The predicted frequency of such events is no more than three WTG fluid spills over the 25-year life of the WTGs and no more than one diesel spill over the life of the Project. Modeling presented by BOEM in the BA (from Bejarano et al. 2013) indicates that there is a 0.01% chance of a “catastrophic release” of oil from the wind facility in any given year. Given the 25-year life of this Project, the modeling supports the determination that such a release is not reasonably certain to occur. Therefore, any fuel or WTG fluid spill is extremely unlikely and not reasonably certain to occur. In the unlikely event of a spill, if a response was required by the EPA or the USCG, there would be an opportunity for the NMFS to conduct a consultation with the lead federal agency on the oil spill response which would allow the NMFS to consider the effects of any oil spill response on ESA-listed marine fish in the Action Area.

Furthermore, all vessels associated with the proposed Project would comply with the USCG requirements for the prevention and control of oil and fuel spills, and Ocean Wind would not allow any refueling of vessels while at sea (Ocean Wind 2022). Proper vessel regulations and operating procedures would minimize effects on Atlantic sturgeon and their prey resulting from the release of debris, fuel, hazardous materials, or waste (BOEM 2012).

The potential for unexpected and unanticipated events to occur are considered extremely unlikely to occur and are therefore **discountable**. Therefore, the effects of unexpected and unanticipated events from the Project **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon**.**

4. CONCLUSIONS AND EFFECT DETERMINATIONS

Table 4-1 summarizes the effects determinations for the listed marine mammals, sea turtles, and fish considered in this BA. Effects determinations incorporated both the Applicant proposed mitigation measures outlined in Table 1-11 and the BOEM proposed mitigation measures outlined in Table 1-12. Three effects determinations were made within the BA:

1. **No effect** – if it is determined the proposed Project would have no impacts, positive or negative, on species or designated critical habitat. Generally, this means that the species or critical habitat would not be exposed to the proposed Project and its environmental consequences.
2. **Insignificant -** effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen but will not rise to the level of constituting an adverse effect.
3. **Discountable** effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is extremely unlikely to occur (NMFS and USFWS 1998).[7]
4. A **may affect, not likely to adversely affect** determination was made when the Project stressors were determined to have **no effect**, **insignificant** effects or were **discountable**. In addition, if the Project had the potential to result in beneficial effects on listed species (for example, the aggregation of prey due to structures), but was also likely to cause some adverse effects, then a determination of **may affect, likely to adversely affect** was made. A may affect, likely to adversely affect determination was made when a Project stressor could not be fully mitigated and was expected to result in an adverse effect on an ESA-listed species that could result in an ESA-level take.

Table 4-1 Effects Determinations by Stressor and Species

Stressor		Project Development Phase	Potential Effect	ESA-Listed Cetaceans	ESA-Listed Sea Turtles	Atlantic Sturgeon
Underwater Noise	Impact Pile-Driving	C	PTS or Injury	LAA for fin whales NLAA for others	LAA for Loggerhead NLAA for others	NLAA
			BD	LAA	NLAA for Green Sea Turtle LAA for others	NLAA
	Vibratory Pile-Driving	C, D	PTS or Injury	NLAA	NLAA	NLAA
			BD	LAA for fin whales and NARW NLAA for blue, sei and sperm whales	NLAA	NLAA

7 When the terms "discountable" or "discountable effects" appear in this document, they refer to potential effects that are found to support a "not likely to adversely affect" conclusion because they are extremely unlikely to occur. The use of these terms should not be interpreted as having any meaning inconsistent with the ESA regulatory definition of "effects of the action."

Stressor		Project Development Phase	Potential Effect	ESA-Listed Cetaceans	ESA-Listed Sea Turtles	Atlantic Sturgeon
	HRG Surveys	pre-C, C, O&M	PTS or Injury	NLAA	NLAA	NLAA
			BD	LAA for others NLAA for blue whales	NLAA	NLAA
	Vessel Noise	pre-C, C, O&M, D	PTS or Injury and BD	NLAA	NLAA	NLAA
	WTG Noise	O&M	PTS or Injury and BD	NLAA	NLAA	NLAA
	UXO	Pre-C, C	PTS or Injury	NLAA	NLAA	NLAA
			TTS/BD	LAA for fin and NARW NLAA for blue, sei and sperm whales	LAA for Loggerhead NLAA for others	NLAA
	Aircraft Noise	pre-C, C, O&M, D	PTS or Injury and BD	NLAA	NLAA	NLAA
	Cable Laying or Trenching Noise	C	PTS or Injury and BD	NLAA	NLAA	NLAA
	Dredging Noise	C	PTS or Injury and BD	NLAA	NLAA	NLAA
Habitat Disturbance		C, O&M, D	Foraging/Prey availability	NLAA	NLAA	NLAA
Secondary Entanglement from Increased Recreational Fishing Due to Reef Effect		O&M	Secondary entanglement	NLAA	LAA for Loggerhead and Leatherback NLAA for Kemp's and Green	NLAA
Turbidity		C, D	Foraging/Prey availability	NLAA	NLAA	NLAA
Vessel Traffic		pre-C, C, O&M, D	Injury/mortality	NLAA	NLAA	NLAA
Monitoring Surveys		pre-C, C, O&M	Injury/mortality	NLAA	LAA for Kemp's and Loggerhead NLAA for Green and Leatherback	LAA
EMF		O&M	Effects on orientation/ migration or navigation	NLAA	NLAA	NLAA

Stressor	Project Development Phase	Potential Effect	ESA-Listed Cetaceans	ESA-Listed Sea Turtles	Atlantic Sturgeon
Air Emissions	C, O&M, D	Contaminant exposure	NLAA	NLAA	NLAA
Dredging	C	Injury/mortality	NLAA	NLAA	NLAA
Lighting/Marking of Structures	C, O&M, D	Photoperiod disruption/ Attraction	NLAA	NLAA	NLAA
Unanticipated Events	C, O&M, D	Contaminant exposure	NLAA	NLAA	NLAA
Oil Spills/ Chemical Release	pre-C, C, O&M, D	Contaminant exposure	NLAA	NLAA	NLAA
Unanticipated Events	C, O&M, D	Contaminant exposure	NLAA	NLAA	NLAA
Overall Effects Determination	pre-C, C, O&M, D	PTS/BD	LAA	NLAA for Green Sea Turtle LAA for others	NLAA

BD = behavioral disturbance; C = construction; D = decommission; EMF = electromagnetic field; ESA = Endangered Species Act; LAA = likely to adversely affect; NLAA = not likely to adversely affect; PTS = permanent threshold shift; Pre-C = pre-construction; O&M = operations and maintenance; TTS = temporary threshold shift

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Appendix A. Marine Mammal Densities

Mean monthly density estimates (animals per 100 square kilometers) of all the marine mammal species in the Project area were derived using the Duke University Marine Geospatial Ecology Laboratory model results (Roberts et al. 2016a, 2016b, 2017, 2018, 2021a, 2021b) (Table A-1), including the recently updated model results for the North Atlantic right whale (NARW). The updated NARW density model includes new abundance estimates for Cape Cod Bay in December. The modeling used the most recent 2010 to 2018 density predictions for the NARW (Küsel et al. 2022).

Densities were calculated for a 50 kilometers (km) buffered polygon that encompassed the Lease Area perimeter. The 50 km extent was derived from studies of mysticetes that demonstrate received levels, distance from the source, and behavioral context are known to influence the probability of behavioral response (Dunlop et al. 2017).

The mean density for each month was determined by calculating the unweighted mean of all 10- by 10-km (5 by 5 km for NARW) grid cells partially or fully within the analysis polygon. Densities were computed for an entire year to coincide with possible planned activities. In cases where monthly densities were unavailable, annual mean densities were used instead.

Although two stocks of bottlenose dolphins occur in or near the Project area, the coastal and offshore stocks (Table A-1), only one Roberts et al. (2016a, 2018) density model was available for the bottlenose dolphin species. Densities for both stocks were calculated by estimating the total bottlenose dolphin densities in the buffered area and then scaling by the relative abundances of each stock.

Table A-1 Mean Monthly Marine Mammal Density Estimates for All Modeled Marine Mammal Species within a 50 km Buffer Around the Lease Area

Marine Mammals	Monthly Densities (animals per 100 km^2)												Annual Mean Density
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Fin whale	0.116	0.126	0.151	0.185	0.212	0.257	0.137	0.088	0.201	0.197	0.102	0.110	0.157
Minke whale	0.039	0.047	0.046	0.149	0.190	0.100	0.016	0.010	0.018	0.052	0.020	0.029	0.060
Humpback whale	0.068	0.046	0.049	0.048	0.056	0.043	0.007	0.006	0.021	0.061	0.043	0.077	0.044
NARW	0.335	0.396	0.464	0.444	0.054	0.004	0.002	0.001	0.002	0.004	0.021	0.161	0.157
Sei whale	0.001	0.001	0.001	0.012	0.010	0.003	0.001	0.001	0.001	0.003	0.002	0.002	0.003
Atlantic white sided dolphin	1.095	0.675	0.736	2.248	2.228	1.423	0.148	0.045	0.144	0.569	1.121	1.278	0.976
Short-beaked common dolphin	10.99	4.990	3.125	3.657	3.130	3.202	3.266	2.576	2.049	4.582	6.076	10.95	4.883
Bottlenose dolphin, coastal	0.313	0.094	0.105	0.343	1.048	2.157	2.368	3.229	2.094	1.127	0.957	0.470	1.192
Bottlenose dolphin, offshore	2.959	0.893	0.998	3.245	9.919	20.42	22.42	30.57	19.82	10.67	9.062	4.453	11.285

Marine Mammals	Monthly Densities (animals per 100 km^2)												Annual Mean Density
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Risso's dolphin	0.024	0.015	0.008	0.007	0.010	0.015	0.103	0.101	0.033	0.010	0.012	0.031	0.031
Long-finned pilot whale	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092
Short-finned pilot whale	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
Sperm whale	0.001	0.001	0.001	0.002	0.003	0.011	0.018	0.012	0.014	0.006	0.003	0.001	0.006
Harbor porpoise	2.403	4.906	6.732	3.196	0.650	0.007	0.016	0.020	0.005	0.072	1.167	2.493	1.805
Seals	4.501	5.589	3.767	3.639	1.089	0.414	0.017	0.007	0.023	0.303	0.438	2.876	1.889

Sources: Roberts et al. 2016a, 2016b, 2017, 2018, 2021a, 2021b

Table A-2 Marine Mammal Density Estimate Ranges for ESA Marine Mammal Species along shipping paths to and from the lease area. Mean density estimates from the 50 km buffer zone around the lease area are used to represent the density estimates for transits to and from the ports of Atlantic city, Hope Creek, and Paulsboro, New Jersey. All model estimates from Roberts et al. (2018).

Marine Mammals/Port	Monthly Densities (animals per 100 km^2)											
Fin Whale	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lease Area with 50km Buffer	0.116	0.126	0.151	0.185	0.212	0.257	0.137	0.088	0.201	0.197	0.102	0.11
Port Elizabeth, NJ	0.032-0.15	0.032-0.068	0.046-0.15	0.046-0.22	0.068-0.15	0.046-0.22	0.032-0.15	0.022-0.1	0.046-0.15	0.068-0.15	0.032-0.1	0.032-0.1
Norfolk, VA or Baltimore, MD	0.032-0.22	0.032-0.22	0.1-0.46	0.046-0.46	0.015-0.32	0.015-0.22	0.01-0.15	0-0.1	0.022-0.32	0.032-0.32	0.022-0.32	0.032-0.22
Charleston NC	0-0.42	0-0.46	0.0-0.46	0-1.0	0-2.2	0-2.2	0-0.46	0-0.32	0-1.0	0-1.0	0-1.0	0-1.0
NARW	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lease Area with 50km Buffer	0.335	0.396	0.464	0.444	0.054	0.004	0.002	0.001	0.002	0.004	0.021	0.161
Port Elizabeth, NJ	0.068-0.68	0.046-0.46	0-0.68	0-0.68	0-0.046	<0.01	<0.01	<0.01	<0.01	<0.01	0-0.022	0.015-0.46
Norfolk, VA or Baltimore, MD	0-1.0	0-1.0	0-1.0	0-0.68	0-0.046	<0.01	<0.01	<0.01	<0.01	<0.01	0-0.046	0-0.68
Charleston NC	0-1.0	0-1.0	0-1.0	0-1.0	0-0.068	<0.01	<0.01	<0.01	<0.01	<0.01	0-0.046	0.01-0.68
Sei Whale	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lease Area with 50km Buffer	0.001	0.001	0.001	0.012	0.01	0.003	0.001	0.001	0.001	0.003	0.002	0.002
Port Elizabeth, NJ	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Norfolk, VA or Baltimore, MD	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Charleston NC	0-0.015	0-0.015	0-0.022	0-0.1	0-0.068	0-0.068	0-0.015	0-0.015	0-0.015	0-0.046	0-0.032	0-0.1
Sperm Whale	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Marine Mammals/Port	Monthly Densities (animals per 100 km^2)											
Lease Area with 50 km Buffer	0.001	0.001	0.001	0.002	0.003	0.011	0.018	0.012	0.014	0.006	0.003	0.001
Port Elizabeth, NJ	<0.01	<0.01	<0.01	<0.01	<0.01	0-0.022	0-0.022	0-0.032	0-0.022	0-0.022	<0.01	<0.01
Norfolk, VA or Balitmore, MD	<0.01	<0.01	<0.01	<0.01	0-0.015	0-0.022	0-0.046	0-0.015	0-0.015	0-0.022	0-0.015	<0.01
Charleston NC	<0.01	<0.01	<0.01	0-0.015	0-0.015	0-0.022	0-0.046	0-0.015	0-0.015	0-0.022	0-0.015	<0.01

Sea Turtle Densities

Densities for sea turtles in the Offshores Project Area were compiled from at-sea densities of sea turtles for a different geographic region as information for the Offshore Wind Area is limited. A multi-year series of seasonal aerial surveys was conducted in the New York Bight region by Normandeau Associates and APEM for the New York State Energy Research and Development Authority (Normandeau Associates and APEM 2018a, 2018b, 2019a, 2019b, 2020). Four sea turtle species were reported as being present in the area during these surveys: loggerhead, leatherback, Kemp's ridley, and green turtles. To estimate the number of sea turtles affected by underwater noise the maximum seasonal abundance for each species was used. The abundance was corrected to represent the abundance in the entire offshore planning area and then scaled by the full offshore planning area to obtain a density in units of animals per km^2. Two categories listed in the reports included more than one species: one combined loggerhead and Kemp's ridley turtles, and the other included turtles that were observed but not identified to the species level. The counts within the two categories that included more than one species were distributed among the relevant species with a weighting that reflected the recorded counts for each species. For example, loggerhead turtles were identified far more frequently than any other species; therefore, more of the unidentified counts were assigned to them. The underlying assumption is that a given sample of unidentified turtles would have a distribution of species that was similar to the observed distribution within a given season. Seasonal sea turtle densities used in animal movement modeling are listed in Table A-3 for loggerhead, leatherback, Kemp's ridley, and green sea turtles.

Table A-3 Sea Turtle Density Estimates Derived from New York State Energy Research and Development Authority Annual Reports

Common name	Density (animals/100 km^2)			
	Spring	Summer	Fall	Winter
Kemp's ridley turtle	0.05	0.991	0.19	0
Leatherback turtle	0	0.331	0.789	0
Loggerhead turtle	0.254	26.799	0.19	0.025
Green turtle	0	0.038	0	0

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Normandeau Associates, Inc. and APEM Inc. 2018a. *Digital aerial baseline survey of marine wildlife in support of offshore wind energy: Summer 2018 taxonomic analysis summary report*. Prepared for New York State Energy Research and Development Authority. Available: https://remote.normandeau.com/docs/NYSERDA_Summer_2018_Taxonomic_Analysis_Summary_Report.pdf.

Normandeau Associates, Inc. and APEM Inc. 2018b. *Digital aerial baseline survey of marine wildlife in support of Offshore Wind Energy: Spring 2018 taxonomic analysis summary report*. Prepared for New York State Energy Research and Development Authority. Available: https://remote.normandeau.com/docs/NYSERDA_Spring_2018_Taxonomic_Analysis_Summary_Report.pdf.

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