Maryland Offshore Wind Project Biological Assessment

For the National Marine Fisheries Service
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U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

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List of Acronyms

μPa	Micropascal
ADCP	acoustic Doppler current profiler
AIM	Acoustic Integration Model©
AIS	Automatic Identification System
ALWTRP	Atlantic Large Whale Take Reduction Plan
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMP	Alternative Monitoring Plan
ANSI	American National Standards Institute
ASSRT	Atlantic Sturgeon Status Review Team
BIA	Biologically Important Area
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
CSA	Continental Shelf Associates
CTD	conductivity-temperature-depth
CTV	crew transfer vessel
CWA	Clean Water Act
dB	Decibel
DC	direct current
DEIS	Draft Environmental Impact Statement
DMA	Dynamic Management Area
DNREC	Delaware Department of Natural Resources and Environmental Control
DPL	Delmarva Power and Light
DPS	distinct population segment
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EMF	electromagnetic field
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FDR	Final Design Report
FHWG	Fisheries Hydroacoustic Working Group
FIR	Fabrication and Installation Reports
GPS	global positioning system
HDD	horizontal directional drilling
HRG	high-resolution geophysical
IPF	impact-producing factor
ISO	International Organization for Standardization
ITA	Incidental Take Authorization
IUCN	International Union for Conservation of Nature
LAA	likely to adversely affect
LED	light-emitting diode
LFC	low-frequency cetacean
LOA	Letter of Authorization
L_{pk}	peak sound pressure level
MFC	mid-frequency cetacean

MMPA	Marine Mammal Protection Act
NARW	North Atlantic right whale
NASA	National Aeronautics and Space Administration
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NLAA	not likely to adversely affect
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	National Research Council
NSRA	Navigational Safety Risk Assessment
NVD	night vision device
OCS	Outer Continental Shelf
OPR	Office of Protected Resources
OSS	offshore substation
OSV	offshore support vessel
PAM	passive acoustic monitoring
PDC	Project Design Criteria
PDE	Project Design Envelope
PJM	PJM Grid Operator
POI	point of interconnection
PRD	Protected Resources Division
PSO	Protected Species Observer
PSU	practical salinity units
PTS	permanent threshold shift
RHA	Rivers and Harbors Act
ROD	Record of Decision
ROV	remotely operated vehicle
RWSC	Regional Wildlife Science Collaborative
SAG	surface active group
SARBO	South Atlantic Regional Biological Opinion
SAV	submerged aquatic vegetation
SBP	sub-bottom profiler
SCADA	Supervisory Control and Data Acquisition
SEFSC	Southeast Fisheries Science Center
SEL	sound exposure level
SEL_{24h}	sound exposure level over 24 hours
SERO	Southeast Regional Office
SFV	sound field verification
SLR	single lens reflex
SMA	Seasonal Management Area
SPL	root-mean-square sound pressure level
SSSRT	Shortnose Sturgeon Status Review Team
TRC	TRC Companies
TSHD	trailing suction hopper dredger
TSS	total suspended solids
TTS	temporary threshold shift
USA	United States of America
USCG	U.S. Coast Guard
USDON	U.S. Department of the Navy
USEPA	U.S. Environmental Protection Agency

USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VHF	very-high frequency
WEA	Wind Energy Area
WHOI	Wood Hole Oceanographic Institution
WTG	wind turbine generator

1 Introduction

In accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 United States Code [U.S.C.] §§ 1531 et seq.), this document transmits the Bureau of Ocean Energy Management's (BOEM's) Biological Assessment (BA) of the effects of the Proposed Action on ESA-listed species and designated critical habitat that occur within the Action Area.

The Proposed Action evaluated in this BA includes the construction, operations and maintenance (O&M), and eventual decommissioning of the Maryland Offshore Wind Project (Project) and associated activities. US Wind, Inc. (US Wind) is proposing to construct and operate a commercial-scale offshore wind energy facility within Lease Area OCS-A 0490 (Lease Area) that would generate approximately 2.2 gigawatts of electricity. The Project will be constructed offshore Maryland and Delaware in the Maryland Wind Energy Area (WEA) and will deliver power to Maryland via an undersea cable that will make landfall in Delaware to be connected to the grid. The Lease Area covers 79,707 acres (32,256 hectares), with the western edge located approximately 10.1 miles (16.2 kilometers) off the coast of Maryland on the Outer Continental Shelf (OCS).

BOEM is the lead federal agency for purposes of Section 7 consultation (50 Code of Federal Regulations [CFR] 402.07); the other co-action agencies include the Bureau of Safety and Environmental Enforcement (BSEE), and the United States Army Corps of Engineers (USACE); and other cooperating agencies include the United States Coast Guard (USCG), the United States Environmental Protection Agency (USEPA), and the National Marine Fisheries Service's Office of Protected Resources (NMFS OPR).

2 Consultation History and Regulatory Authorities

2.1 Consultation History

The Energy Policy Act of 2005, Public Law 109-58, added Section 8(p)(1)I to the Outer Continental Shelf Lands Act. This section authorized the Secretary of the Interior to issue leases, easements, and rights-of-ways in the OCS for renewable energy development, including wind energy. The Secretary delegated this authority to the former Minerals Management Service, and later to BOEM. Final regulations implementing this authority (30 CFR part 285) were promulgated on April 22, 2009. These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove US Wind's Construction and Operations Plan (COP).

On August 11, 2020, US Wind submitted a COP to BOEM for the construction, operation, and eventual decommissioning of the Project. Updated versions were submitted on November 23, 2021, March 3, 2022, May 27, 2022, November 30, 2022, May 27, and July 28, 2023. BOEM issued a Notice of Intent to prepare an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) (42 U.S.C. §§ 4321 et seq.) on June 8, 2022, to assess the potential impacts of the Proposed Action and Alternatives (87 *Federal Register* 34901). The Draft EIS was published by BOEM on September 29, 2023, with the official Notice of Availability of a Draft EIS in the *Federal Register* published on October 6, 2023[1].

[1] 88 Federal Register 69658. 2023. Notice of Availability of a Draft Environmental Impact Statement for US Wind Inc's Proposed Wind Energy Facility Offshore Maryland. October 6, 2023. Available at: https://www.federalregister.gov/documents/2023/10/06/2023-21749/notice-of-availability-of-a-draft-environmental-impact-statement-for-us-wind-incs-proposed-wind.

This BA is being submitted to NMFS to support BOEM's request for initiation of ESA Section 7 consultation, in coordination with co-action agencies the Bureau of Safety and Environmental Enforcement's (BSEE) and the United States Army Corps of Engineers (USACE). The request for Section 7 consultation includes the following proposed federal actions: BOEM's approval of the COP; the USACE's issuance of a permit for in-water work, structures, and fill under Section 10 of the Rivers and Harbors Act (RHA) and Section 404 of the Clean Water Act (CWA); NMFS's issuance of a Marine Mammal Protection Act (MMPA) Incidental Take Authorization (ITA); and the USCG's proposal to issue a Private Aids to Navigation (PATON) permit. BOEM has ensured that the final BA has been reviewed by the other co-action agencies and it includes all the information required by 50 CFR 402.14(c).

2.2 Other Regulatory Authorities

2.2.1 Bureau of Safety and Environmental Enforcement

BSEE's mission is to enforce safety, environmental, and conservation compliance with any associated legal and regulatory requirements during project construction and future operations. BSEE will oversee the review and approval of the Facility Design Report (FDR) and Fabrication and Installation Reports (FIR) and will oversee inspections and enforcement actions, as appropriate; closeout verification efforts; facility removal inspections/monitoring; and bottom-clearance confirmation.

2.2.2 United States Army Corps of Engineers

The USACE regulates discharges of dredged or fill material into United States (U.S.) waters and structures or work in navigable waters of the U.S. under Section 404 of the CWA and Section 10 of the RHA. Such work includes construction of offshore wind turbine generators (WTGs), scour protection around the base of WTGs, Offshore substations (OSSs), inter-array cables connecting WTGs to the OSSs, offshore export cables, dredging during installation of inshore export cables, and other activities subject to USACE approval. The USACE Baltimore District anticipates requests for authorization of a permit action to be undertaken through authority delegated to the District Engineer by 33 CFR 325.8, under Section 10 of the RHA (33 U.S.C. 403) and Section 404 of the CWA (33 U.S.C. 1344). In addition, a Section 408 permission is anticipated to be required pursuant to Section 14 of the RHA (33 U.S.C. 408) for any proposed actions that could alter, occupy, or use any federally authorized civil works projects.

The purpose of USACE Section 408 permit permission, as determined by Engineer Circular 1165-2-220, is to determine whether US Wind's proposed alterations are injurious to the public interest or impair the usefulness of an USACE project (defined as a USACE federally authorized Civil Works project, including those operated or maintained by USACE and those operated and maintained by a non-federal sponsor). USACE Section 408 permission is needed to ensure that congressionally authorized projects continue to provide their intended benefits to the public.

The Baltimore District of the USACE is serving as a co-action agency of this Project, and intends to issue a permit for this associated action. US Wind submitted the initial draft application materials for all required USACE permits and approvals to the USACE in February 2023. US Wind submitted the permit application materials to the USACE in October 2023. The USACE issued a public notice on the application with a public comment period from October 6 to December 5, 2023.

2.2.3 United States Coast Guard

The USCG administers the permits for PATON located on structures positioned in or near navigable waters of the U.S. For the Project, USCG District 5 will review and issue PATON permits for WTGs, OSSs, and the Meteorological Tower (Met Tower), which will allow the USCG to specify and oversee the placement of structure lighting, lighting patterns and intensities, and flash or color characteristics. These aids serve as a visual reference to support safe maritime navigation.

All project vessels will be required to comply with existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR 151.2025).

2.2.4 United States Environmental Protection Agency

The OCS Air Regulations (40 CFR part 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 (CAA). Section 328 of the CAA requires that OCS sources located within 25 miles (40 kilometers) of States' seaward boundaries submit a Notice of Intent and apply for an OCS air permit to construct and operate the OCS source in accordance with the requirements of the Corresponding Onshore Area. In addition, Section 328 of the CAA creates a more comprehensive program for sources within States' seaward boundaries, stating: "Such requirements shall be the same as would be applicable if the source were located in the corresponding onshore area, and shall include, but not be limited to, State and local requirements for emission controls, emission limitations, offsets, permitting, monitoring, testing, and reporting." For the Project, the USEPA will delegate authority to the Maryland Department of Environment to issue the OCS air permit. US Wind filed a Notice of Intent to apply for an OCS air permit on 5 August 2022, and the revised air modeling protocols were submitted to the Maryland Department of Environment on 10 March 2023.

The USEPA delegated authority to Maryland or Delaware state agencies, a National Pollutant Discharge Elimination System (NPDES) general permit if there is regulated discharge of pollutants into waters of the U.S. NPDES general permits are issued under Section 402 of the CWA (33 U.S.C. 1342 et seq.) to authorize routine discharges by multiple dischargers. Although the construction and operation of an offshore wind energy project would not likely create an ongoing source of water pollution, specific activities during construction may be considered a regulated discharge. US Wind submitted their NPDES application in August 2023.

2.2.5 National Marine Fisheries Service Office of Protected Resources

The MMPA, as amended, and its implementing regulations (50 CFR part 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."

2.2.5.1 Description of Request for an MMPA Incidental Take Authorization

NMFS Office of Protected Resources (OPR) 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 OPR's issuance of an MMPA ITA 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 OPR action—which is a direct outcome of the Project's request for authorization to take marine mammals incidental to specified activities associated with the Project (e.g., pile driving)—is to evaluate the Project's request under the requirements of the MMPA (16 U.S.C. 1371(a)(5)(D)) and its implementing regulations administered by NMFS and decide whether to issue the authorization.

On August 31, 2022, US 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 monopile foundations for the WTGs; the installation of monopiles, piled jackets, or jackets on suction buckets for the OSSs; the installation of bracing piles for the Met Tower; and performance of high-resolution geophysical (HRG) site characterization surveys operating at less than 180 kilohertz (TRC Companies [TRC] 2023). US Wind is including activities in the LOA request that could cause acoustic disturbance to marine mammals during construction of the Project pursuant to 50 CFR § 216.104. Updated applications were submitted on January 24 and March 31, 2023, with revisions to incorporate comments from NMFS. The application was deemed complete by NMFS on April 3, 2023. A proposed rule is scheduled for publication in January 2024. This BA will be supplemented by NMFS consideration of the draft proposed rule to be submitted by NMFS OPR to NMFS GARFO before ESA section 7 consultation is initiated.

3 Description of the Proposed Action and Action Area

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the U.S. or upon the high seas (50 CFR 402.02). The Proposed Action addressed in this BA covers the construction, O&M, and decommissioning of the Maryland Offshore Wind Project (Project) as it is currently described in the COP by the Applicant (COP Volume I; US Wind 2023). A geographic overview of the Proposed Action footprint is provided in Figure 3-1.

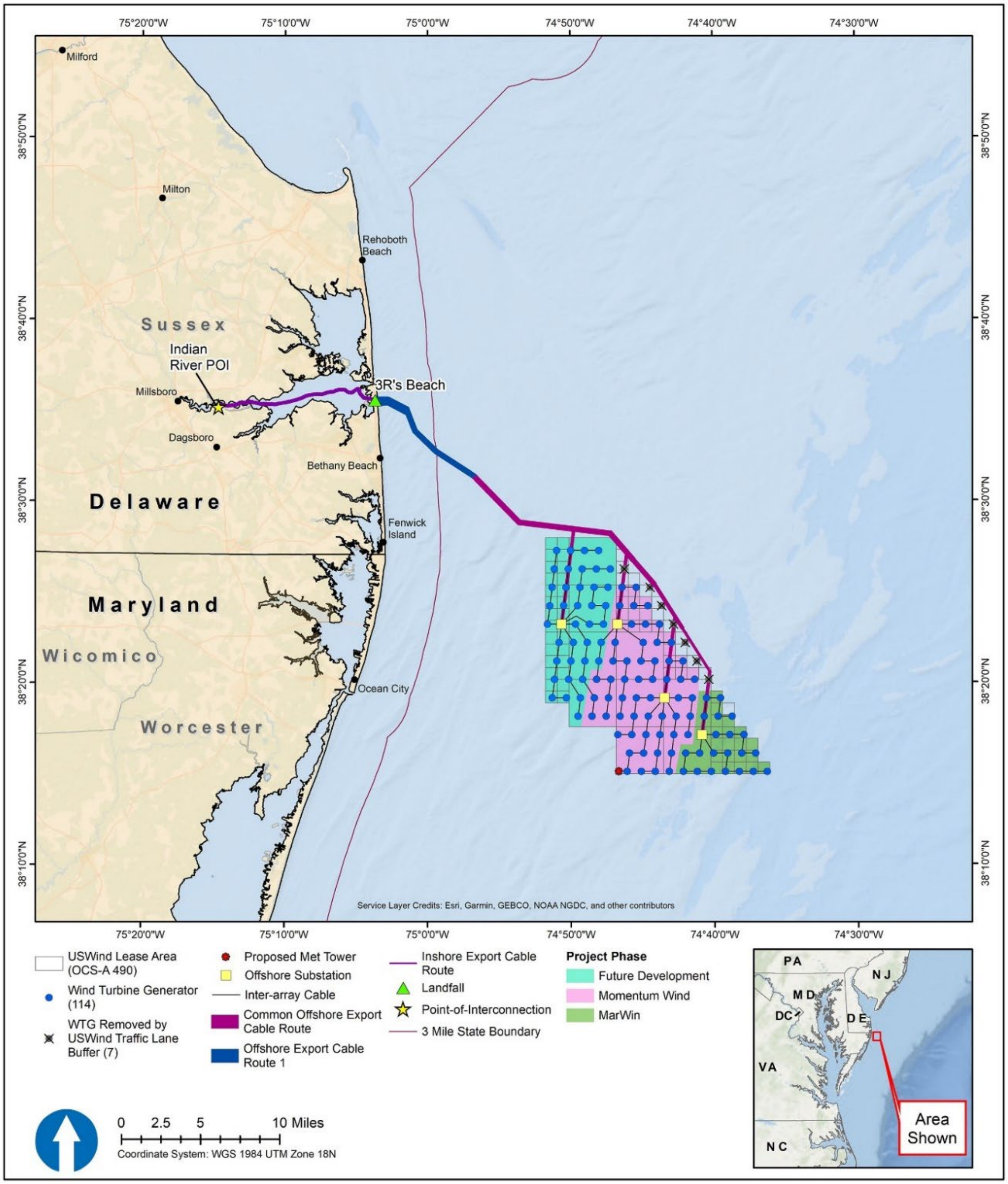

Figure 3-1. Maryland Offshore Wind Proposed Action footprint

3.1 Description of Activities

The Proposed Action would allow US Wind to construct, operate, maintain, and decommission an up to a 2.2-gigawatt wind energy facility in the Lease Area, 10.1 miles (16.2 kilometers) off the coast of Maryland. The project design envelope (PDE) would consist of up to 121 WTGs—ranging from 14 to 18 MW each, up to four offshore substations (OSSs), inter-array cables in strings of four to six linking the WTGs to the OSSs, and substation interconnector cables linking the OSSs to each other. The Proposed Action includes a 1 nautical mile (1.9 kilometer) setback from the traffic separation scheme (TSS) from Delaware Bay which removes 7 of the 121 WTG positions, resulting in a total of 114 WTGs in the Proposed Action. Up to four offshore export cables (installed within one Offshore Export Cable Route) that connect through a transition vault to the Inshore Export Cable Route and to the existing Indian River substation owned by Delmarva Power and Light (DPL). The Inshore Export Cable Route originates at the landfall at 3R's Beach, traverses Indian River Bay, and connects to two Onshore substations next to the point of interconnection (POI) at the Indian River substation in Dagsboro, Delaware. The POI will include an expansion of the existing substation as well as the construction of two new substations adjacent to or within 0.5 miles (0.8 kilometers) of the existing substation (US Wind 2023). The following subsections provide more detail regarding the key project components and activities considered in this BA.

3.1.1 Construction – Offshore Infrastructure

In the renewable energy industry, a permit application or plan that describes a reasonable range of designs is referred to as a PDE approach. BOEM gives offshore renewable energy lessees the option to use a PDE approach when submitting a COP, which allows US Wind the option to submit a reasonable range of design parameters within its permit application. BOEM then analyzes the maximum impacts that could occur from the range of design parameters and may approve a Proposed Action that is constructed within that range. PDE parameters for the offshore infrastructure of the Project are summarized in Tables 3-1 and 3-2.

The Proposed Action would include the construction and installation of onshore, inshore, and offshore facilities with the proposed construction schedule targeted over four campaigns with in-water work (foundations, cables, and WTG installations) initiated in 2024 and completed in 2027. US Wind anticipates construction starting with MarWin and moving to the northwest in approximately 300- to 400-megawatt sections. The subsequent campaigns would comprise Momentum Wind and any future build out of the remaining Lease Area. The offshore elements of the MarWin construction campaign are scheduled to be initiated in 2024 and completed in 2025; the offshore elements of Momentum Wind construction phase is scheduled to be initiated in 2025 and completed in 2026; and the offshore elements of the future development construction campaign is scheduled to be initiated in 2026 and completed in 2027. All of work associated with the installation of the inshore export cable within Indian River Bay is anticipated to be completed in 2024 and 2026. Construction and installation of the phased development is targeted for completion in 2027 depending on if the construction is staggered.

In the Notice of Receipt of Application post from NMFS on the *Federal Register* (88 FR 27463), US Wind refers to the construction campaigns as construction phases which comprises all development for a given construction campaign from construction through to O&M. Each phase (or construction campaign) would include installation of WTG and OSS foundations using impact pile driving; inter-array and export cable trenching, laying, and burial; and installation of a single Met Tower for the Momentum Wind construction campaign (which corresponds with NMFS phase 2). However, effects analysis in Section 6 is largely driven by estimates of risk of exposure to a given stressor on an annual basis (for stressors with that level of temporal difference) as this is consistent with the information provided by the Applicant in the COP (US Wind 2023) and LOA application (TRC 2023). Because the construction campaigns, or phases, span multiple calendar years, they do not align with one given campaign or phase so the discussion in Section 6 is broken out based on the construction year rather than construction campaign or phase.

The MarWin construction campaign (corresponding with NMFS phase 1) is scheduled to be constructed in 2025; the Momentum Wind construction phase (corresponding with NMFS phase 2) is scheduled to be constructed in 2026; and the future development construction campaign (corresponding to NMFS phase 3) is scheduled to be constructed in 2027 (Table 3-2). HRG site characterization surveys would be conducted only during the Momentum Wind and future development campaigns (NMFS phases 2 and 3). The offshore Project components include the WTGs, OSSs, Met Tower, foundations, inter-array cables, and offshore export cables. Horizontal directional drilling (HDD) would be conducted in nearshore waters, linking the offshore Project components to onshore Project components at the Landfall site. Vessels would be used to transport crew, supplies, and materials to the Project area to support construction throughout all construction campaigns and O&M. BOEM assumes that US Wind will select the maximum design size for each Project parameter (Table 3-1) and the maximum duration for each Project activity (Table 3-2), in order to analyze the greatest potential impact on ESA-listed species and critical habitat.

Table 3-1. Summary of key offshore Project components

Project Parameter	Details
General (project layout and size)	Up to 121 WTGs and 4 OSSs evenly distributed throughout the Lease Area at a distance of 0.77 nautical miles (1.43 kilometers) apart in the east-west direction and 1.02 nautical miles (1.89 kilometers) apart in the north-south direction
Foundations	WTG: 26.2- to 36.1-feet (8- to 11-meters) diameter monopile foundations OSS: 26.2- to 36.1- feet (8- to 11-meters) diameter monopile foundations, 32.8- to 49.2-feet (10- to 15-meters) suction bucket jacket foundations, or 6.6- to 13.1-feet (2- to 4-meters) pin pile jacket foundations Up to six-leg jackets included for OSSs Met Tower: Braced Caisson foundation
WTGs	Up to 18 megawatt nameplates
OSSs	One OSS for each grouping of 300-to-400-megawatt WTG capacity (four maximum)
Met Tower	One Met Tower at the western edge of the southernmost row of the Lease Area layout Installed on a 5.9-feet (1.8-meters) diameter Caisson steel pile that tapers to 4.9 feet (1.5 meters) in diameter above the mudline with two 4.9-feet (1.5-meters) bracing piles Subsurface equipment suite may include an Acoustic Doppler Current Profiler and conductivity-temperature-depth (CTD) sensor
Inter-array cables	66 kilovolt AC submarine cable Will run primarily in north-south direction connecting 4 to 6 WTGs in a string Up to (125.6 miles (202.2 kilometers) length
Offshore export cables	Up to 4 cables located in up to two 1,969-feet (600-meter) corridors 230 to 275 kilovolt AC submarine cables Up to 142.5 miles (229.3 kilometers) length

AC = alternating current; O&M = operations and maintenance; OSS = Offshore substation; WTG = wind turbine generator

Table 3-2. Anticipated construction milestones and time frames

Project Component	Activity Duration	Anticipated Time Frame
Mar Win Construction Campaign (Phase 1)		
Procurement and design of Project infrastructure	Varied	Q1 2022 to Q3 2025 (depending on component)
Foundation installation	22 pile driving days[1]	Q2 2025 to Q3 2025
Submarine cable installation[2]	N/A	Q2 2025 to Q3 2025
OSS installation	N/A	Q1 2024 to Q2 2025
WTG installation	N/A	Q2 2025 to Q4 2025
Landfall (HDD) cable installation	N/A	Q1 2025 to Q2 2025
Momentum Wind Construction Campaign (Phase 2)		
Procurement and design	Varied	Q1 2022 to Q4 2024
Foundation installation	58 pile driving days[1]	Q2 2026 to Q3 2026
Submarine cable installation[2]	N/A	Q3 2025 to Q3 2026
OSS installation	N/A	Q3 2025 to Q3 2026
WTG installation	N/A	Q2 2026 to Q4 2026
Micro-siting HRG surveys	Maximum of 14 days	Q2 2026 to Q3 2026
Future Development Construction Campaign (Phase 3)		
Procurement and design	Varied	Q1 2022 to Q3 2024
Foundation Installation	39 pile driving days[1]	Q2 2027 to Q3 2027
Submarine cable installation[2]	N/A	Q2 2026 to Q3 2027
OSS installation	N/A	Q3 2026 to Q3 2027
WTG installation	N/A	Q2 2027 to Q4 2027
Micro-siting HRG surveys	Maximum of 14 days	Q2 2027 to Q3 2027

HDD = horizontal directional drilling; HRG = high-resolution geophysical; N/A = not applicable; OSS = Offshore substation; Q = quarter; WTG = wind turbine generator.

Source: US Wind (2023); TRC (2023)

[1]Includes all pile types (e.g., monopile, skirt pile, pin pile); however, installation of the piles for the Met Tower will only occur in phase 2.

[2] Includes both the Offshore Export Cable and inter-array cable installation.

3.1.1.1 Wind Turbine Generators

The Project will use WTGs designed for offshore use. The PDE includes up to 121 WTGs with individual nameplate capacities of up to 18 megawatts, a total tip height of 938 feet (286 meters) above mean sea level, and a nacelle height of 528 feet (161 meters). WTGs will be installed with an approximate spacing between foundations of 0.77 nautical miles (1.43 kilometers) in the east-west direction and 1.02 nautical miles (1.89 kilometers) in the north-south direction within the 80,000-acre (32,975-hectare) Lease Area. However, the Proposed Action includes a mitigation measure of a 1-nautical mile (1.85-kilometer) setback from the Traffic Separation Scheme (TSS) in Delaware Bay, in which seven WTG positions may be removed for a maximum likely layout of 114 WTGs. The parameters for the WTGs under the Proposed Action are summarized in Table 3-3, with a schematic provided in Figure 3-2.

Table 3-3. Range of the PDE from which the maximum impact is derived due to WTGs

Design Parameter	Design Size
Turbine size	Up to 18 megawatts per WTG
Number of WTGs	Up to 121
Spacing between WTGs	0.77 nautical miles (1.43 kilometers) in the east-west direction and 1.02 nautical miles (1.89 kilometers) in the north-south direction within the 80,000-acre (32,375-hectare) Lease Area
Tip height	938 feet (286 meter)
Nacelle height	528 feet (161 meter)
Air gap[1]	118 feet (36 meter)

[1] This represents the lower tip height in relation to mean sea level.

US Wind is considering different types of WTG models, but all models being considered will have a maximum individual nameplate capacity of 18 megawatt with industry standard three-bladed, upwind, horizontal axis configurations. The rotor-nacelle assembly sits atop a multi-section tubular steel tower (i.e., the foundation) at a height of up to 528 feet (161 meter). The nacelle houses the power-generating components of the turbine, including the gear box, generator, transformer, converter, and other auxiliary systems. A pitch-and-yaw system will allow the WTG to optimize its performance by positioning the direction of the rotor and the angle of the blades. The brake, pitch, and yaw systems may be controlled using hydraulics. The Project would mount the WTGs on 36-foot (11-meter) monopile foundations driven up to 164 feet (50 meter) into the seafloor (COP, Volume I, Section 2.2; US Wind 2023).

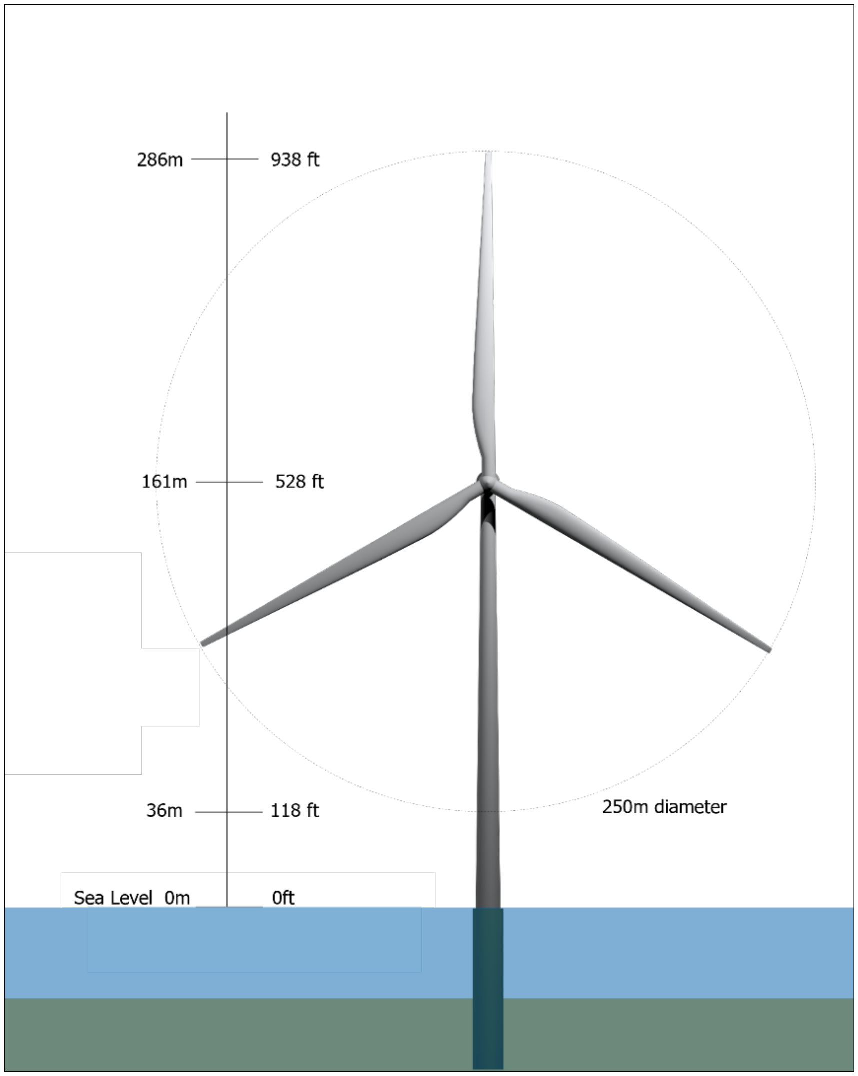

Figure 3-2. WTG schematic (maximum design parameter)
Source: US Wind 2023

The WTG components will be received and pre-assembled at a staging area at Sparrows Point, Maryland, in the Greater Baltimore area. Some WTG components such as towers, blades, and nacelles may originate in Europe and delivery would be accomplished using a mix of heavy lift and general cargo vessels. WTG components will be stored and pre-assembled at the staging area, then moved offshore for installation (COP, Volume I, Section 3.7; US Wind 2023).

The WTG installation vessel will likely sail to the installation site from ports in Europe; however, US Wind anticipates that U.S. flag installation vessels may become available prior to construction of this Project as the market develops (COP, Volume I, Section 3.7; US Wind 2023).

Typical monopile foundation installation procedures are as follows:

- Foundation location is verified, any obstructions are removed, if required.
- Feeder or installation vessel transports foundation to site; alternatively, monopiles are self-floating and towed to site.
- Installation vessel positions itself at foundation location, including jacking and preloading as required. The use of anchors may be required in some instances.
- Monopile delivered to installation vessel, lifted from feeder vessel, upended, and installed in pile-gripper frame or temporary template placed on the seafloor.
- Monopile verticality verified, and pile allowed to penetrate the seafloor under its own weight.
- Noise mitigation procedures will be implemented.
- Pile hammer placed on monopile, and soft-start process commenced.
- Pile driven to target penetration depth, using as low impact energy as possible and no more than 4,400 kilojoules.
- In the unlikely event that pile meets refusal prior to the embedment depth, "relief drilling" of the pile may be required. Relief drilling" would be conducted using a trailing suction hopper dredger (TSHD) which would suction sediments from around the pile. Whilst the main installation vessel continues with subsequent pile installations, a TSHD would be mobilized to site. . Upon completion of relief drilling to free up the pile, normal pile hammering would resume until the pile has reached target penetration.
- Transition piece (TP) lifted from installation vessel or feeder vessel and installed (if applicable).
- Monopile internal and external platforms and boat landing lifted from feeder vessel and installed on monopile.
- Installation vessel jacks down if required and moves to the next foundation position.
- Installation of scour protection, as required.

A more detailed description of the WTG installation procedures will be provided in the FDR and FIR submitted by US Wind following COP approval. Once the WTG is fully assembled, the commissioning of the WTG commences, including the verification of structural and component fasteners and electrical and mechanical system field connections (COP, Volume I, Section 3.7; US Wind 2023).

3.1.1.2 Offshore Substations

US Wind proposes to install up to four OSSs for the Project, one for each grouping of approximately 300 to 400 megawatts of WTG capacity, deployed on jacket foundations (described in Section 3.1.1.5.2). US Wind is evaluating a modular configuration of the OSS topsides, each of which are anticipated to contain medium-voltage switch gear (66 kilovolts), a high-voltage transformer (66 to 230 kilovolts), a Supervisory Control and Data Acquisition (SCADA) interface, control systems and a connection to the export cables, a generator, and associated safety and ancillary equipment. The backup generator is needed to power the SCADA and other communication and control systems in case of a grid connection outage. The modular topside configuration is intended to be standardized to the extent possible to reduce cost, simplify installation, and facilitate review and approval. OSS topside dimensions are anticipated to be approximately 98 feet by 141 feet (30 meters by 43 meters) and 164 feet (50 meters) high (COP, Volume I, Section 2.3; US Wind 2023).

US Wind's modular approach to the OSS topside design allows for components to be fabricated at various locations with final assembly and testing completed at a port facility. The OSS topsides are expected to be supplied from and assembled in a port in Brewer, Maine. Then they will be loaded onto an appropriate feeder vessel for delivery to the installation location. Supply of the OSS topsides from the Gulf of Mexico is also being considered as an alternate option. There are four roundtrips expected for the transportation of OSS topsides.

The OSS topside installation is expected to be conducted in the following sequence:

- Installation vessel positioned at the OSS foundation location. Anchors may be required in some instances for installation and feeder vessel positioning.
- Foundation is installed at the target locations.
- OSS topside is lifted from feeder vessel and lowered onto foundation.
- OSS topside is secured per design, which could include a bolted, grouted, or welded connection.

Following installation of the OSS topside, inter-array and offshore export cables can be landed and terminated. Alternatively, the offshore export cables can be pulled in prior to topside installation and temporarily stored on the cable deck of the jacket if jacket foundations are installed. OSS commissioning activities are expected to be supported from either a floating hotel (Flotel) or jack-up vessel. Final installation procedures will be provided in the FDR and FIR (COP, Volume I, Section 3.4.2; US Wind 2023).

3.1.1.3 Met Tower

The Project includes a Met Tower, which will serve as a permanent metocean monitoring station. The data collected by the Met Tower will support project operations and long-term monitoring. The proposed Met Tower location is at the western edge of the southernmost row of the array. That location is expected to provide nearly unobstructed exposure to the prevailing southwest and northwest wind directions, which improves the value of the wind data collected. This is anticipated to help operations planning (along with the associated metocean measurements) and Project performance audits. Additionally, the location is also within four rotor-diameters of the adjacent WTG, which is expected to potentially support power curve testing and overall energy production audits. The proposed location on the western edge of the row also has a clear line of sight to Ocean City, which facilitates high-speed remote data communications (COP, Volume I, Section 2.4; US Wind 2023).

The primary structure of the Met Tower has been fabricated and is currently in storage at the Modern American Recycling Services facility in Gibson, Louisiana, which would be transported to the lease area via barge; a single transit during Year 2 of construction is planned. The Met Tower is planned to include a robust suite of monitoring, data logging, and remote communications equipment as well as associated power supply, lighting, and marking equipment. The Met Tower structure was engineered to employ standard design elements that have been successfully deployed in similar environments. The mast and platform deck will be equipped with the proper safety lighting, markings, and signal equipment. The mast will be outfitted with scientific instruments (e.g., anemometers, vanes, barometers, temperature sensors, relative humidity sensors, pyranometer, precipitation sensors) for recording empirical environmental and biological conditions in situ. The Met Tower is also planned to include a vertical profiling light detection and ranging (LiDAR) wind sensor as well as bottom-mounted and subsurface instrumentation packages to gather oceanographic data and additional biological observations. At a minimum, the subsurface package will include an acoustic Doppler current profiler (ADCP) system to measure currents, wave heights, and other oceanographic data and a conductivity-temperature-depth (CTD) sensor. In addition to monitoring and safety equipment, the Met Tower is planned to have a robust suite of data logging, remote high-speed communications, and power supply equipment (COP, Volume I, Section 2.4; US Wind 2023).

3.1.1.4 Inter-array and Offshore Export Cables

The offshore cables include the inter-array cables and the offshore export cables. The inter-array cables connect the WTGs to the OSSs and will be run in a primarily north-south direction connecting up to four to six WTGs in a string. The cables will transition from their primary north-south direction to an east-west direction as required to connect the WTG strings to the OSSs. Based on the maximum WTG and OSS layout, up to 152 miles (245 kilometers) of inter-array cable will be used (Figure 3-3). Inter-array cables connecting the WTG strings to an OSS will be 66 kilovolt three-core, solid dielectric (XLPE23 or EPR24) construction. The sizes of the cables will vary depending on the distance of a WTG from the OSS and the number of WTGs on a given string.

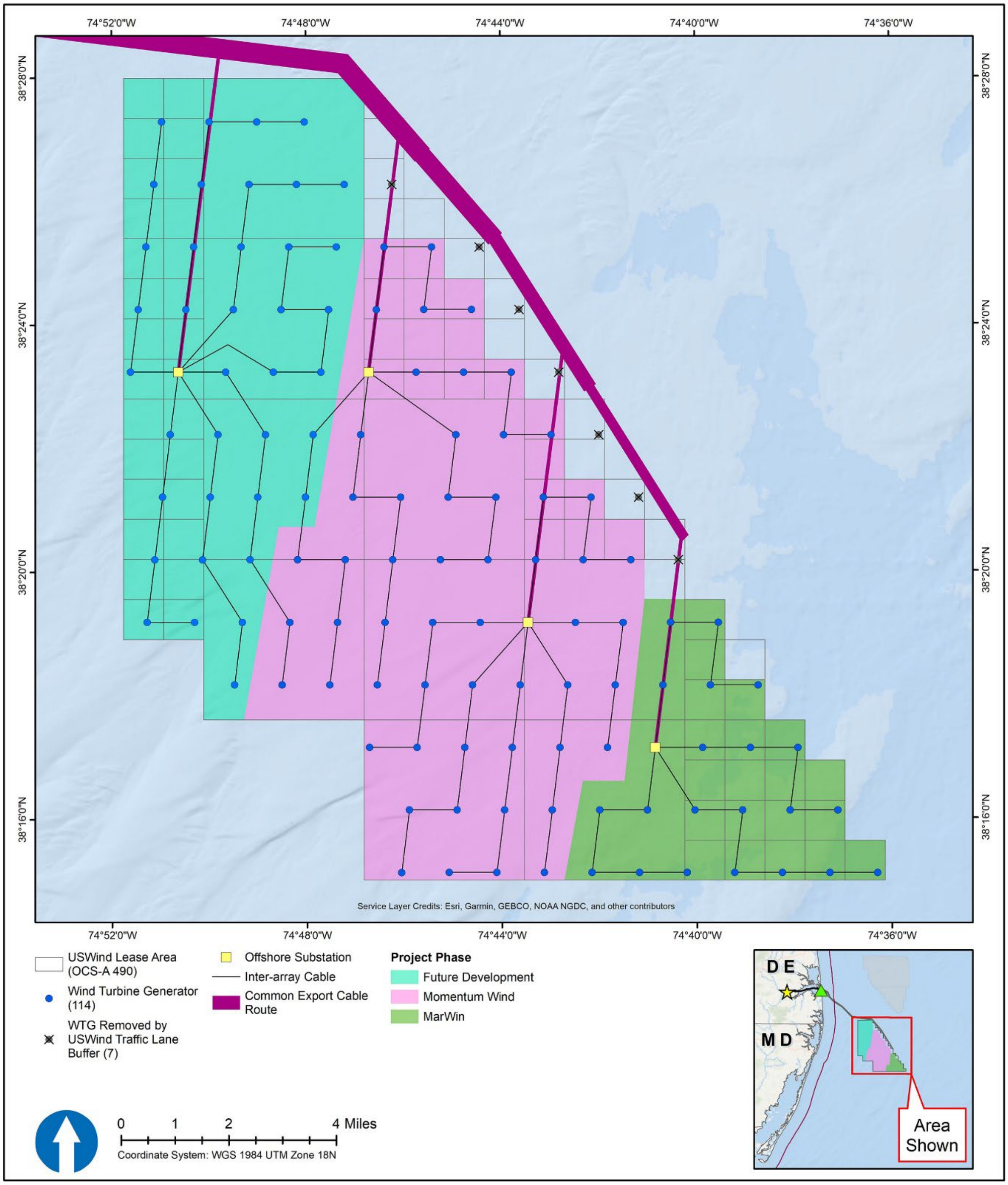

Figure 3-3. Indicative inter-array cable layout

Inter-array cables for the Project are anticipated to be sourced in the U.S. and Europe, with components that might originate in Asia, depending on availability, and delivered to a staging area in Baltimore, Maryland for load out to the installation vessel. No direct Project vessel routes have been identified from Asia to the U.S. As such, no ports in Asia are considered in the Proposed Action. The main elements of the inter-array cable installation are:

- Route clearance, including a pre-installation survey and grapnel run;
- Installation trials, as required;
- Cable lay and burial;
- Cable protection system installation;
- Pull-in and termination at OSSs and WTGs; and
- Installation of scour protection around the WTG foundations to avoid the development of cable-free spans due to scouring, and to stabilize the cable protection system.

A pre-lay grapnel run will be conducted along the cable route to remove debris that could impact the cable lay and burial. Collected debris will be recovered and disposed of in appropriate shore-side facilities. Additional seafloor leveling, pre-trenching, or boulder removal is not expected, and no sand wave leveling is included under the Proposed Action; therefore, these activities are not assessed as part of the Proposed Action.

The inter-array cables will be installed from a dynamically positioned cable-installation vessel equipped with the required industry standard cable-handling equipment. US Wind assumes the inter-array cables will be installed using a towed or self-driving jet plow, which allows for direct installation and burial of the cable. A jet plow uses a combination of high-pressure water to temporarily fluidize the sediment, and the cable subsequently settles into the area opened by the jets through a combination of its own weight and a depressor arm. The displaced sediment settles back over the cable, effectively burying the cable. If soil conditions do not permit the use of a jet plow, a mechanical cutting/trenching tool or conventional cable plow may be employed. Jet plows and trenching tools do not operate the same way as traditional hydraulic dredgers such as trailing suction hopper dredges (TSHDs) used for projects such as navigational channel deepening or inlet widening; those projects require much larger equipment and dredged areas than what is needed for the Proposed Action. US Wind plans to bury inter-array cables 3.3 to 6.6 feet (1 to 2 meters) deep, but no more than 13.1 feet (4 meters) deep.

The cable-installation vessel will maneuver as close as possible to the WTGs or OSSs, the cable will be cut, and the required cable protection and pulling mechanisms will be installed. The cable will then be pulled into the WTG to the hang-off platform, or into the OSS through a J-tube, secured, and terminated. Scour protection will be placed over the cable as required. Post-lay burial will be completed as needed. This is anticipated to be accomplished by employing a cable -installation support vessel and a remotely operated vehicle (ROV) system. Areas with cable crossings or hard bottoms may require additional protection such as mattresses, rock placement, or cable protection systems.

The proposed offshore export cables connecting each OSS to the landing location will be via a single 230 to 275 kilovolts, three-core cable up to 12 inches (300 millimeters) in diameter. Up to four offshore export cables located in up to two 1,968-foot (600-meter) corridors from the OSSs to the planned landfall near 3R's Beach are possible under the Proposed Action. The Offshore Export Cable Route from the Lease Area to US Wind's Onshore substations will span between 40 to 60 miles (65 to 97 kilometers) in length, depending on the OSS location and the final routing through Indian River Bay or on land to the POI. The Offshore Export Cable Route is shown as the Common and Offshore Export Cable Route 1 in Figure 3-4.

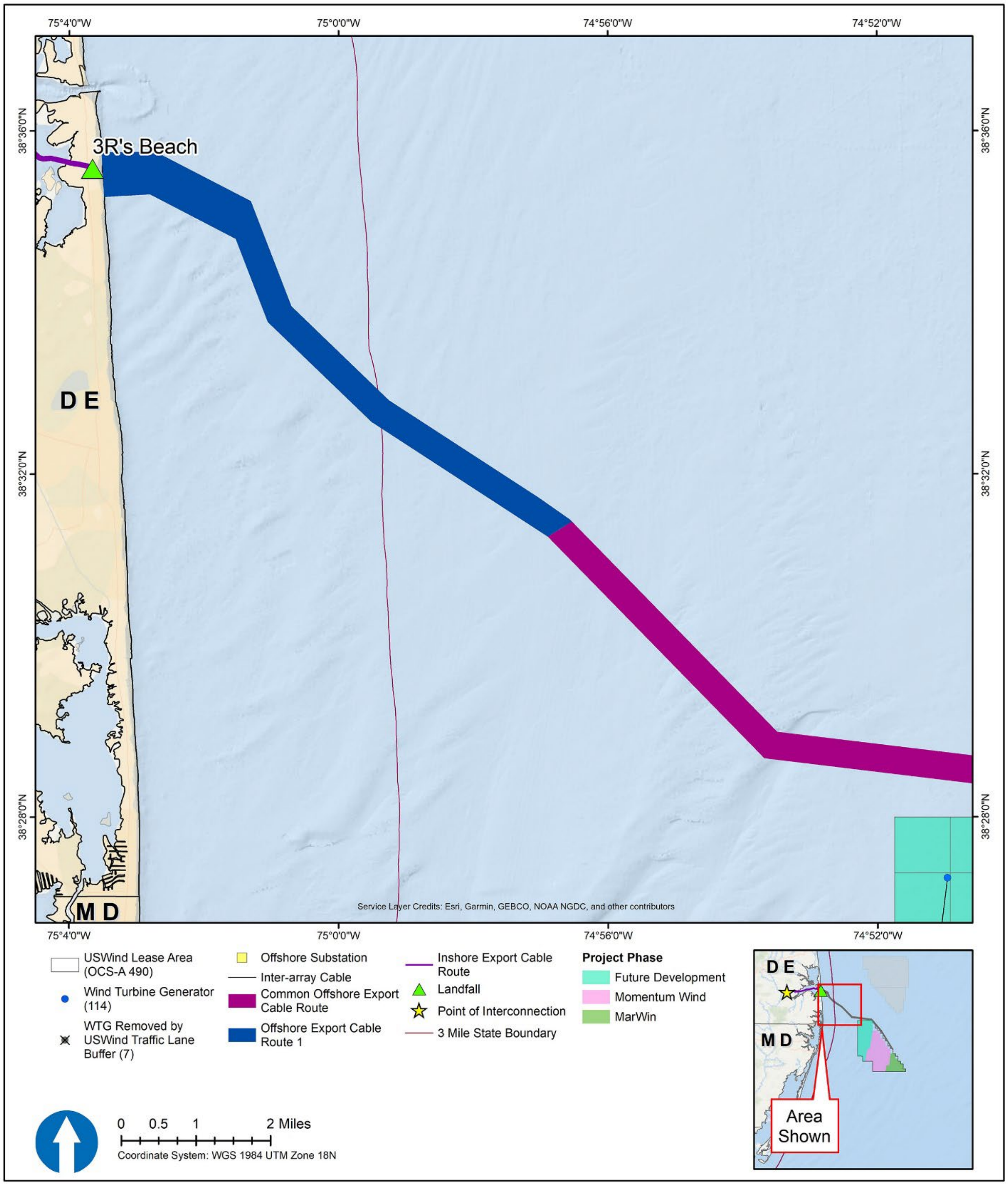

Figure 3-4. Proposed Offshore Export Cable Route

US Wind proposes the offshore export cables will be loaded at the manufacturing facility onto the cable-installation vessel. The cable-installation vessel will then transit to the installation location. The main elements of the offshore export cable installation are:

- Insertion of gravity cells, if required, and installation of HDD ducts at landfall;
- Route clearance including a pre-installation survey and grapnel run;
- Jet plow installation trial;
- Installation and simultaneous jetting of cable;
- Pull-in of the cables through HDD ducts into jointing/transition vaults;
- Cable pull-in at the OSS; and
- Post-lay burial and mattressing, if needed.

Route clearance activities will be conducted prior to offshore export cable installation including a pre-installation survey and grapnel run. The pre-installation survey and grapnel run will be conducted along the Offshore Export Cable Route to remove debris such as lost fishing nets or other objects that could impact the cable lay and burial. Collected debris will be recovered and disposed of in appropriate shore side facilities. Pre-installation seafloor preparation, such as levelling, pre-trenching or boulder removal, is not currently expected (COP, Volume I, Section 3.6.1; US Wind 2023).

The installation process will commence with the offshore cable pull in through the HDD duct (Section 3.1.1.7 for HDD process) into the cable jointing/transition vault at the landfall location. Upon completion of this phase the cable-installation vessel will commence the direct laying of the cable on the seafloor along the prescribed route to the OSS. Based on the sandy seafloor observed along the Offshore Export Cable Route, it is expected that a jet plow will be employed to bury the cable to target depths of approximately 3.3 to 9.8 feet (1 to 3 meters), not more than 13.1 feet (4 meters). The jet plow uses a combination of high-pressure water to temporarily fluidize the sediment and the cable subsequently settles into the area opened by the jets through a combination of its own weight and a depressor arm. The displaced sediment settles back over the cable effectively burying the cable. If needed, a trenching tool may be employed in areas with harder bottoms. At the offshore end in the Lease Area, the cable will be pulled into the OSS, tested, and terminated.

Concrete mattresses will be installed at areas with insufficient burial depth if needed. US Wind estimates a maximum of 10 percent of the offshore export cable would require additional protection and is likely to be significantly less. The unburied cable section close to the OSS will run through a cable protection system, covered by the armor layer of the scour protection (COP, Volume I, Section 3.6.1; US Wind 2023). The cable-installation vessel will employ dynamic positioning, although anchors may be used in shallow waters. If anchors are employed, US Wind will utilize mid-line anchor buoys (COP, Volume I, Section 3.6.1; US Wind 2023).

A summary of the design parameters for the inter-array and offshore export cables is provided in Table 3-4 with a summary of the proposed installation methods in Table 3-5.

Table 3-4. Offshore cable specification with maximum design scenario

Design Parameter	Inter-array Cable	Offshore Export Cable
Number of cables	1	4
Type of cable	66 kilovolts three-core solid dielectric	230 to 275 kilovolts three-core
Cable capacity	66 kilovolts	230 to 275 kilovolts
Number of foundations per inter-array	4 to 6	N/A
Cable length	125.6 miles (202.2 kilometers)	142.5 miles (229.3 kilometers)
Burial depth	13.1 feet (4 meters)	3.3 to 9.8 feet (1 to 3 meters)
Bottom disturbance due to cable installation, Jack-up vessels and vessel anchoring	30 acres (12 hectares)	34 acres (14 hectares)
Cable protection	30 acres (12 hectares)	34 acres (14 hectares)

Source: COP, Volume II, Section 1.3 (US Wind 2023)

Table 3-5. Summary of Proposed inter-array and offshore export cable installation methods

Project Component	Approximate Water Depth Range	Approximate Distance Offshore	Likely Installation Method
Inter-array cable	46 to 135 feet (14 to 41 meters)	10.1 miles (16.2 kilometers)	Towed or self-driving jet plow
Offshore export cable	0 to 135 feet (0 to 41 meters)	Maryland shoreline out to 10.1 miles (16.2 kilometers)	Jet plow

Source: COP, Volume I, Section 3.6.1 (US Wind 2023)

3.1.1.5 Foundations

The following subsections provide an explanation of monopiles, jacket foundations, and Braced Caisson foundations, which are included in the Proposed Action.

3.1.1.5.1 WTG Monopile Foundations

A monopile is a single, hollow cylinder fabricated from steel that is secured in the seafloor. The monopile foundations for the WTGs under the Proposed Action consist of a monopile with an integrated or separate TP (Figure 3-5). The top of the monopile typically consists of a flanged connection that allows for a bolted connection between the TP and turbine tower. The foundation TP acts as an interface between the monopile and WTG tower. The TP commonly incorporates space for switch gear, dehumidification equipment, and control systems, while also providing boat landing, access, and service platforms. If a monopile foundation without a separate TP is selected, the switch gear, dehumidification equipment, and control systems would be installed in a suspended structure inside the monopile, with the boat landing, access, and service platform attached to the exterior of the foundation. US Wind intends to include scour protection in the form of rock around the base of the monopile foundation, an area approximately three times the diameter of the foundation (COP, Volume I, Section 2.2.1; US Wind 2023).

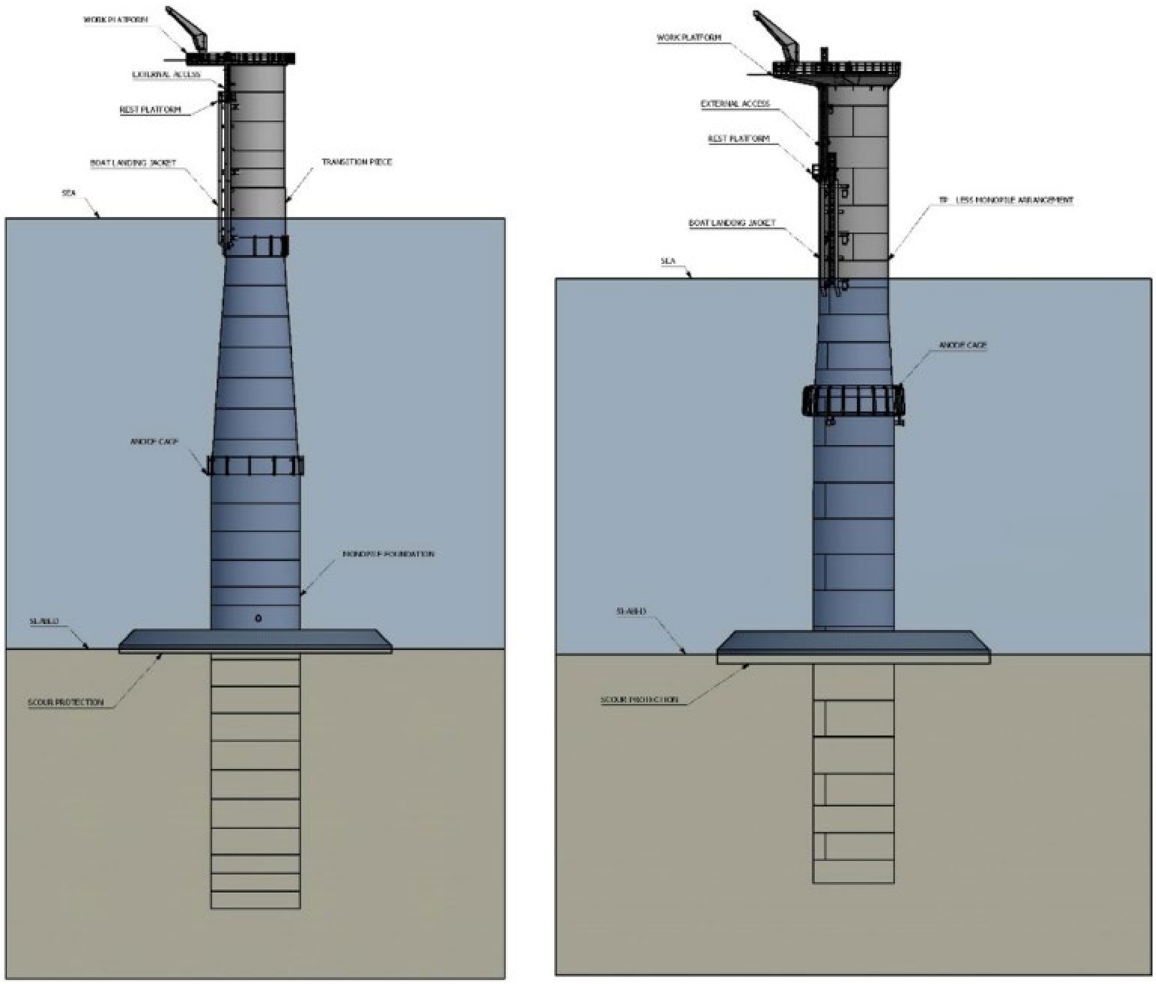

Figure 3-5. Examples of monopile foundations for the WTGs under the Proposed Action with a TP (left) and without a TP (right)
Source: US Wind 2023

A summary of the design parameters for the WTG monopile included under the Proposed Action is provided in Table 3-6.

Table 3-6. Summary of the Project design envelope from which the maximum impact is derived – WTG Monopile Foundations

Design Parameter	Parameter Details and Size
Number of foundations	Up to 121
Diameter	36 feet (11 meters)
Number of piles per foundation	1
Seafloor footprint—no scour protection—all foundations	2.84 acres (1.15 hectares)
Seafloor footprint—with scour protection—all foundations	25.6 acres (10.36 hectares)
Seafloor disturbance for installation of all WTGs (seabed preparation, vessel anchoring and Jack-up vessels[1])	74.8 acres (30.27 hectares)

Design Parameter	Parameter Details and Size
Hammer size for monopile foundation	Up to 4,400 kilojoules
Max penetration depth into seafloor	164 feet (50 meters)
Duration of pile driving (hours/pile)	2
Number of piles installation per day	1[2,3]
Duration of installation (hours/foundation)	2 to 4

Source: COP, Volume II, Section 1.3 (US Wind 2023)

[1] Estimated temporary disturbance based on the 984-foot (300-meter) radius area within which US Wind proposes to confine bottom disturbance during installation of each monopile foundation.

[2] No nighttime piling is planned; however, piling after dark or during inclement weather may be required due to unanticipated events that would require a pile to be completed during those conditions.

[3] BOEM will require US Wind 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 unless an acceptable Alternative Monitoring Plan (AMP) is submitted to and approved by BOEM, BSEE, and NMFS.

The WTG monopile foundations will be installed using impact pile driving methods, with varying hammer energies and blow counts per pile depending on the pile location. Acoustic propagation of the 36-foot (11-meter) diameter monopiles were modeled using a maximum strike energy of 4,400 kilojoules for a 2-hour duration. However, the monopiles are not expected to be installed using the maximum hammer energy for the full 2-hour installation period. Therefore, to account for the differences in expected hammer energy versus modeled maximum hammer energy, the modeled spectra was scaled to reflect each of the lower hammer energies presented in Table 3-7 (Appendix A; TRC 2023). Acoustic effects are based upon the hammer energy progression to include the effects of lower hammer energies in the sound field produced. The pile progression used in the acoustic modeling assessment is provided in Table 3-7. Piles will be installed over three construction years following the timeframes provided in Table 3-2.

Table 3-7. Summary of the PDE from which the maximum impact is derived for WTG monopile foundations

Pile Type	Number of Piles Installed per Day	Hammer Energy (kilojoules)	Duration at Hammer Energy (minutes)	Blows per Minute	Blows per Pile	Total Duration for Pile Installation per Day (minutes)	Total Number of Blows per Day
36-foot (11-meter) WTG monopile	1	1,100	30	20	600	120	4,800
		2,200	60	40	2,400		
		3,300	30	60	1,800		

Source: Appendix A; TRC 2023

Monopile foundations equipped with self-floating capabilities will be transported offshore to the installation site by being towed by a tug vessel. Alternative transportation methods under consideration include the utilization of feeder vessels (e.g., freight ships) or direct installation vessels (COP Volume I, Section 3.3.2; US Wind 2023).

The transport methodology will be determined by the location of the fabrication facility and availability of Jones Act (46 U.S.C. § 50102) compliant vessels. The number of feeder vessels employed will be determined based on foundation size and installation rate. US Wind assumes up to four feeder vessels could be employed to support monopile installation. The feeder vessels may be jack-up vessels or tug and barge units. The feeder vessels may employ anchors for positioning. If anchors are employed, US Wind will use mid-line anchor buoys. The feeder vessels will sail from Baltimore, Maryland, to the Lease Area either via the Chesapeake and Delaware Canal and Delaware Bay or via Chesapeake Bay. Installation of the monopile foundations offshore will be conducted using a dynamically positioned crane vessel, a jack-up style installation vessel equipped with a hydraulic impact hammer to drive the monopiles into the seafloor, or both. Prior to or following installation of a monopile into the seafloor, the first layer of scour protection rocks will be deployed in a circle around the pile location. This layer of small rocks, the filter layer, will stabilize the sandy seafloor, avoiding the development of scour holes. The rocks will be placed by a specialized rock-dumping vessel with a layer thickness of up to 2 feet (0.5 meters). Once the inter-array cables have been pulled into the monopile, a 2- to 7-feet (1- to 2-meters) thick second layer of larger rocks, the armor layer, will be placed to stabilize the filter layer. The area of seafloor covered by scour protection at each WTG is estimated to be approximately 0.19 acres (0.08 hectares). A complete list of the monopile foundation installation procedures can be found in COP, Volume I, Section 3.3.2 (US Wind 2023). Foundation installation will generally involve the following procedure:

- Clearing the foundation location of any obstacles;
- Transporting the foundations to the site;
- Positioning the installation vessel and loading of the foundation, as required;
- Lifting the foundation and allowing it to penetrate the seafloor under its own weight;
- Implementing a noise mitigation system; and
- Driving the pile to the target penetration depth.

In the unlikely event that pile meets refusal prior to the embedment depth, "relief drilling" of the pile may be required. Relief drilling would be conducted using a TSHD which would suction sediments from around the pile. Whilst the main installation vessel continues with subsequent pile installations, a TSHD would be mobilized to site. Upon completion of relief drilling to free up the pile, normal pile hammering would resume until the pile has reached target penetration. If used, the TP will be installed following installation of the foundation and scour protection, as required.

Based on current drivability assessment there is a very low likelihood that the piles will not reach penetration depth. The estimates are subject to drivability assessments and subsequently hammer selection by the installation contractor.

US Wind intends to employ both near-to-pile and far-from-pile underwater sound mitigation technologies while the monopile is driven into the seafloor. Near-to-pile sound abatement technologies could include AdBm Technologies Noise Mitigation System and using a damper between the hammer and sleeve to prolong the impact pulse. Far-from-pile technologies could include a large double bubble curtain (COP, Volume I, Section 3.3.2; US Wind 2023). These or other applicable mitigation technologies will be deployed to achieve the minimum 10 dB noise reduction commitment, but US wind will be targeting 20 dB noise reduction (COP Volume II, Section 9.3; US Wind 2023).

The installation procedures will be refined as the design process continues and installation equipment is selected. The final installation processes will be included in the FDR and FIR.

3.1.1.5.2 OSS Jacket Foundations

A jacket foundation is a large, lattice-type steel structure that includes piles (i.e., legs) connected with welded steel, tubular cross-bracing. The Proposed Action includes a four-leg jacket structure for the OSSs (Figure 3-6). Piles driven into the seafloor are used as a foundation for the jacket and to support the topsides. The piles will be installed through jacket pile guides. The weight and dimensions of the jacket will be refined through the design process and provided in the FDR and FIR. US Wind intends to include scour protection in the form of rock around the base of the OSS foundation, an area approximately three times the diameter of the piles (COP, Volume I, Section 2.3.1, US Wind 2023; LOA Appendix A, TRC 2023). The area of seafloor covered by scour protection at the jacketed OSS foundations is estimated to be approximately 0.06 acres (0.02 hectares) (Table 3-8).

Figure 3-6. Conceptual design for the OSS installed on a jacket foundation
Source: US Wind 2023

A summary of the design parameters for the OSS jacket foundations included under the Proposed Action is provided in Table 3-8.

Table 3-8. Summary of the PDE from which the maximum impact is derived for OSS large-jacket foundations

Design Parameter	Parameter Details and Size
Number of foundations	4
Diameter	9.8 feet (3 meters)
Number of piles per foundation	4
Seafloor footprint—no scour protection—all foundations	0.056 acres (0.023 hectares)
Seafloor footprint—with scour protection—all foundations	0.50 acres (0.20 hectares)
Hammer size for monopile foundation	Up to 1,500 kilojoules
Max penetration depth into seafloor	98 to 262 feet (30 to 80 meters)
Duration of pile driving (hours/pile)	2
Number of piles installation per day	4
Duration of installation (hours/foundation)	8

Source: COP, Volume II, Section 1.3 (US Wind 2023); LOA Appendix A, TRC 2023

The four 9.8-foot (3-meter) post-piled skirt piles installed per day for the OSS jacket foundations will be impact driven at a maximum strike energy of 1,500 kilojoules and a duration of 2 hours per pile. The impact hammer for the OSS jacket foundations will be operated at approximately 40 blows per minute for a total blow count of 19,200 per day and a duration of up to 8 hours per day to install all four pin piles for a jacket (LOA Appendix A, TRC 2023).

The OSS jacket foundations will be post-piled, in which the piles are driven through jacket skirts. US Wind does not anticipate seabed preparation would be necessary to provide a level surface at any of the post-piled jacket or jacket on suction bucket foundation locations for the OSSs. In the unlikely event that seabed leveling is needed, US Wind anticipates using equipment such as a TSHD to level the seabed and estimates a maximum case scenario of approximately 5,000 cubic yards (3,823 cubic meters) of dredge material at each OSS location. Dredged material would be placed or moved aside within the immediate vicinity within the defined OSS construction footprint.

A complete list of the jacket foundation installation procedures can be found in COP, Volume I, Section 3.4.1.1 (US Wind 2023), but will generally involve the installation vessel transporting the foundations to the site; the jacket being placed on the seafloor and piles being stabbed into the jacket pile guides (i.e., skirts); and an underwater hammer driving the piles to the target penetration depth. The jacket will then be leveled, as needed, and the top of the piles rigidly connected to the pile guides of the jacket. In the unlikely event that pile meets refusal prior to the embedment depth, "relief drilling" of the pile may be required. Relief drilling would be conducted using a TSHD which would suction sediments from around the pile. Whilst the main installation vessel continues with subsequent pile installations, a TSHD would be mobilized to site. Upon completion, normal pile hammering would resume until the pile has reached target penetration.

A noise mitigation system like that described in Section 3.1.1.5.1 will also be used during installation of the OSS jacket skirt piles (COP, Volume I, Section 3.4.1.1; US Wind 2023).

3.1.1.5.3 Met Tower Braced Caisson Foundations

A Braced Caisson design consists of a main Caisson steel pile with two bracing piles; this will be used for the Met Tower under the Proposed Action. The main Caisson will be a 6-feet (1.8-meter) diameter pile that tapers to 5 feet (1.5 meters) in diameter above the mudline. The pile will be driven to an anticipated maximum depth of 175 feet (53 meters). The two bracing piles each will be 5 feet (1.5 meters) in diameter (Figure 3-7). These piles will be driven to an anticipated maximum depth of 66 feet (51 meters) (COP, Volume I, Section 2.4.2.1; US Wind 2023). Actual pile depths are anticipated to be shallower based on water depths at the proposed location but will be confirmed by a Keystone's analysis of site-specific geotechnical data. A steel grillage deck will be fixed onto the installed piles. A galvanized steel lattice mast will be erected onto the deck. Multiple measurement sensors will be placed on cross-arms at various levels on the mast. The height of the Met Tower, including the mast and foundation, will be approximately 328 feet (100 meters) above mean sea level and no higher than the maximum WTG tip height previously noted in Table 3-3.

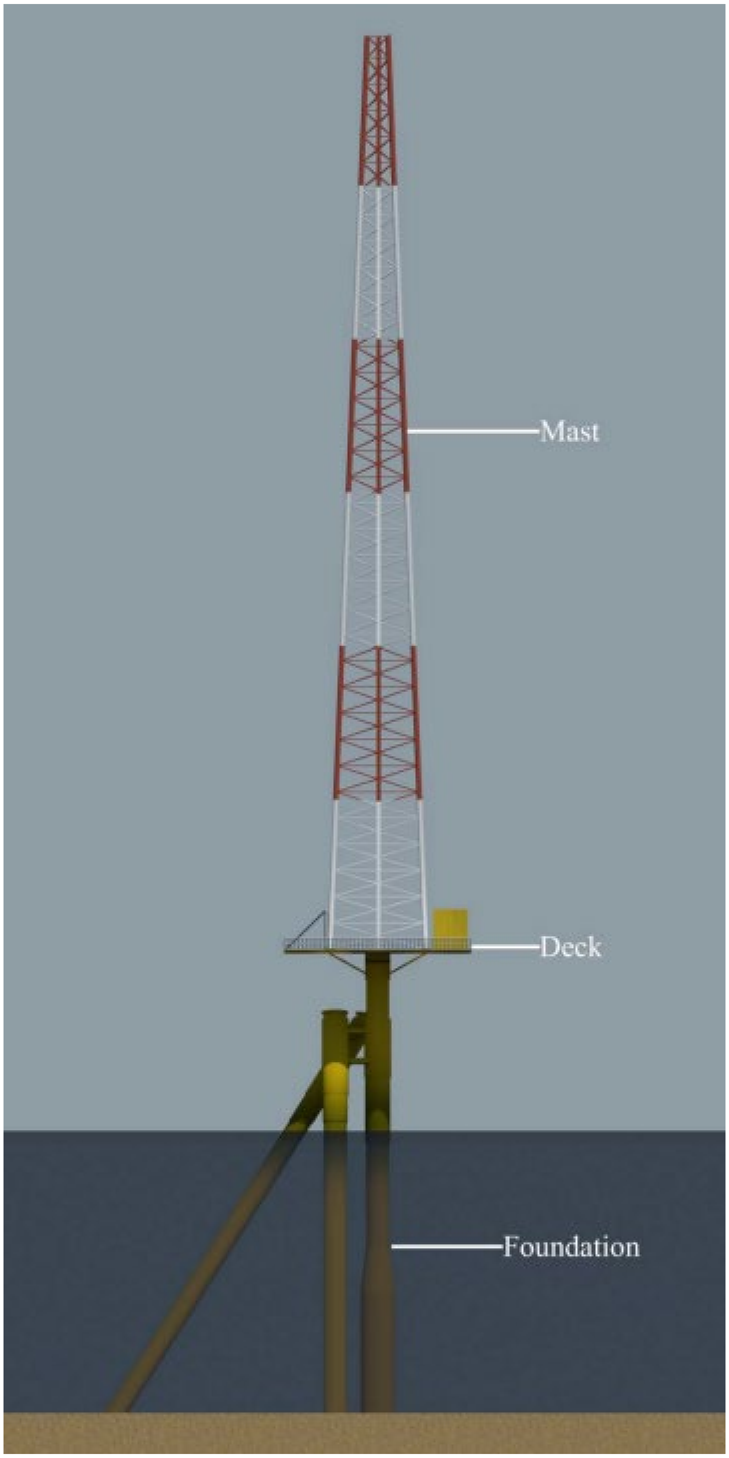

Figure 3-7. Simplified rendering of the Met Tower under the Proposed Action
Source: US Wind 2023

A summary of the design parameters for the Met Tower Braced Caisson foundation included under the Proposed Action is provided in Table 3-9.

Table 3-9. Summary of the PDE from which the maximum impact is derived for the Met Tower foundations

Design Parameter	Parameter Details and Size
Number of foundations	1
Diameter	Up to 6 feet (1.8 meters)
Number of piles per foundation	3
Hammer size for monopile foundation	Up to 500 kJ
Max penetration depth into seafloor	166 feet (51 meters)
Duration of pile driving (hours/pile)	2
Number of piles installation per day	3
Duration of installation (hours/foundation)	6

Source: COP, Volume II, Section 1.3 (US Wind 2023); LOA Appendix A, TRC 2023

The three 6-feet (1.8-meters) diameter piles for the Met Tower foundation will be impact driven at a maximum strike energy of 500 kJ and a duration of 2 hours per pile (Appendix A; TRC 2023). The impact hammer for the Met Tower Braced Caisson foundation piles will be operated at approximately 8 blows per minute for a total blow count of 3,000 per day and a duration of up to 6 hours to install the three Caisson piles (Appendix A; TRC 2023).

Installation of the Met Tower will be conducted by a qualified marine construction contractor. US Wind will select the contractor based on final Met Tower design, installation timing, and vessel availability. Candidate installers include U.S. contractors based in Maryland and the Gulf of Mexico region, as well as US Wind's WTG and foundation installation contractor. If a vessel from the Gulf of Mexico is selected for Met Tower installation, one round trip will be conducted from the Gulf of Mexico to Maryland during year two of Project construction (Table 3-11; Section 3.1.1.6). This is the only vessel transit anticipated to originate from the Gulf of Mexico under the Proposed Action.

A complete list of the monopile foundation installation procedures can be found in COP, Volume I, Section 3.5.1 (US Wind 2023), but will generally involve a brief seafloor visual survey to ensure the area is free of debris prior to placement of the installation vessel legs and piles; the main 6-feet (1.8-meter) Caisson pile will be lifted to a driving template guide; after the Caisson pile penetrated into the seafloor, it will be driven to the target penetration depth using an impact hammer; after installation of the main Caisson pile, the bracing pile guide will be lifted from the materials barge and set onto the Caisson, and the two bracing piles will be driven to the target penetration depth; the steel deck and boat landing appurtenances will be installed on top of the Braced Caisson foundation and then checked for level and secured (COP, Volume I, Section 3.5.1; US Wind 2023). A noise mitigation system like that described in Section 3.1.1.5.1 will also be used during Met Tower foundation installation.

3.1.1.6 Vessels and Potential Ports

Ports identified for the supporting the construction of the Project, including the primary ports located in Baltimore (Sparrows Point), Maryland; Ocean City, Maryland; Gulf of Mexico (e.g., Ingleside, Texas, Houma/Harvey, Louisiana); Brewer, Maine; and Europe are considered under the Proposed Action (Table 3-10). Baltimore (Sparrows Point), Maryland and Ocean City, Maryland, are expected to be the most heavily used ports during the construction phase to support various construction and installation activities.

Table 3-10. Proposed construction activities and related port facilities

Port Facility	Project Element	Activity
Baltimore, Maryland (Sparrows Point)	WTG – Primary	Delivery, storage, pre-assembly and load out to feeder vessel
	Foundation – Primary	Fabrication, assembly of components, load out to feeder vessel or self-floating and mobilization of fallpipe vessel for scour protection
	OSS – Alternate	Fabrication, assembly of components, load out to feeder vessel
	Cable – Primary	Storage, load out to installation vessel including export and inter-array cables
	Inshore Cable – Primary	Storage, load out to installation vessel (Indian River Bay crossing)
Hampton Roads area, Virginia	WTG – Alternate	Delivery, storage, pre-assembly and load out to installation or feeder vessel
	Foundation – Alternate	Fabrication, assembly of components, load out to feeder or installation vessel and mobilization of fallpipe vessel for scour protection
	Support – Alternate	Large support vessels, assembly of components, load out to feeder vessel, including Jack-up vessels and Multipurpose OSVs
Ocean City, Maryland	Support – Primary	Support services, crew transfer including commercial fishing vessels, CTVs, dive support vessel, rigid inflatable boats and sport fishing boats
Port Norris, New Jersey	Support – Alternate	Support services, crew transfer
Lewes, Delaware	Support – Alternate	Support services, crew transfer
Cape Charles, Virginia	Support – Alternate	Assembly of components, load out to feeder vessel including commercial fishing vessels, Jack-up vessels, Multipurpose OSVs
Port of New York/ New Jersey	WTG – Alternate	Delivery, storage, pre-assembly and load out to installation or feeder vessel
	Foundations – Alternate	Assembly of components, load out to feeder or installation vessel and mobilization of fallpipe vessel for scour protection
	Cables – Alternate	Storage, load out to installation vessel including export and inter-array cables
	Support – Alternate	Support services including commercial fishing vessels, Jack-up vessels, Multipurpose OSVs
Charleston, South Carolina	Cables – Alternate	Storage, load out to installation vessel including export and inter-array cables
Delaware River and Bay (e.g., Paulsboro, New Jersey, Hope Creek, New Jersey, Wilmington, Delaware)	Foundations – Alternate	Fabrication, assembly of components, load out to feeder or installation vessel and mobilization of fallpipe vessel for scour protection
	Cables – Alternate	Storage, load out to installation vessel including export and inter-array cables
	Support – Alternate	Support services including commercial fishing vessels, Jack-up vessels, Multipurpose OSVs
Gulf of Mexico (e.g., Ingleside, Texas, Houma/Harvey, Louisiana)	OSS Foundations – Alternate	Fabrication, assembly of components, load out to feeder or installation vessel
	Met Tower Foundation – Primary	Fabrication, assembly of components, load out to feeder or installation vessel
Brewer, Maine	OSS topside – Primary	Fabrication, assembly of components, load out to feeder or installation vessel

Source: US Wind 2023

Many vessels will be required to support activities carried out during the development, construction, and operation phases of the Proposed Action. Currently, US Wind does not anticipate the use of any aircraft for Project Activities (COP, Volume I, Section 4.0; US Wind 2023). Specific vessels are required for surveying and support activities and for foundation, OSS, cable, and WTG installation. The vessels will vary in size and complexity based on their function on the Project. The vessels employed will be required to comply with applicable USCG and Jones Act regulations for conducting operations in U.S. waters. All foreign flag vessels employed on the Project will, in addition to USCG and Jones Act requirements, be required to meet International Maritime Organization and International Marine Contractors Association requirements. US Wind will also implement an Oil Spill Response Plan (COP, Volume I, Appendix A; US Wind 2023), which will apply to all construction and operations activities, including vessel transits.

Most of the vessels are expected to have conventional propeller- or thruster-based propulsion systems. Smaller vessels designed primarily for crew transfer applications are expected to employ water jet-drive-based systems. The anticipated number of vessel transits during construction were provided over an annual basis rather than by Project phase as shown in Table 3-2; therefore, the discussion of vessel strike risk in Section 6.4 is based on annual vessel transit numbers, not Project phase. Additionally, the specific vessels selected to perform the required tasks during development and construction will depend on availability at the commencement of each activity. US Wind will secure vessel supply in advance to prevent any delays to the construction schedule (COP, Volume I, Section 4.0; US Wind 2023). An overview of the number and types of vessels anticipated to be used with the estimated number of transits and primary ports for construction are provided in Table 3-11, and comprise Baltimore, Maryland (Sparrows Point); Ocean City, Maryland; Gulf of Mexico (e.g., e.g., Ingleside, Texas; Houma/Harvey, Louisiana); Brewer, Maine; and Europe (port not yet determined). A primary port is one that has been identified by the developer as a port that will be used on a regular basis during construction and/or O&M due to its location and infrastructure, project design and planning, and evaluation of anticipated activities and contracting.

US Wind has indicated that alternate ports for project vessels could include: Port Norris, New Jersey; Lewes, Delaware; Cape Charles, Virginia; Hampton Roads area, Virginia; Port of New York/New Jersey; Charleston, South Carolina; Delaware River and Bay (e.g., Paulsboro, New Jersey; Hope Creek, New Jersey; and Wilmington, Delaware). The number of vessel transits are anticipated to remain the same in the case of utilization of any alternative ports such that the number of vessels and the number of transits would not differ based on the port used.

The primary ports are used as the basis for the effects determination in this BA for all species except shortnose sturgeon. Shortnose sturgeon would be the only ESA-listed species to be affected by the use of any of the alternate ports. For shortnose sturgeon, the effects determination included the potential use of the alternate port and transit of vessels to and from the Paulsboro Marine Terminal since it is the only alternative port where shortnose sturgeon are likely to be present due to its location further upstream in the Delaware River and is an area where shortnose sturgeon occur in greater numbers (Section 6.4.7).

The transport of some components and vessels for the Project may originate outside of the U.S. The only confirmed international Project-related vessel transit involves the heavy installation vessel traveling directly from Europe (port not yet known) to the Lease Area; this vessel route is included under the Proposed Action and has been considered in the effects analysis. Some WTG components may potentially originate from Europe or Asia. These components could be transported to the U.S. ports using a mix of heavy lift and general cargo vessels and pre-assembled at the Project's staging location in Baltimore (Sparrows Point), Maryland, then moved offshore for installation. In addition, submarine cables may originate in Europe or Asia and be transported to a U.S. port as described above. While these international transport details are still pending confirmation, the utilization of additional global regions for other components will be determined only when contracts are finalized, and supply chains are established. Until such details are available, potential routes from these regions are not considered part of the Proposed Action for evaluating potential effects.

Table 3-11. Estimated Proposed Action vessel use parameters for primary ports during construction

Primary Ports[1]	Vessel Class	Vessel Role	Approximate Length	Number of Vessels	Vessel speed (Maximum / Average)	Number of Round Trips per Year		
						Year 1	Year 2	Year 3
Europe	Heavy lift vessel	Foundation installation	394–735 feet (120–223 meters)	1	12 kts / 2kts	2	2	2
Baltimore (Sparrows Point), Maryland	Multipurpose OSV	Support	210–295 feet (65–90 meters)	1	15 kts / 4 kts	2	4	2
Baltimore (Sparrows Point), Maryland	Fallpipe vessel	Scour protection	400–550 feet (120–170 meters)	1	12 kts / 2kts	2	4	4
Baltimore (Sparrows Point), Maryland	Tug	Foundation transport/feeder	75–115 feet (16–35 meters)	4	8 kts / 4 kts	13	32	22
Baltimore (Sparrows Point), Maryland	Multipurpose OSV	Support	210–295 feet (65–90 meters)	1	15 kts / 4 kts	2	4	3
Baltimore (Sparrows Point), Maryland	Jack-up vessel	WTG installation	400–740 feet (120–225 meters)	1	10 kts / 1kt	2	2	2
Baltimore (Sparrows Point), Maryland	Tug	WTG transport/feeder	75–115 feet (16–35 meters)	3	8 kts / 4 kts	25	62	43
Baltimore (Sparrows Point), Maryland	CTV	Support	30–100 feet (10–30 meters)	3	25 kts / 8 kts	198	512	346
Baltimore (Sparrows Point), Maryland	Multipurpose OSV	Support	210–295 feet (65–90 meters)	1	15 kts / 4 kts	9	18	9
Baltimore (Sparrows Point), Maryland	Tug	Transport/feeder	75–115 feet (16–35 meters)	3	8 kts / 4 kts	3	6	3
Baltimore (Sparrows Point), Maryland	Multipurpose OSV	Support	210–295 feet (65–90 meters)	2	15 kts / 4 kts	2	4	2
Baltimore (Sparrows Point), Maryland	Jack-up vessel	Support	400–740 feet (120–225 meters)	1	10 kts / 1kt	2	2	2
Baltimore (Sparrows Point), Maryland	Cable lay vessel	Inter-array cable installation	262–492 feet (80–150 meters)	1	10 kts / 3 kts	2	6	4
Baltimore (Sparrows Point), Maryland	Multipurpose OSV	Support	210–295 feet (65–90 meters)	1	15 kts / 4 kts	1	1	1
Baltimore (Sparrows Point), Maryland	Multipurpose OSV	Inter-array cable installation	210–295 feet (65–90 meters)	1	15 kts / 4 kts	2	2	2
Baltimore (Sparrows Point), Maryland	Heavy transport carrier	Offshore export cable transport/feeder	394–735 feet (120–223 meters)	1	12 kts / 10 kts	1	1	1
Baltimore (Sparrows Point), Maryland	Jack-up vessel	Support	400–740 feet (120–225 meters)	1	10 kts / <1kt	1	2	1

Primary Ports[1]	Vessel Class	Vessel Role	Approximate Length	Number of Vessels	Vessel speed (Maximum / Average)	Number of Round Trips per Year		
						Year 1	Year 2	Year 3
Baltimore (Sparrows Point), Maryland	Cable lay vessel	Offshore export cable installation	262–492 feet (80–150 meters)	1	10 kts / 3 kts	1	2	1
Baltimore (Sparrows Point), Maryland	Multipurpose OSV	Support	210–295 feet (65–90 meters)	1	15 kts / 4 kts	2	2	2
Baltimore (Sparrows Point), Maryland	Multipurpose OSV	Offshore export cable installation	210–295 feet (65–90 meters)	1	15 kts / 4 kts	1	2	1
Ocean City, Maryland	CTV	Support	30–100 feet (10–30 meters)	1	25 kts / 8 kts	10	28	19
Ocean City, Maryland	Commercial fishing vessel	Support	45–80 feet (15–25 meters)	1	15 kts / 2 kts	21	55	38
Ocean City, Maryland	Sportfisher	Support	45–80 feet (15–25 meters)	1	25 kts / 2 kts	21	55	38
Ocean City, Maryland	CTV	Support	30–100 feet (10–30 meters)	2	25 kts / 8 kts	120	280	200
Ocean City, Maryland	Commercial fishing vessel	Support	45–80 feet (15–25 meters)	1	15 kts / 2 kts	0	6	4
Ocean City, Maryland	Dive support vessel	Support	N/A	1	15 kts / 1 kt	1	2	1
Ocean City, Maryland	Rigid inflatable boat	Support	N/A	1	20 kts / 2 kts	14	28	14
Brewer, Maine	Heavy lift vessel	OSS topside installation	394–735 feet (120–223 meters)	1	12 kts / 2 kts	1	2	1
Gulf of Mexico (e.g., Ingleside, Texas; Houma/Harvey, Louisiana)	Heavy lift vessel	Met Tower installation	394–735 feet (120–223 meters)	1	12 kts / 2kts	0	1	0

Source: COP, Volume II, Section 1.3 (US Wind 2023); Appendix A, TRC 2023
CTV = crew transfer vessel; N/A = not available; OSV = offshore support vessel
[1] US Wind anticipates WTG, foundation, and cable components will be shipped from European and other U.S. East Coast ports, including ports in the Gulf of Mexico, to a staging area in Baltimore (Sparrows Point), Maryland. The exact ports to be used will not be known until final contracts are in place.

Vessels transiting between the Lease Area and Baltimore (Sparrows Point), Maryland may utilize routes through Chesapeake Bay or Delaware Bay via the C&D Canal (Figure 3-8). In addition, a heavy-lift foundation installation vessel will undergo up to two round trips from a port in Europe to the lease area per construction year and delivery of the OSS topside and Met Tower from Brewer, Maine and the Gulf of Mexico, respectively, are identified and considered under the Proposed Action.

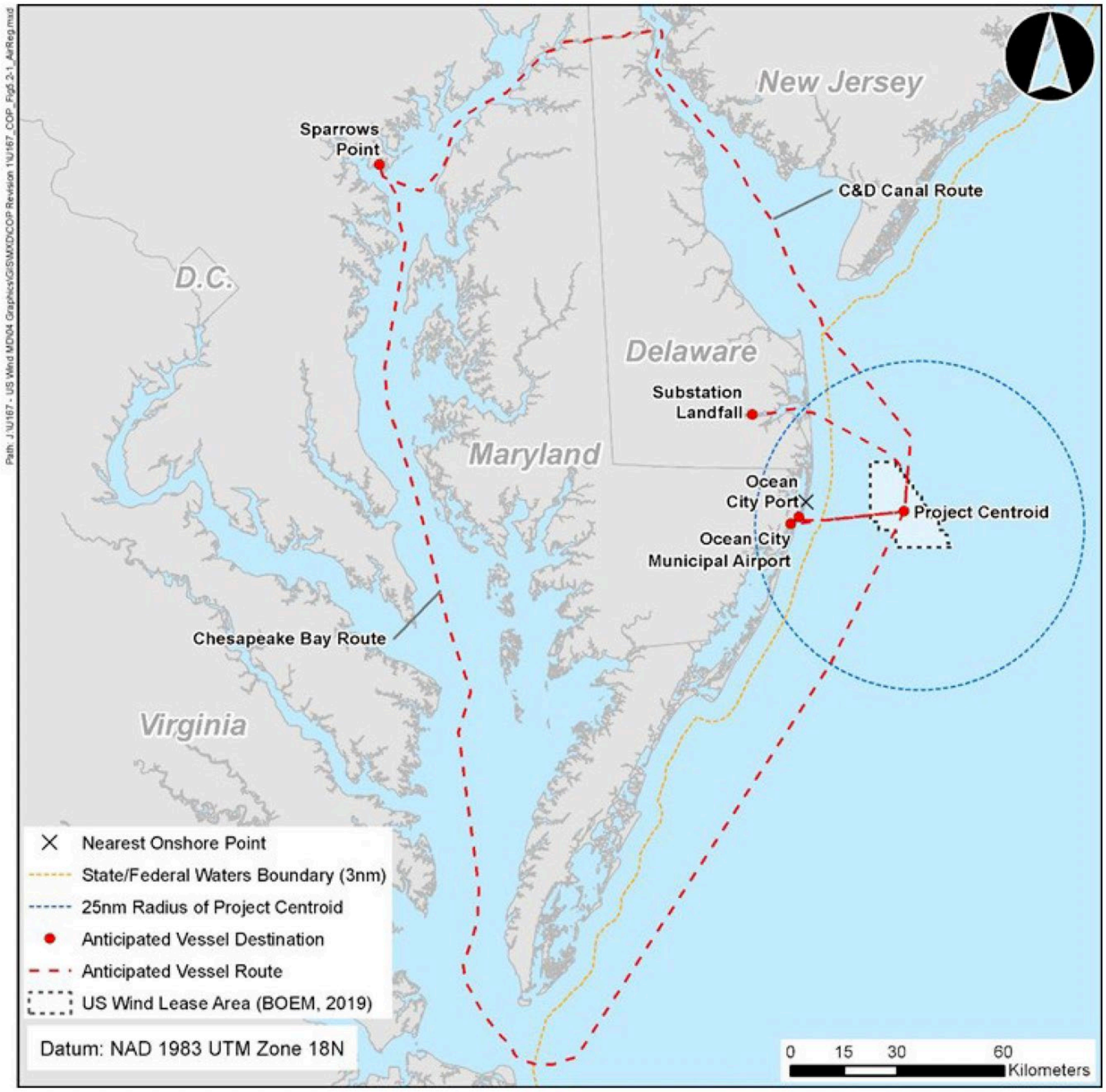

Figure 3-8. Vessel transit routes from Baltimore (Sparrows Point), Maryland
Source: COP, Volume II, Section 5.2, Figure 5-1 (US Wind 2023)

Ports in Europe, Maine, and the Gulf of Mexico are only anticipated to be utilized during construction. It should be noted that the exact ports to be used will not be known until final contracts are in place. 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 transits.

3.1.1.7 Horizontal Directional Drilling

The Proposed Action includes HDD at up to three locations: between the Atlantic Ocean and the landfall location at 3R's Beach; from 3R's Beach into Indian River Bay (Old Basin Cove); and from the Indian River (Deep Hole) to the US Wind Onshore substations. When fully installed, the shore end of the HDD ducts will terminate in a transition vault, and the water end will be sealed and buried to the installation depth of the offshore export cables. The proposed vaults are each approximately 40 feet (12 meters) long, 10 feet (3 meters) wide, and 10 feet (3 meters) deep. The HDD ducts will be connected to the transition vaults and backfilled. The transition vaults, when fully installed, will be accessed from ground-level access points.

The primary HDD equipment will be located on land and will consist of a drilling rig, mud pumps, drilling fluid cleaning systems, pipe-handling equipment, excavators, and support equipment such as generators and trucks. Land-side operations will be in existing parking areas or other already developed areas (e.g., access roads) to avoid impacts to sensitive coastal habitats. Water-side HDD equipment will vary based on the installation location but will generally consist of a work platform (either a barge or small jack-up) and associated support vessels (e.g., tugs, small work boats). The work platform will be equipped with a crane, an excavator, winches, and auxiliary equipment, including generators and lights. The limited water depth in Indian River Bay is expected to require in-water operations to be based on a barge equipped with spuds for positioning. The offshore (ocean-based) HDD works may be supported by a jack-up or barge depending on the final design and installation requirements in the FDR/FIR process. Approximate dimensions of the proposed HDD sites are provided in Table 3-12. Final HDD lengths will depend on factors such as soil conductivity, cable design, and available installation methods to minimize disturbance in shallow areas of the bay close to the landfall locations. The water side of the HDD duct may employ temporary gravity cells or a casing pipe to facilitate the installation of the cables, retain cuttings and drilling fluids, and to ensure the HDD duct remains free of debris prior to installation of the export cable. The use of cofferdams, which would require vibratory hammers to install sheet piles into the seafloor, were considered but not selected due to increased underwater sound (COP Volume I, Section 3.6.1.2; US Wind 2023), so all infrastructure associated with the HDD, including casing pipes, would be installed using gravity-based installation methods under the Proposed Action. It is expected that the gravity cells for in-water operations would be up to 197 feet (60 meters) long and 33 feet (10 meters) wide. The gravity cells will be designed to minimize the release of drilling cuttings and fluids and would be open on the seaward (outbound) side to facilitate installation of the export cables.

Table 3-12. Approximate parameters of the proposed HDD sites

Location	Length of HDD	Depth of Duct Below Grade	Water Depth Exit	Distance from Transition Vault to Shoreline
Atlantic Ocean (offshore export cable and 3R's Beach landfall)	1,600–5,300 feet (488–1,600 meters)	8–60 feet (2–18 meters)	30 feet (9 meters)	550 feet (167 meters)
Old Basin Cove (3R's Beach landfall and inshore export cable in Indian River Bay)	1,700–6,500 feet (518–2,000 meters)	8–50 feet (2–15 meters)	2–5 feet (>1–1.5 meters)	1,700 feet (518 meters)
Deep Hole (inshore export cable and Indian River substation in the Indian River)	1,600–3,200 feet (487–975 meters)	8–40 feet (2–12 meters)	2–5 feet (>1–1.5 meters)	1,350 feet (411 meters)

Source: US Wind 2023

HDD operations commence with a pilot hole that is enlarged by using progressively larger reaming tools. During drilling operations, drilling mud will be injected to cool the drill bit, provide lubrication, and stabilize the borehole. The drilling fluid (mud) is an inert bentonite slurry and will carry the cuttings back to the shoreside excavation pit for collection/removal and reuse. HDD operations will include monitoring of the downhole water/bentonite slurry to minimize the potential of drilling fluid breakout. A series of reamers will be added to the drill string, as soil conditions allow, to progressively increase the size of the borehole until it is large enough to accept the final export cable duct. When the required borehole diameter is achieved, a pulling head is attached to the drill string at the in-water end of the bore. Prefabricated sections of duct are attached to the drilling head and pulled into the borehole. The duct sections are expected to be fabricated on shore and floated to the barge or jack-up for installation. A duct approximately 24 inches (60 centimeters) in diameter is planned; final sizing of the duct will be confirmed based on cable sizing and thermal properties of the soils (COP, Volume I, Section 3.6.3; US Wind 2023).

3.1.2 O&M Facility

US Wind's operations and maintenance facility (O&M Facility) will provide a suitable location to plan and coordinate WTG and OSS maintenance and servicing operations for the Project from the Ocean City, Maryland region (see Figure 3-9). The O&M Facility will be comprised of onshore office, crew support, and warehouse spaces with associated parking in the Ocean City commercial harbor and will include quayside and berthing areas for four or more crew transfer vessels (CTVs). The O&M Facility will also house a Marine Coordination Center, which will serve to monitor the status of the WTGs and OSSs via SCADA systems, plan maintenance operations and dispatch CTVs, monitor marine activity in the Project area, coordinate drills and exercises, and communicate with outside agencies.

The proposed O&M facility location is likely to be located on two adjacent sites on the waterfront in West Ocean City, Maryland. The waterfront sites together are approximately 1.5 acres (0.61 hectares) in size. Specifically, both potential parcels are waterfront properties with suitable water depth and mooring space in the commercial harbor to safely support four or more CTVs. The two waterfront properties currently under consideration are 12933 Harbor Road and 12929 Harbor Road.

US Wind would grade portions of the sites to prepare for construction of new buildings approximately three stories and no more than 45 feet (13.7 meters) high, set back at least 25 feet (7.6 meters) from the tidal waters. New buildings would include a crew support facility and a temporary warehouse, as well as a combined administrative building and warehouse to be completed later in the Project. Expansion or replacement of the existing waterfront access points would be undertaken in consultation with the Maryland Department of the Environment (MDE) and U.S. Army Corps of Engineers (USACE), including for the replacement or expansion of pavement to allow for vehicle parking and vehicular/forklift access to new cranes or davits that would load materials onto the CTVs stationed at the berth/quayside.

The waterfront property will support the onloading and offloading of parts, tools, and personnel needed for operations and maintenance on the WTGs and OSSs with ingress/egress to the Project area via the Ocean City Inlet. Site improvements would include the replacement of a timber pier and the existing bulkhead/quay wall. The pier is anticipated to be up to 625 feet (191 meters) long and 28 feet wide (8.5 meters). The existing bulkhead/quay wall would be replaced from the end of the pier to 175 feet (53 meters) west. Equipment deployed on the pier deck would include jib cranes and mooring hardware to allow for CTVs to dock and receive the necessary crew and equipment. The 28-foot (8.5-meters) wide pier would allow for a truck to assist in loading equipment onto vessels.

Figure 3-9. Proposed location of the O&M Facility for US Wind
Source: US Wind 2023

Activities that could be required during construction of a new O&M Facility and could affect ESA-listed species considered in this BA are described herein based on other available project descriptions.

3.1.2.1 Shoreside Improvements

Construction at the O&M Facility will include repairs to the existing concrete wharf (bulkhead repair and timber fender systems). Bulkhead repairs including steel sheet pile and an attached timber fender system will occur along the existing concrete wharf 175 feet (53.3 meters). The bulkhead repairs will be performed by placing sheet piling a maximum of 18 inches beyond the existing wharf face and filling the void between the two before being capped. The existing floating dock which is 75 feet (22.9 3 meters) long and the existing pier which is 550 feet (17.7 meter) long by 12-foot (3.7 meters) wide will be replaced by a fixed pier which will be 625 feet (190.5 meters) long and range from by 30 feet (9.1 meters) to 32 feet (9.7 meters) wide. The length of the proposed pier will not extend any further into Ocean City Harbor any further than the current dock and pier structures. Additional bulkhead repairs will occur within the same footprint of a segment (235 feet [71.6 meters]) of the proposed fixed pier. The footprint of the proposed bulkhead repairs and fixed pier would permanently impact approximately 19,700 square feet (1,830.2 square meters) of seafloor.

New construction at the O&M Facility would occur from a barge mounted crane which is anticipated to include pile driving for the pier and installation of concrete pile caps, deck and curbs. Equipment such as jib cranes are anticipated to be installed on the pier deck and mooring hardware mounted along the curb as required for the CTVs. There is no proposed dredging for the construction or operations of the pier.

3.1.2.2 Pile Driving

Up to 170 steel pipe pier piles- 12-to-18-inch (30.5 to 45.7 centimeters) diameter, 100 to 125 feet (30.5 to 38.1 meters) in length would be driven by impact hammer. A 2-foot- (0.6 meter) wide timber fender system along the north side of the pier and along the steel sheet pile bulkhead will be installed. Also, a 2-foot-(0.6 meter) wide timber fender system and wave screen on the south side of the pier would be installed. Up to 240 timber fender system piles 12-to-18-inch (30.5 to 45.7 centimeters) diameter, 40 to 45 feet (12.2 to 13.7 meter) in length would be driven by impact hammer. The piling duration for the steel pipe pier piles and timber fender system piles would occur over a period of up to 6-months. The sheet pile bulkhead would include up to 120 sheets that would be driven by impact hammer over a period of up 3 months.

The means and methods of pile installation would be consistent with similar scale projects in the area. The specific hammer energy would be further refined as the Project progresses, however US Wind does not anticipate any exceptional or non-traditional methods of installation that vary from similar work.

3.1.3 Construction – Inshore and Onshore Infrastructure

PDE parameters for the onshore infrastructure of the Project are summarized in Tables 3-13 and 3-14. The inshore and onshore Project components include the landfall, inshore export cable, onshore substations, and substation interconnections.

Table 3-13. Summary of key onshore Project infrastructure components

Project Parameter	Details
Inshore export cables	Up to 97 miles (156 kilometers) long (including inshore export cable through Indian River Bay) 230 to 275 kilovolt AC submarine cables in a minimum 131-foot (40-meter) wide corridor (maximum width dependent on bay bottom conditions) Runs between landfall location and the Indian River POI
Interconnection points	POI anticipated to include two substations to be built by US Wind and expansion of existing DPL 230 kilovolt substation
Landfall location	Near 3R's Beach parking lot 1 mile (1.6 kilometers) south of the Indian River Inlet

AC = alternating current; CTV = crew transfer vessel; DPL = Delmarva Power and Light; O&M = operations and maintenance; POI = point of intersection

Table 3-14. Anticipated construction milestones and time frames

Project Component	Activity Duration	Anticipated Time Frame
MarWin Construction Campaign (Phase 1)		
Procurement and design of Project infrastructure	Varied	Q1 2022 to Q3 2025 (depending on component)
Onshore substation construction and installation	N/A	Q1 2024 to Q3 2025
Inshore cable installation	Approximately 18 months	Q3 2024 to Q1 2026
Landfall (HDD) cable installation	N/A	Q1 2025 to Q2 2025
Momentum Wind Construction Campaign (Phase 2)		
Procurement and design	Varied	Q1 2022 to Q4 2024
Onshore substation construction and installation	N/A	Q1 2024 to Q2 2026
Inshore cable installation	Approximately 18 months	Q3 2024 to Q12 2026
Future Development Construction Campaign (Phase 3)		
Procurement and design	Varied	Q1 2022 to Q3 2024
Onshore substation construction and installation	N/A	Q3 2026 to Q2 2025

Source: US Wind (2023); TRC (2023)
HDD = horizontal directional drilling; N/A = not applicable; Q = quarter

From the landfall, the export cables would continue along the Inshore Export Cable Route within Indian River Bay to connect to an onshore substation adjacent to the point of interconnection (POI) at the Indian River substation owned by Delmarva Power and Light in Dagsboro, Delaware. The POI will include an expansion of the existing substation and construction of three new substations adjacent to the existing substation (US Wind 2023). An overview of the Inshore Export Cable Route is provided in Figure 3-10. The minimum width of the four-cable installation would be 131 feet (40 meters), while the maximum width would depend on bay bottom conditions, considering the thermal properties of the soil and proper cable spacing. US Wind has not determined a preferred Inshore Export Cable Route, northern or southern, through Indian River Bay. US Wind is considering both routes for up to four cables, or some combination thereof, (i.e., one cable in the northern route and three cables in the southern route, or three cables in the north and one cable along the southern route).

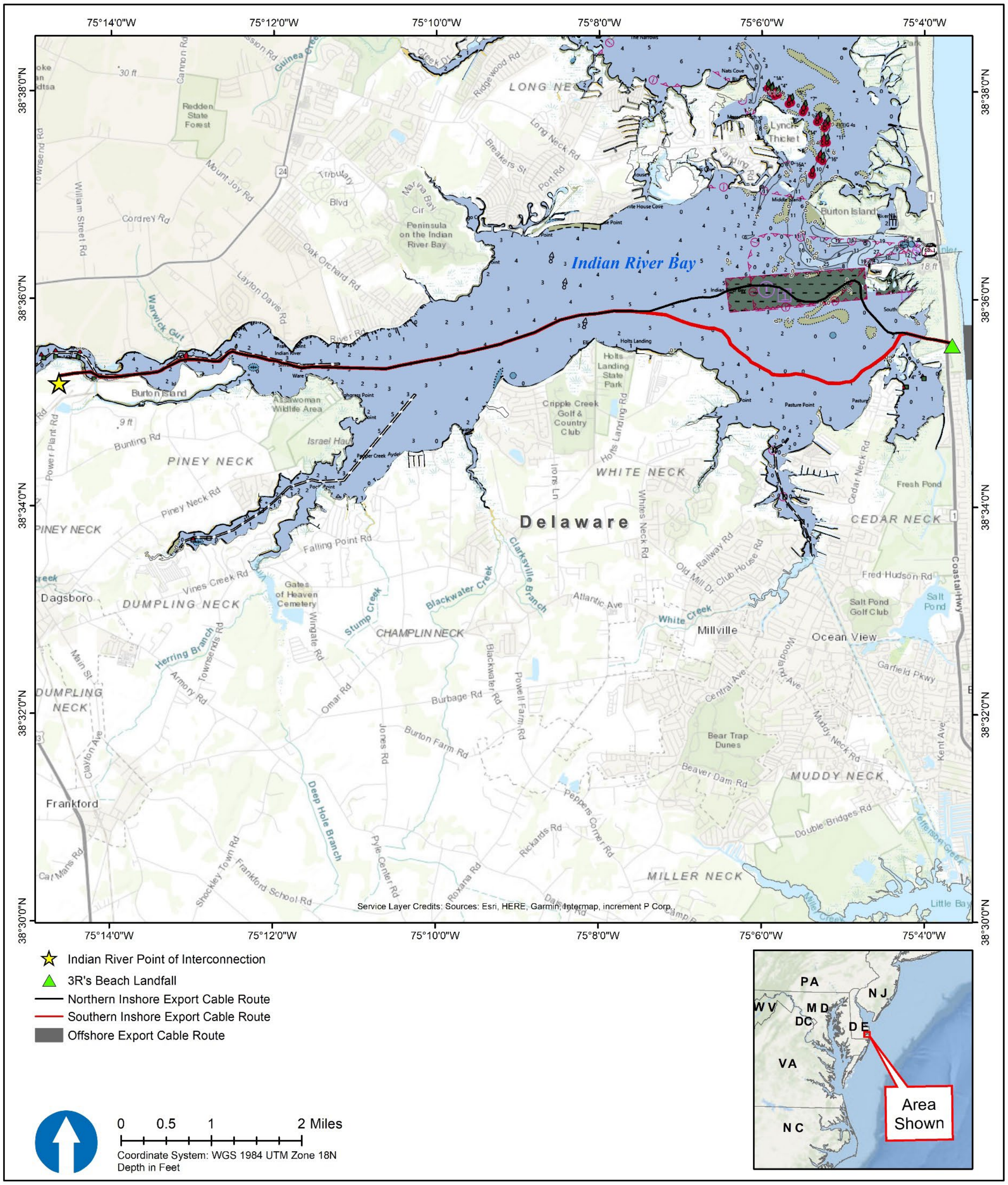

Figure 3-10. Proposed Inshore Export Cable Route

To achieve the target burial depth, US Wind and its contractors have determined dredging for barge access in locations along the Inshore Export Cable Routes would be necessarily preceding cable installation. US Wind assumes that cable installation in Indian River Bay would be occur over two construction seasons (Campaign 1 – one cable, associated with MarWin and Campaign 2 – up to three cables, associated with Momentum and future development). Dredging would be conducted using mechanical, or most likely, hydraulic means. The specific type of hydraulic method to be used is not known yet. The maximum volume of dredging, assuming all four cables were installed within both the northern and southern Inshore Export Cable Routes is estimated to approximately 390,648 cubic yards (298,6712 cubic meters). US Wind assumes all construction within Indian River Bay, including any dredging, would occur in October-March window, observing the general time of year restrictions for summer flounder and other species. Time of year restrictions would be determined through consultations with DNREC.

Under the Proposed Action it is anticipated that the dredged material would be deposited within the construction corridor of approximately 633 feet (193 meters) on either side of the centerline of the Inshore Export Cable Route using a floating pipeline system, barge, or scow. Dredge material disposal would occur within the surveyed Inshore Export Cable Route in areas with compatible physical and chemical characteristics. The sediment habitat within the Indian River Bay consists of a 100% soft bottom (Section 3.2.1.1.2). Furthermore, the sediments will have to meet State standards prior to placement.

US Wind is also considering using the dredge materials for beneficial reuse for beach renourishment north of Indian River Inlet, habitat reconstruction in Indian River and Indian River Bay, or other projects identified by USACE, DNREC, and other stakeholders. Based on the dredge volumes US Wind is relatively confident the dredged material can be beneficially reused for the beach nourishment along with some wetland or marsh restoration projects in Indian River Bay. Specific dredge disposal locations for beneficial use have not yet been selected but anticipate the dredge disposal would occur in the immediate area and not require offshore or onshore disposal. Beneficial reuse of dredge material projects would require additional ESA consultation and design/permitting and are thus not part of the Proposed Action.

Seabed preparation for inshore cables including route clearance activities will be conducted prior to cable installation including a pre-installation survey and grapnel run. The pre-installation survey and grapnel run will be conducted along the cable routes to remove debris such as lost fishing nets or other objects that could impact the cable lay and burial. Collected debris will be recovered and disposed of in appropriate shore side facilities. Pre-installation seafloor preparation, such as levelling, pre-trenching or boulder removal, is not currently expected (COP, Volume I, Section 3.6.1; US Wind 2023).

The cable installation spread will be arranged to maintain a limited draft and may be arranged on multiple barges. A cable storage barge will be equipped with a turntable, loading arm, and cable roller highway (which is used to reduce cable tension) towards a cable installation barge. The barges would be suitable for positioning close to the HDD exit points (Old Basin Cove -Indian River Bay and Deep Hole – Indian River) due to the flat bottom and shallow draft. It is expected that the barge will be moved along the cable route using a six-point anchor system, assisted by an anchor handling tug, in combination with spud piles.

The inshore export cable will be fed to the HDD ducts using small boats and floatation where it will subsequently be pulled through the ducts into the jointing/transition bays. If necessary, a temporary cable roller highway (used to reduce cable tension) will be pre-installed in shallow water. The cable barge will lay and bury the cable between the two end points maneuvering along the cable route using its anchoring system and positioned using spuds as required. Based on the sediments observed along Inshore Export Cable Route in Indian river Bay, it is assumed that a barge mounted vertical injector, which fluidizes the soil, will be the primary burial tool for the cable. The use of a cable plough or barge mounted excavator may be required in some areas. In shallow water, a self-driving or towed post-lay cable burial tool may be used.

No cable or pipeline crossings have currently been identified within the Inshore Export Cable Route based on currently available information. It is anticipated that the cable will be installed in a continuous length, however if operational needs warrant, the cable can be installed in smaller sections and spliced. US Wind will optimize the cable installation and construction methodologies and include the details in the Facility Design Report and Fabrication and Installation Report process.

With any of the cable burial methods within the Inshore Export Cable Route, the trench in the bay bottom would be narrow and would collapse immediately after the cable has been depressed into the trench. The required burial depth will be based on the anticipated long-term bay bottom morphology and is expected to be 3 to 7 feet (1 to 2 meters). Up to 4 export cables may be laid in Indian River Bay with spacing of 32 to 98 feet (10 to 30 meters) between the parallel alignments to allow for construction and any future maintenance. Construction would be confined to an approximately 1,640-foot (500-meter) corridor along the Inshore Export Cable Route within Indian River Bay. US Wind assumes all construction within Indian River Bay, including any dredging, would occur in October-March window, observing the general time of year restrictions for summer flounder and other species. Time of year restrictions would be determined through consultations with DNREC.

The parameters of the inshore export cable and route are summarized in Table 3-15.

Table 3-15. Inshore Project cable specifications

Design Parameter	Design Size and Detail
Type of Cable	Three-phase 230–275 kilovolt AC
Cable Capacity	230–275 kilovolt
Onshore Export Cable Routes	Four cables in 1 route
Cable Length	96 miles (156 kilometers)

Source: US Wind 2023

3.1.3.1 Onshore Substation Interconnections

The US Wind onshore substations would connect to the existing Indian River Substation via overhead line. The transmission line between the new US Wind substations and the Indian River Substation POI is expected to be a short overhead transmission line, subject to any applicable DPL discretion. US Wind proposes that the three substations will be adjacent to one another such that any overhead transmission line will be less than 500 feet (152 meters) long. There are no terrestrial Onshore Export Cable Routes associated with the Proposed Action. The route connecting the landfall at 3R's Beach with the Onshore substation at Indian River substation (DPL substation adjacent to the Indian River Power Plant) is considered part of the Inshore Export Cable Route.

3.1.3.2 Onshore Substations

The existing 230-kilovolt Indian River substation, located in Dagsboro, Delaware, is the proposed POI for the Project. The existing Indian River substation is adjacent to the Indian River Power Plant. Connection of the Project to the electrical grid is anticipated to involve expansion of the existing Indian River substation as well as construction of three new substations adjacent to or within 0.5 miles (0.8 kilometers). The Proposed Action includes the expansion of the existing Indian River substation at 1.84 acres (0.74 hectares) and three proposed substations totaling 10.3 acres (4.2 hectares) and a permanent access road of 1.43 acres (0.58 hectares). Construction of the interconnection facilities also includes the temporary construction laydown area of 4.02 acres (1.63 hectares), and a temporary access road of 0.76 acres (0.31 hectares). Expansion of the existing Indian River substation is expected to accommodate the new capacity and required transformers, breakers, switches, and control gear.

The existing Indian River substation and new adjacent substations are shown in Figure 3-11. The figure shows a preliminary general arrangement of the substations; however, the final design may vary within the shown footprint. The new substations would be constructed northwest and southwest of the Indian River substation. The proposed arrangement of the new substations allows for expansion of the Indian

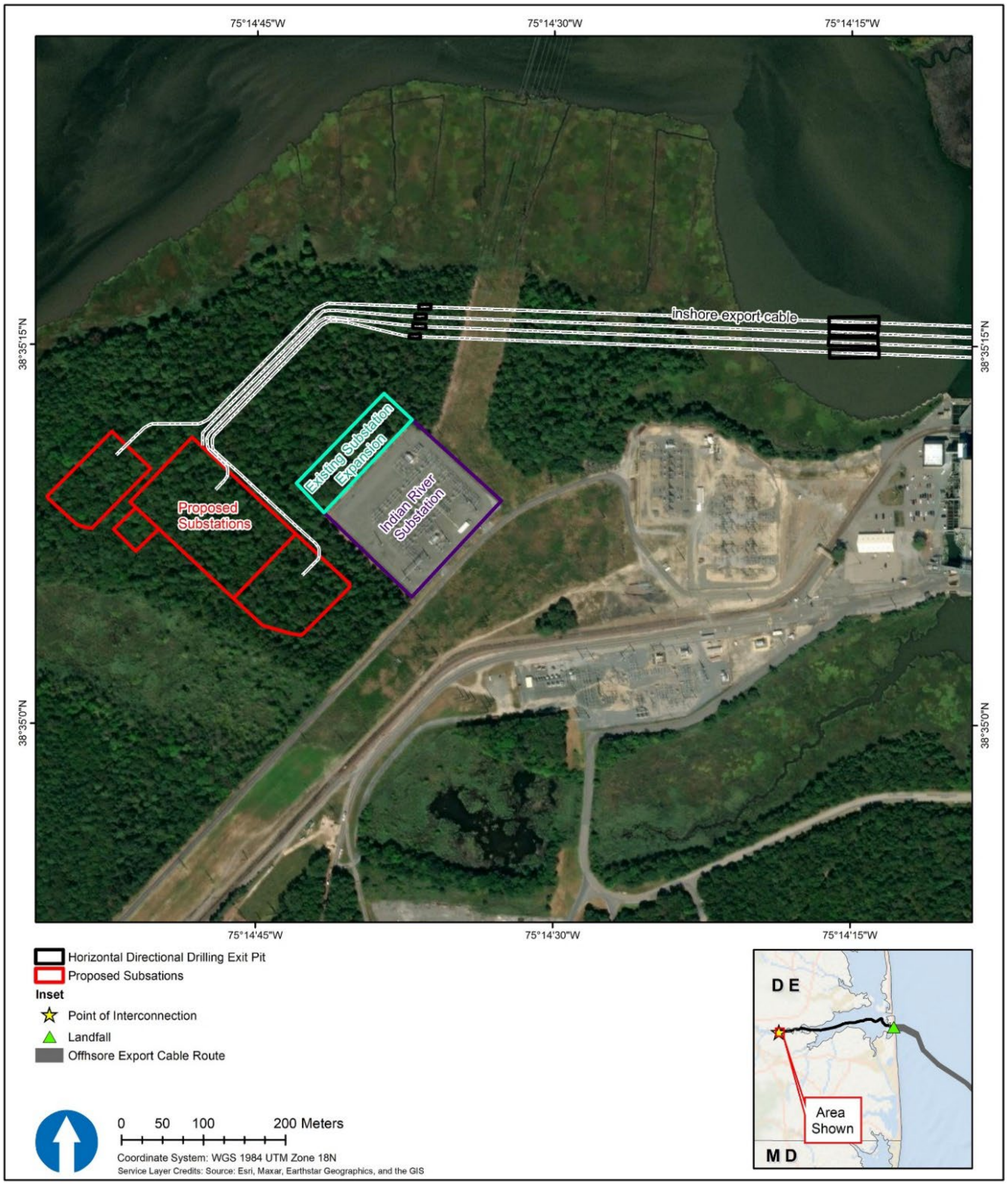

Figure 3-11. Onshore Indian River substation with proposed expansion and the three new proposed US Wind substations

River substation and for sequential construction of the new substations. The onshore export cables would exit the HDD duct, enter underground transition vaults approximately the same size as the transition vaults at 3R's Beach landfall, and traverse underground to be terminated at the respective new substation block. The new substations would connect to the Indian River substation via a short overhead line approximately 500 feet (152 meters) long.

US Wind is evaluating gas- and air-insulated substations, which have different maximum footprints and tallest structures. Ground disturbance below the new substations is estimated to extend 12 feet (4 meters) below grade.

3.1.3.3 Landfall Site

The proposed offshore export cables (described in Section 3.1.1.4) would make landfall south of the Indian River Inlet at 3R's Beach within the Delaware Seashore State Park. The proposed scenario is a landfall location in the vicinity of the 3R's Beach parking lot approximately 1 mile (1.6 kilometers) south of the Indian River Inlet (Figure 3-12). Also depicted in Figure 3-12 are wetlands near the 3R's Beach landfall site. These include (COP, Volume II, Section 6.1; US Wind 2023):

- A tidal salt marsh along the eastern edge of Indian River Bay, across Delaware State Route (SR) 1 from the landfall site;
- A non-tidal freshwater scrub-shrub wetland between the tidal salt marsh and the western edge of SR 1; and
- A non-tidal freshwater marsh wetland immediately south of the 3R's Beach parking lot.

Figure 3-12. 3R's Beach landfall: **HDD with offshore/onshore transition vault connection and surrounding wetlands**

3.1.4 Operations and Maintenance

The O&M facility's waterfront location in the Ocean City commercial harbor will allow technicians efficient access to the Project offshore via CTVs, ensure dedicated monitoring of WTG and OSS operations, support planning and coordination of maintenance activities, allow marine coordination with US Wind CTVs, other marine traffic, and emergency response agencies, and facilitate world-class support of the WTG and OSS maintenance technicians. The co-location of administration, operations, and warehousing will support efficient planning and coordination, limit maintenance crew travel times, house spare parts, tools, and equipment next to the CTVs on the waterfront, and reduce unnecessary handling of parts and equipment (Figure 3-13). The CTVs will transport maintenance crews to the offshore site on an as -needed basis depending on weather conditions.

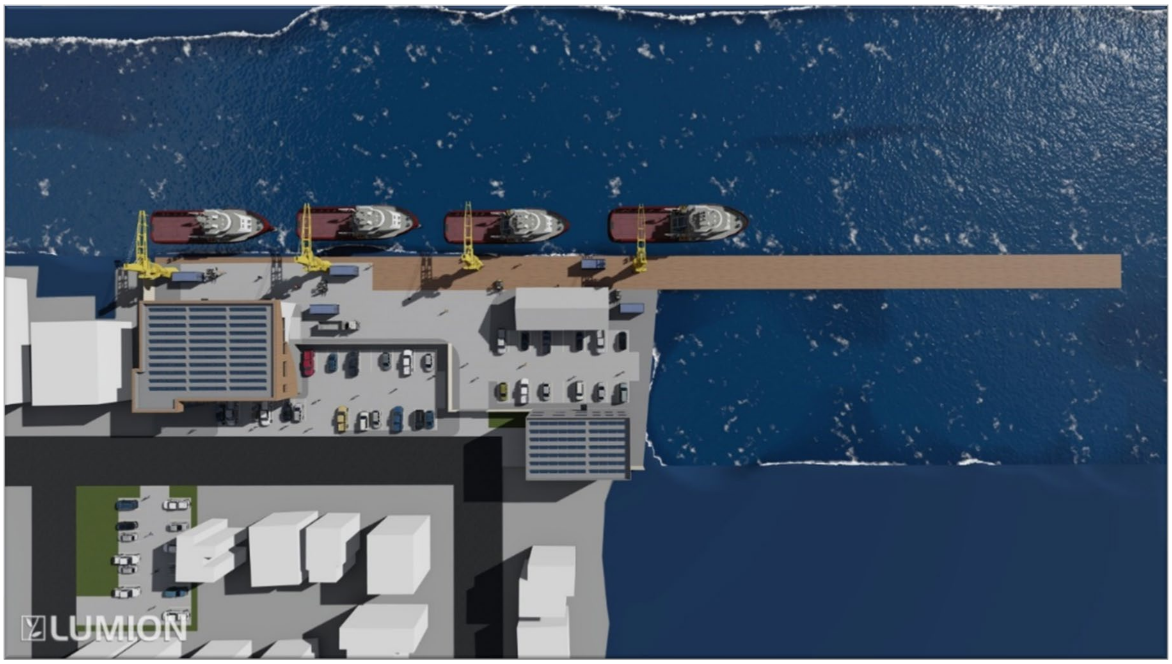

Figure 3-13. Overhead view of notional O&M Facility in Ocean City, Maryland
Source: US Wind 2023

The local O&M team will have the appropriate training to execute the maintenance scope of the Project, including required safety training for marine, WTG, and electrical systems. Personnel will be trained and deemed competent to perform maintenance operations on the WTGs, OSSs, and supporting equipment. The O&M strategy for the Project will be refined in conjunction with the OEM; engineering, procurement, and construction contractors; and regulatory agencies as design development, selection of project components, and installation data progresses under the FDR/FIR process.

3.1.4.1 WTGs and OSSs

WTGs are designed to be operated remotely and only accessed by technicians for routine maintenance and inspections, or in the event of a fault that requires local reset or intervention. Operations monitoring will be performed remotely from the O&M Facility and the OEM remote operations center. All operational decisions are managed between the O&M Facility and the OEM remote operations center, including coordination on marine and aviation safety with the USCG, Federal Aviation Administration (FAA), relevant local authorities, and grid operator. A list of operational and maintenance activities for the WTGs and OSSs is provided below.

- The Project SCADA system allows for operation and monitoring from the O&M Facility and the OEM remote operations center. As noted above, the OEM remote operations center will maintain a 24/7 telecommunication protocol with all members and entities required for the Project operation, including management, technicians, and PJM. The OEM remote operations center will have the ability to start and stop WTGs.
- Perform remote monitoring of the WTGs and corrective actions, where appropriate.
- Maintain operational data of the Project and develop daily production forecasts.
- Analyze alarms and develop corrective and troubleshooting actions.
- Reset faults in the WTGs and Project electrical system.
- Perform emergency shutdowns.

Per the Oil Spill Response Plan submitted with the COP (Appendix A-1, US Wind 2023) the estimated oil types onboard each of the WTGs include oil, grease and synthetic ester dielectric fluids with total volumes of approximately 1,390 gallons (5,260.5 liters). US Wind has not achieved the final design specifications for the OSS. Oil volumes are based upon industry expert estimates for a notional 400 MW OSS, which may include diesel oil, synthetic ester oil, marine diesel oil, hydraulic oil and motor oils with total volumes of approximately 84,972 gallons (321,649 liters).

Scheduled maintenance of the OSS components occur at predefined intervals in accordance with the manufacturer's recommendations. Planned maintenance outages will be scheduled with PJM to avoid peak load periods. Scheduled maintenance will include high-voltage protection functional testing, switchgear tests, and detailed transformer inspections. The OSSs will be serviced by technicians trained in high-voltage equipment. Routine maintenance and inspection of the OSS structure and support systems will also be conducted, such as structural integrity, corrosion protection, seafloor scouring and maintenance of safety systems.

3.1.4.2 Met Tower

The Met Tower is designed for high reliability, redundancy, and remote operations. US Wind's operations team and a third-party contractor will jointly monitor Met Tower operations remotely via the high-speed remote data link and anticipated near real-time data transmission capabilities. Data issues, alarms, and other operational anomalies are anticipated to be flagged promptly via remote operations and monitoring.

Operational protocols and scheduled maintenance plans for the Met Tower will be built on the final equipment configuration and the associated manufacturers' and engineers' recommendations. Annual in-person site visits are planned to conduct instrumentation, data logging, power, safety, and communication systems maintenance, along with above-water structural checks. Unscheduled maintenance will be conducted as necessary, based on the nature of the issue as well as related health, safety, environmental and operational parameters. Met Tower operational decisions are planned to be managed between the O&M Facility and the contractor's remote facility. This process will include coordination on marine and aviation safety with the USCG and FAA as well as engagement with other relevant local authorities and stakeholders (e.g., National Oceanic and Atmospheric Administration [NOAA]), as appropriate.

3.1.4.3 Foundations

Planned maintenance operations for foundations include visual inspections of the topside portions of the foundations and remotely operated vehicle (ROV)-supported inspection of the underwater portions of the foundation, including cable protection and cable entry, cathodic protection, and scour systems. During the initial operational period of approximately 2 years following construction for each phase, foundations will be inspected visually above and below the waterline at least once. The findings of the initial inspections will inform the frequency of inspections to be completed later in the Project life cycle, likely every 4 to 5 years.

3.1.4.4 Cables

Subsea cables are exposed to tides and sediment flows and, in extreme cases, experience failure due to anchor strike. US Wind will monitor and survey the offshore export cables and inter-array cables and repair them as needed. Survey and remedial work will be subcontracted to an appropriate specialist service provider depending on the need. Routine procedures will include cable surveys, typically required to check the cable burial depths, especially in locations with sand waves or high fishing activity that can impact buried cables. Cable surveys are anticipated in year 1, year 3, and then every 5 years after during O&M for each Project phase. The frequency of the surveys may be adjusted based on the results of the first survey. The determination of cable burial depths may be derived indirectly from observed bathymetric changes with respect to the as-built situation. The effects of migrating sand waves will be taken into consideration. In case of insufficient burial or cable exposure, whether attributable to natural or human-caused issues, appropriate remedial measures will be taken, including reburial or placement of additional protective measures. If a cable failure occurs, an appropriate cable repair spread will be mobilized.

3.1.4.5 Onshore Substations

Maintenance of the Onshore substation primarily consists of non-intrusive inspections of switchgear, transformers, control systems, conductors, and support structures. Similar to the OSSs, the scheduled maintenance of the Onshore substation components will occur at predefined intervals, in accordance with the manufacturer’s recommendations and in coordination with the PJM.

3.1.4.6 Vessels and Potential Ports

Ports identified to support the O&M activities include the primary ports located in Ocean City, Maryland, Lewes, Delaware, Hampton Roads area, Virginia, Baltimore (Sparrows Point), Maryland, Hope Creek, New Jersey and the Port of New York/New Jersey (Table 3-16). Maintenance activities for WTGs, OSSs, and routine inspections using CTVs are expected to operate out of the O&M facility in Ocean City and Lewes, Delaware. Major maintenance activities requiring deep draft or jack-up vessels are expected to operate from Baltimore (Sparrows Point) and Hampton Roads area, Virginia.

Table 3-16. Proposed O&M activities and related ports

Ports	Potential O&M Activities
Ocean City, Maryland	Maintenance activities for WTGs, OSSs, and routine inspections
Lewes, Delaware	Maintenance activities for WTGs, OSSs, and routine inspections
Hampton Roads area, Virginia	Major maintenance activities requiring deep draft or jack-up vessels
Baltimore, Maryland (Sparrows Point)	Major maintenance activities requiring deep draft vessels
Hope Creek, New Jersey	Major maintenance activities requiring deep draft or jack-up vessels
Port of New York/New Jersey	Major maintenance activities requiring deep draft or jack-up vessels

Source: US Wind 2023

An overview of the number and types of vessels anticipated to be used and the estimated number of transits and primary ports for O&M are provided in Table 3-17. The specific vessels selected to perform the required tasks during development and construction will depend on availability at the commencement of each activity. US Wind will secure vessel supply in advance to prevent delays to the construction schedule (COP, Volume I, Section 4.0; US Wind 2023).

Table 3-17. Estimated Proposed Action vessel use parameters during O&M

Primary Port	Vessel Class	Vessel Role[1]	Approx. Length	Number of Vessels	Vessel Speed (Maximum / Average)	Number of Annual Round Trips
Lewes, Delaware	CTV	Support – routine maintenance	30–100 feet (10–30 meters)	1	25 kts / 8 kts	58
Ocean City, Maryland	CTV	Support – routine maintenance	30–100 feet (10–30 meters)	4	25 kts / 8 kts	760
Ocean City, Maryland	Sportfisher	Support – routine maintenance	45–80 feet (15–25 meters)	1	25 kts / 2 kts	4
Baltimore (Sparrows Point), Maryland; Hope Creek, New Jersey; Port of New York/ New Jersey	Multipurpose OSV	Support – non-routine maintenance	210–295 feet (65–90 meters)	1	15 kts / 4 kts	<1
Baltimore (Sparrows Point), Maryland; Hope Creek, New Jersey; Port of New York/New Jersey	Jack-up vessel	Support – non-routine maintenance	400–740 feet (120–225 meters)	1	10 kts / <1kt	<1

Source: US Wind 2023
CTV = crew transfer vehicle; OSV = offshore support vessel

3.1.5 Decommissioning

Under 30 CFR 285 and commercial Renewable Energy Lease OCS-A 0498, US Wind would be required to remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by the Project. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (30 CFR 285.910(a)). Absent permission from BOEM, US Wind would have to achieve complete decommissioning within 2 years of termination of the lease and either reuse, recycle, or responsibly dispose of all materials removed. US Wind has submitted a conceptual decommissioning plan as part of the COP (Volume I, Section 7.0; US Wind 2023), and the final decommissioning application would outline US Wind's process for managing waste and recycling Project components.

BSEE would require US 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 in the Lease Area, or 90 days after cancellation, relinquishment, or other termination of the lease (30 CFR 285.905). Upon completion of the technical and environmental reviews, BSEE 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 agencies. US Wind would need to obtain separate and subsequent approval from BOEM to retire in place any portion of the

Project. Approval of such activities would require compliance under NEPA and other federal statutes and implementing regulations.

If the COP is approved or approved with modifications, US 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 US Wind would not be able to decommission the facility.

3.1.5.1 WTGs

The WTGs, including the nacelles, towers, and turbine blades, will be decommissioned using equipment similar to that employed for installation. The turbines will be shut down, and any oils associated with the turbines will be drained in accordance with the Oil Spill Response Plan. A jack-up or floating crane vessel will be used to remove the blades, nacelle, and tower, and the components will be transported to shore for recycling or disposal. The Project may use different types of foundations for the WTGs from those used for the OSSs. Removal of each foundation type will include removal of the TP (if applicable) and the foundation structure as required, potentially to 15 feet (5 meters) below the seafloor. Foundation removal is expected to be conducted using a combination of floating crane vessels, jack-up vessels, and associated support vessels. Monopile and piled jacket foundations would be removed to a level below the mudline of the seafloor in accordance with the conditions of the Lease. In the case of an OSS foundation consisting of a jacket with suction buckets, the buckets would be removed by reversing the installation process, pushing the buckets out of the seafloor. Once the foundations are free from the seafloor, they will be lifted onto transport vessels for recycling or disposal onshore.

Based on approval of the agencies, scour protection systems used to protect foundations and cables may be left in place to provide seafloor habitat. If removed, a crane will pick up the material and place it on a barge. The rock in these systems can be reused for other projects and will not require disposal in a landfill. If required, the scour systems will be removed in such a manner that the seafloor will be returned to pre-project conditions, with no obstructions remaining to future activities.

3.1.5.2 OSSs

The OSSs will be decommissioned in a sequential manner similar to how they were installed. The equipment on the platforms will be de-energized and made safe for removal. Any cabling connections to the OSSs will be removed. Hazardous materials will be removed from the platform(s) and transported to shore in accordance with the Oil Spill Response Plan to prevent contamination of the environment. OSS removal will be conducted using a combination of floating crane vessels, jack-up vessels, and associated support vessels. The OSS topside can be removed in its entirety or on a component-by-component basis. Foundation piling will be removed to a level below the mudline of the seafloor in accordance with the conditions of the Lease.

3.1.5.3 Met Tower

Met Tower decommissioning will include removal of small ancillary equipment, then a heavy lift derrick barge will be mobilized to the site to lift the mast and the heavier ancillary equipment from the Met Tower deck and placed on either the lift barge or a materials barge. The Met Tower foundation piles will be cut to a depth of 15 feet (5 meters) below the surveyed datum, in accordance with 30 CFR 285.910, and removed to the deck of the lift barge or materials barge, then transported to shore for processing at a licensed recycling facility.

3.1.5.4 Cables

The inter-array, offshore export, and inshore export cables will be disconnected from the WTGs and OSS, and, subject to discussions with the appropriate regulatory agencies on the preferred approach to minimize environmental impacts, either retired in place or removed from the seafloor and recovered onto a barge or suitably equipped vessel. The cable routes will be exposed as needed to dislodge and recover the cables. When the cables are recovered, they will be transported to shore for disposal or recycling.

3.1.5.5 Onshore Substations

The decommissioning process for the Onshore substations will include powering down a section of the substation and removing the equipment in the opposite order that it was installed. The Onshore substations are anticipated to include perimeter fencing/access controls, security lighting, and up to four circuit breakers and associated disconnect switches, metering, relay, and control panels. Aboveground transmission structures will be dismantled, and foundations removed, as required by regulatory standards or landowner requirements. If underground cables are employed, the cables and associated conduits/duct banks and vaults will be removed. Typical onshore construction equipment, including cranes and earth-moving equipment, will be employed to decommission the Onshore substations.

3.1.5.6 Vessels and Potential Ports

The number of vessels, number of vessel transits, and ports used for decommissioning activities is currently unknown and will depend on the selected decommissioning contractor. However, it is reasonable to assume that the vessels, transits, and ports used for decommissioning activities would be similar to that for construction activities, described in the *Vessels and Potential Ports* in Section 3.1.1.6, though the possibility exists for additional vessels and ports to become available and potentially meet the criteria for supporting decommissioning activities.

3.1.6 Pre-, During, and Post- Construction Surveys

US Wind will conduct surveys as part of the COP as well as monitoring activities after COP approval. These include pre-construction, during construction, and post-construction nearshore and offshore geological and geophysical, fisheries resource monitoring surveys, and marine mammal monitoring surveys. The following subsections provide an overview of each survey program.

3.1.6.1 Geological and Geophysical Surveys

Under the Proposed Action, HRG surveys will only be conducted during phase 2 and phase 3 of construction as detailed in the anticipated construction time frames in Table 3-2 to refine the locations of project elements such as construction footprints, WTG and OSS foundations, and cables, or to meet BOEM or other agency requirements for additional survey. Micro-siting HRG surveys may include use of some or all of the following:

- Multibeam bathymetry (echosounder) to provide water depth data and general bottom topography information;
- Marine magnetometer to detect ferrous/magnetic targets that may be present on or below the seafloor;
- Side-scan sonar seafloor imaging to provide information about the characteristics and morphologies of the seafloor;
- Ultra-short baseline system for acoustic positioning of equipment;
- Shallow-penetration sub-bottom profiler (SBP) to map near-surface geologic structures and sediment stratigraphy (down to generally less than 65.6 feet [20 meters] below the seafloor); and
- Medium-penetration SBP to map deeper geologic structures and sediment stratigraphy (down to 328 feet [100 meters] below the seafloor).

The primary HRG survey equipment that is carried forward in the effects assessment in Chapter 6 of this BA are the shallow- and medium-penetration SBPs. All other HRG sources included under the Proposed Action either operate outside the relevant sound frequencies for ESA-listed marine mammals, sea turtles, and fish (i.e., greater than 180 kilohertz) or are not expected to result in any effects given the characteristics of the sound source (TRC 2023).

3.1.6.2 Fisheries Resource Monitoring Program

Fisheries monitoring surveys will be conducted in partnership with UMCES as part of the monitoring program, "Tailwinds", or Team for Assessing Impacts to Living resources from offshore WIND turbineS, which bridges fisheries and marine mammal monitoring (https://tailwinds.umces.edu/). The goal of the commercial and recreational fisheries monitoring program is to evaluate the extent that black sea bass (*Centropristis striata*) change their aggregate behaviors before, during, and after Project construction in association with newly introduced offshore infrastructure. Black sea bass are structure-oriented with large aggregations occurring near artificial reefs and wrecks. Turbine foundations will add three-dimensional structure within US Wind's Lease Area where very little currently exists. This program will assess fish aggregation effects, including potential benefits, in association with Project foundations. In addition, population metrics (i.e., size, sex, and diet) of black sea bass collected will be evaluated during all phases of study. The overall goal of the fisheries monitoring program is to evaluate to what extent wind turbine tower foundations increase black sea bass availability to commercial fishers and charter anglers during and after construction in comparison to a 2-year before period. The surveys will be conducted over a 6-year survey period, divided into 2-year phases corresponding with before, construction, and after periods.

The fisheries resource monitoring program considered under the Proposed Action will consist of two components: 1) a commercial ventless pot survey and 2) a recreational charter fisheries survey using bottom drift and jig angling techniques. Prior to each survey, a subset of project sites (within the Project area) and control sites (adjacent areas) will be randomly selected (Figure 3-14). Site characteristics of the project and control sites for the pot survey are similar in bathymetry and soft sediment bottom type; project and control sites chosen are all located in >65 feet (>20 meters) water depth.

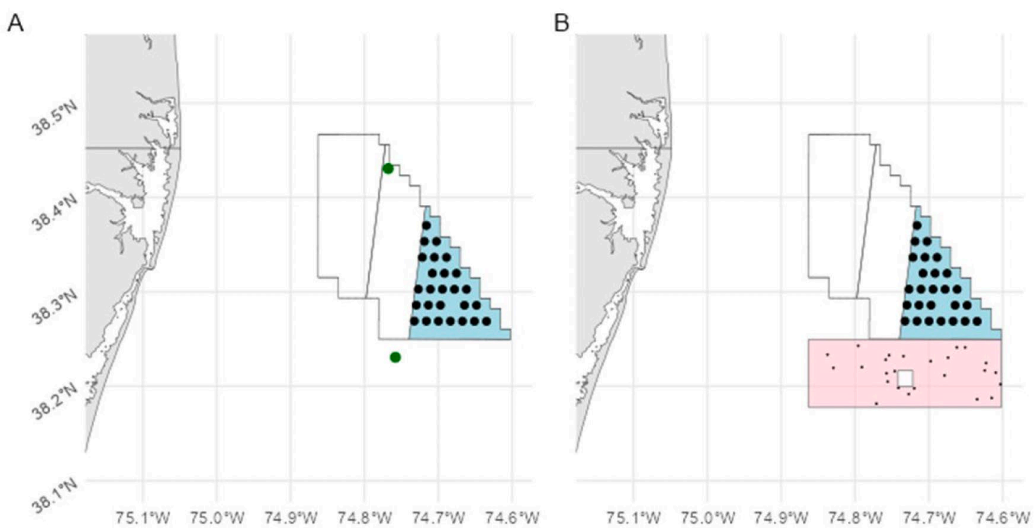

Figure 3-14. Study site for recreational[1] (A) and commercial[2] (B) surveys

[1]For the recreational survey, reference artificial reef sites (green points) and two turbine sites are selected per surveys.

[2]For each commercial survey, four turbine and two control sites are randomly selected from within the MarWin (blue) and control (red) regions. Turbine locations are shown as large black points and example control site selections are represented by small black points. *Note recent changes from the initial COP from 26 turbines – shown above – to 21 turbines are noted and the plan will be accordingly adjusted.*

A commercial pot survey will consist of rigs of 15 commercial pots each, with pots spaced proximate and distant to turbine structures to capture both turbine- and project-scaled changes in black sea bass catch rates. Monthly pot surveys (March through November) of six rigs (four in the Project area and two in an adjacent control area) will be conducted. Prior to each monthly survey, a subset of four project and two control sites will be randomly selected from all possible turbine and control sites (Figure 3-14B). Pots will be soaked for a single night (<24 hr) and retrieved. Upon pot retrieval, black sea bass are counted and measured for total length and weight and, for a retained subsample of fish; all other species are identified to the lowest taxon possible and enumerated. Ropeless gear will be utilized to eliminate the use of vertical buoy lines. This consists of an EdgeTech device connected to a retrieval cage containing buoys and a coiled line; the lid of the cage is released upon remote acoustic signaling from a deck box on the vessel, which allows the buoys to be released and rise to the surface for recovery. In adherence to best practices aimed at avoiding impacts on protected species (BOEM 2023a), specific procedures and protocols will be implemented. These include, in addition to the use of ropeless technologies, restricting vessel speeds to not exceed 10 knots and monitoring the survey area prior to gear deployment; if a whale is sighted within 1 nautical mile, an alternate site will be used.

The recreational survey will compare two well-fished artificial reef sites (control) to two turbine sites. The two reference artificial reef sites are the southern Site 1: the sunken freighter, the *USS Saetia* (1918), a 98 m vessel of mostly <2 m hull relief; and the northern Site 2: the "Great Eastern Reef," a deposition area of opportunistic materials (primarily concrete units and cable mounds) with <2 m relief (Figure 3-14A). In each year, six monthly surveys (May through October) will use standard angling techniques to obtain catch rates at two reference artificial reef sites and at two sites where turbine foundations will be constructed. For each month, one control and one turbine site are visited per day across two days, with the order of site visits randomized within a day and all sites visited within a 2-day window to limit bias owing to sea conditions and time of day. Using an experienced charter vessel (F/V Fin Chaser) and three anglers, drift and jigging methods commonly used for black sea bass angling will be conducted; effort will be a 3-minute drop, with each site fished for 45 minutes (15 drops/angler). At each site, a jigging trial is conducted by the mate upon arrival for a 15-minute period prior to the onset of the drift, near-bottom angling.

Additional details of the fisheries resource monitoring program are included in Appendix A of this BA.

3.1.6.3 Marine Mammal Monitoring Program

Marine mammal monitoring surveys will be conducted in partnership with UMCES as part of the monitoring program Tailwinds. UMCES Tailwinds will conduct passive acoustic monitoring studies within the area of potential effect for the Maryland Lease Area. These studies will analyze the response of marine mammals during the construction and operation of offshore wind farms, with a comparison to pre-construction data. The study area will cover up to approximately 30 km and will include acoustics data from dolphins, porpoises, and whales. For the initial two years (Year 1 and 2), data from the US Wind metocean buoy will be analyzed. Subsequently, a 10-hydrophone array will be deployed and utilized to collect data for the following years (Year 2 until Year 8). PAM recorders will be deployed from the University of Delaware vessel R/V *Daiber*, the UMCES vessel the R/V *Rachel Carson* or from a fishing vessel in Ocean City, MD (previously chartered the F/V *Seaborn* and F/V *Integrity*). Vessel trips are expected to happen only twice per year since recorders will be deployed and recovered every 6 months. Additional details of the marine mammal monitoring program are included in Appendix B of this BA.

3.1.6.4 Near Real-Time Whale Buoy Monitoring Program

US Wind, in partnership with UMCES, will support the ongoing Near Real-Time Whale Buoys (RTWB) as part of the UMCES Tailwinds program. RTWBs are employed to detect and promptly alert the presence of North Atlantic Right Whales and other baleen whales. Satellite communication occurs every two hours and can be accessed through a website, mobile app, or direct messaging (under subscription).

Raw acoustic data will be archived in NOAA's National Centers for Environmental Information and the Northeast Fisheries Science Center's Passive Acoustic Program. The data collected by these buoys will be used to analyze the presence and occurrence of whales, their response to vessels, and will be compared to visual whale sightings. Yearly vessel transits are planned for the near-real time whale buoy monitoring program, totaling four vessel days over the four-year study. Additional details of the near real-time whale buoy monitoring program are included in Appendix C of this BA.

3.2 Action Area

The Action Area is defined by 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The Action Area for this consultation includes Lease Area OCS-A 0490, where Project activities will occur; the surrounding areas ensonified by Project noise; all cable routes, including the offshore, onshore, and inshore export cables and the inter-array cables; the areas where geophysical and geotechnical surveys and fisheries and habitat surveys will occur; and all vessel transit routes from U.S. and international ports for all Project phases. This area encompasses all effects of the Proposed Action considered here.

The Action Area, as defined, includes vessel transit routes between port locations, including ports outside Maryland, necessary for completion of the Proposed Action.

The primary ports anticipated to be used by US wind project vessels include Baltimore (Sparrows Point), Maryland; Ocean City, Maryland; Gulf of Mexico (e.g., Ingleside, Texas; Houma/Harvey, Louisiana); Brewer, Maine; and Europe (port not yet identified). In addition, US Wind acknowledges that alternate ports for the project vessels could include Hampton Roads area, Virginia; Port Norris, New Jersey; Lewes, Delaware; Cape Charles, Virginia; Port of New York/New Jersey; Charleston, South Carolina; Delaware River and Bay (e.g., Paulsboro, New Jersey; Hope Creek, New Jersey; and Wilmington, Delaware). The Action Area is inclusive of all primary and alternate ports identified here.

3.2.1 Components of the Action Area

3.2.1.1 Project Area

For the purposes of this BA, the Project area is considered the portion of the Action Area where construction and eventual O&M of the Proposed Action will occur. The Project area, therefore, encompasses the Lease Area, all inter-array cable routes, and the transmission cable right-of-way to the onshore cable landing location. Regional vessel transits originating from ports in Maryland, Delaware, New Jersey, and Virginia are considered part of the Project area. Due to the difference in risk to ESA-listed species associated with Project activities within the Project area compared to activities within the Action Area, this portion of the Action Area is treated separately, where applicable, in Chapter 6. Any activities outside this area (e.g., longer vessel transit routes from Europe, Maine, or the Gulf of Mexico) are considered the Action Area outside the Project area and are discussed as so in Chapter 6.

Existing habitat conditions within the Project area, which serve to establish baseline conditions from which the analysis of the Proposed Action is built from, are described in the following subsections.

3.2.1.1.1 Ecoregion

The Project area falls within the Virginian Atlantic ecoregion, which is designated based on the similar physical and oceanographic settings contained within the area (Wilkinson et al. 2009). This ecoregion extends from Cape Hatteras, North Carolina, to Cape Cod, Massachusetts, where coastlines were formed by glacial processes and river sedimentation, resulting in complex and variable geomorphology. The Virginian Atlantic ecoregion has a broad continental shelf extending up to 93 miles (150 kilometers) from the coastline north of Long Island, New York, narrowing to about 25 miles (40 kilometers) at Cape

Hatteras (Wilkinson et al. 2009). This ecoregion is characterized by large coastal watersheds and estuaries (e.g., Delaware Bay), so several areas experience freshening of nearshore waters during spring flooding and summer wet seasons (Wilkinson et al. 2009). Ocean currents in this ecoregion generally flow from north to south parallel to the coast year-round. The eastward-turning Gulf Stream, with its moderating influence on the climate of the Virginian Atlantic ecoregion, lies just offshore, creating a zone of transition to the east where complex current structures lead to upwelling (Wilkinson et al. 2009).

3.2.1.1.2 Seafloor Conditions

The Lease Area covers approximately 80,000 ac (32,375 ha) of seafloor, with water depths up to 135 feet (41 meters). Water depths in the Offshore Export Cable Route range from 36 to 104 feet (11 to 32 meters) in federal waters, and 49 feet (15 meters) or less in state waters (COP, Volume II, Appendix K7; US Wind 2023). Salinities in the water column are consistent year-round in offshore waters but vary between 27 and 31 parts per thousand near shore (USACE 2016).

The seafloor characteristics of the Project area are consistent with the larger Mid-Atlantic Bight region; soft-bottom sediments characterized by sand with patches of gravel and silt/sand mixes. The primary morphological feature is the sand ridges and smaller sand waves. In the Project area, benthic habitat is generally characterized by mobile sandy substrates on gentle slopes, with shell hash frequently accompanying mineral substrates (Guida et al. 2017). A total of 93 percent of the seafloor slope within the Project area and Offshore Export Cable Route is 1 degree or less. Within the Offshore Export Cable Route, the slope did not exceed 5 degrees, and is therefore classified as a gentle slope. Steeper slopes exceeding 20 degrees were identified in the western portion of the Lease Area. These slopes, classified as very steep, would complicate cable-laying activities (COP, Volume II, Appendix K5; US Wind 2023).

According to the NMFS-modified Coastal and Marine Ecological Classification Standards, sand was the dominant substrate group observed, followed by gravelly and gravel mixes (COP, Volume II, Appendix D4; US Wind 2023). However, patches of shell hash and gravel (including pebble/granule, cobble, and boulder clasts) were also documented in some transects as well as larger solitary boulders and mounds of smaller boulders and cobbles, though rare (COP, Volume II, Appendix D4; US Wind 2023). These lone standing boulders and cobble-size clasts were occasionally observed in underwater imagery dominated by sand, gravelly substrates, or gravel mixes. Some complex habitats contained a high enough fraction of shell to be classified as shell hash. One transect in the southwestern portion of the Project area, identified a cobble pile of suspected anthropogenic origin, and the presence of a worm reef was identified along a sandy transect on the western side of the Project area (COP, Volume II, Appendix D4; US Wind 2023). Although regional studies have documented muddy sands within portions of the central Project area, the most recent sampling for the COP did not observe any fine sediments (i.e., muddy sands, sandy muds, and muds) (COP, Volume II, Appendices D4 and E1; US Wind 2023). Subsurface sediments are predominantly sands, with occasional interlays of clay and gravel. Overall, though variations in sediment have been observed over small spatial scales within the Project area, few hard-bottom patches are believed to be present (Cutter et al. 2000; Guida et al. 2017; COP, Volume II, Appendix D4, US Wind 2023). These findings align with previous studies that indicate hard-bottom benthic habitats are rare in the Project area and primarily occur as gravel- or cobble-dominated substrates (National Ocean Service 2015; Guida et al. 2017). In summary, 66,175 ac (26,780 ha) of the Project area are characterized as soft bottom, with the remaining 297 ac (120 ha) characterized as complex, heterogenous, and large-grained combined, each having less than 247 ac (100 ha) of coverage (COP, Volume II, Appendix E1; US Wind 2023).

3.2.1.1.3 Water Column Conditions

Waters in the Project area include marine and inland waters. The marine waters include the Atlantic Ocean within the Project area and along the Offshore Export Cable Route as well as coastal waters along vessel routes to/from the port facilities. Inland waters include waters of the Indian River and Indian River

Bay along the Inshore Export Cable Route from the Delaware coast to the proposed landfall at the Indian River substation.

Deeper Atlantic waters, including the Offshore Export Cable Route and Lease Area, exhibit little variation in salinity and temperature, although a vertical variation occurs on a seasonal basis due to stratification (Boyer et al. 2018). Stratification typically reaches a maximum in the summer when surface waters are warmer (77.2 degrees Fahrenheit [°F], 25.1 degrees Celsius [°C]) and somewhat less saline (31.6 practical salinity units [PSU]) than bottom waters (49.1°F [9.5°C]; 32.8 PSU); well-mixed and more uniform vertical salinity and temperature profiles are evident in the fall (surface to bottom: 71.1°F to 61.2°F [21.7°C to 16.2°C]; 32.0 to 33.4 PSU) (COP, Volume I, Section 4.1.1, Table 4-1; US Wind 2023). Coincident with this stratification is a reduction in dissolved oxygen, from supersaturated conditions near the surface to less well-oxygenated (near 80 percent saturation) waters at the bottom (COP, Volume I, Section 4.1.1; US Wind 2023). Suspended sediment concentrations and turbidity can vary by an order of magnitude at a single location over time, from less than 1 milligram per liter (mg/L) to several hundred, with higher values associated with storm events (COP, Volume I, Section 4.1.1; US Wind 2023). With increasing distance from shore, oceanic circulation patterns play an increasingly larger role in dispersing and diluting anthropogenic contaminants (e.g., nutrients) and determining water quality.

The onshore Project area—including the coastal Indian River Bay Watershed in Sussex County, Delaware, along the Delmarva peninsula—is underlain by the Northern Atlantic Coastal Plain aquifer, a large aquifer system that extends from New Jersey through North Carolina, containing multiple aquifer and confining units (United States Geological Survey [USGS] 1997). The Indian River Bay Watershed is situated above an unconfined surficial aquifer, which is the uppermost aquifer in the system. A substantial proportion of the total fresh water flux to the Delmarva coastal bays comes from ground water flowing through the surficial aquifer (Krantz et al. 2004).

Beneath Indian River Bay are fresh groundwater subsurface zones alternating with zones dominated by the flow of salt water down into the surficial aquifer. Through geophysical and geotechnical data, Krantz et al. (2004) showed advective flow produces plumes of fresh ground water 1,312 to 1,969 feet (400 to 600 meters) wide and 66 feet (20 meters) thick may extend more than 0.6 miles (1 kilometers) beneath the bay, where incised valleys are filled with 3 to 7 feet (1 to 2 meters) of silt and peat that act as a semi-confining layer to restrict the downward flow of salt water. Stormwater runoff is also an increasingly important driver of nutrients into the Indian River Bay Watershed.

The USEPA monitors water quality trends over time through a national coastal condition assessment. This assessment establishes a water quality index to describe the water quality of various coastal areas by assigning three condition levels (good, fair, and poor) for several water quality parameters. Table 3-18 lists the USEPA Region 3 condition levels per parameter from 2005, 2010, and 2015 (USEPA 2022); Region 3 includes the coastal waters in the Project area. Since 2005, the percentage of "good" ratings has increased for all analyzed parameters (e.g., water clarity ratings within the good category have increased from 41.7 percent in 2005 to 52.5 percent in 2015). The sole exception to this trend is dissolved phosphorus, which has steadily decreased (i.e., phosphorous ratings within the good category have decreased from 64.8 percent in 2005 to 52.5 percent in 2015). Overall, coastal water quality is in good condition.

Table 3-18. Water quality index for the USEPA Region 3 stations based on data collected in 2005, 2010, and 2015

Parameter	2005	2010	2015
Dissolved oxygen	Fair (20%), good (62%)	Fair (10.7%), good (62.5%)	Fair (14.3%), good (65.4%)
Chlorophyll *a*	Fair (56%), good (7.3%)	Fair (88%), good (5.6%)	Fair (71.2%), good (9.4%)
Water clarity	Fair (31.3%), good (41.7%)	Fair (28.7), good (49.1%)	Fair (18.3%), good (52.5%)
Dissolved nitrogen	Fair (14.8%), good (76.2%)	Fair (11.3%), good (83.4%)	Fair (7.4%), good (89.1%)
Dissolved phosphorous	Fair (23.6%), good (64.8%)	Fair (29.4%), good (60.4%)	Fair (37.6%), good (52.5%)

Source: USEPA 2022

Lower Indian River Bay is impaired/non-attaining for fish, aquatic life, and wildlife regarding copper and nutrients, while dissolved oxygen, total suspended solids, and zinc were listed as good (USEPA 2022). While Upper Indian River Bay was listed as impaired by the DNREC, it does not meet the CWA Section 303(d) requirements for non-attainment. Issues were identified with fish, aquatic life, and wildlife for nutrients, temperature, and total suspended solids. The Indian River is listed as impaired/non-attaining under the CWA Section 303(d) requirements for fish, aquatic life, and wildlife (due to copper, dissolved oxygen, nutrients, temperature, and total suspended solids) as well as primary contact recreation (*Enterococcus* bacteria) (USEPA 2022). No probable sources of impairment were identified for either waterbody. The DNREC has restoration plans in place for most of the identified issues within the respective areas.

3.2.1.1.4 Underwater Noise

Martin et al. (2014) collected *in situ* data for one year at two sites offshore Delaware, which included and were adjacent to the Project area, with accompanying wind speed, wave height, and sea surface temperature data acquired from a nearby National Buoy Data Center buoy. Autonomous underwater sound recorders were deployed on four separate occasions to examine potential seasonal differences. The collected data showed that the primary sources of ambient sound in this region were increased wave energy from passing storms (i.e., physical source), anthropogenic sound (e.g., shipping noise), and biological sounds (Martin et al. 2014). The low-frequency bands (less than 100 hertz) showed the highest sound levels for the recording period, ranging between approximately the 95th and 5th percentile (60 and 105 decibels referenced to 1 micropascal [dB re 1 µPa], respectively). Contributing sound sources in this frequency band were primarily weather events and anthropogenic noise, notably from shipping traffic. Between 200 and 1,000 hertz, the sound pressure levels (SPLs) in the 5th percentile reached about 95 dB re 1 µPa, but the 95th percentile for this frequency band was lower, approximately 50 dB re 1 µPa. The peak SPLs in this frequency band correlated with increased fish vocalizations, specifically the striped cusk-eel (*Ophidion marginatum*), in the late summer and fall. This was the main deviation observed during the recording period; ambient noise levels were otherwise comparable throughout the year, and no discernable seasonal variation was documented (Martin et al. 2014).

More recently, a dedicated passive acoustic study (Bailey et al. 2018) in the Project area described the ambient noise environment. Bailey et al. (2018) deployed a series of long-term acoustic recorders throughout the Maryland WEA as well as offshore and inshore of the WEA to monitor mysticetes (baleen whales) and low-frequency (1 to 1,000 hertz) noise (Figure 3-15). The measured ambient noise levels were affected by the proximity of shipping lanes into the Philadelphia area, just north of the Project area. Ambient noise levels were increased at three sites (A-4M, A-7M, and T-2M) adjacent to or within shipping lanes (Table 3-19).

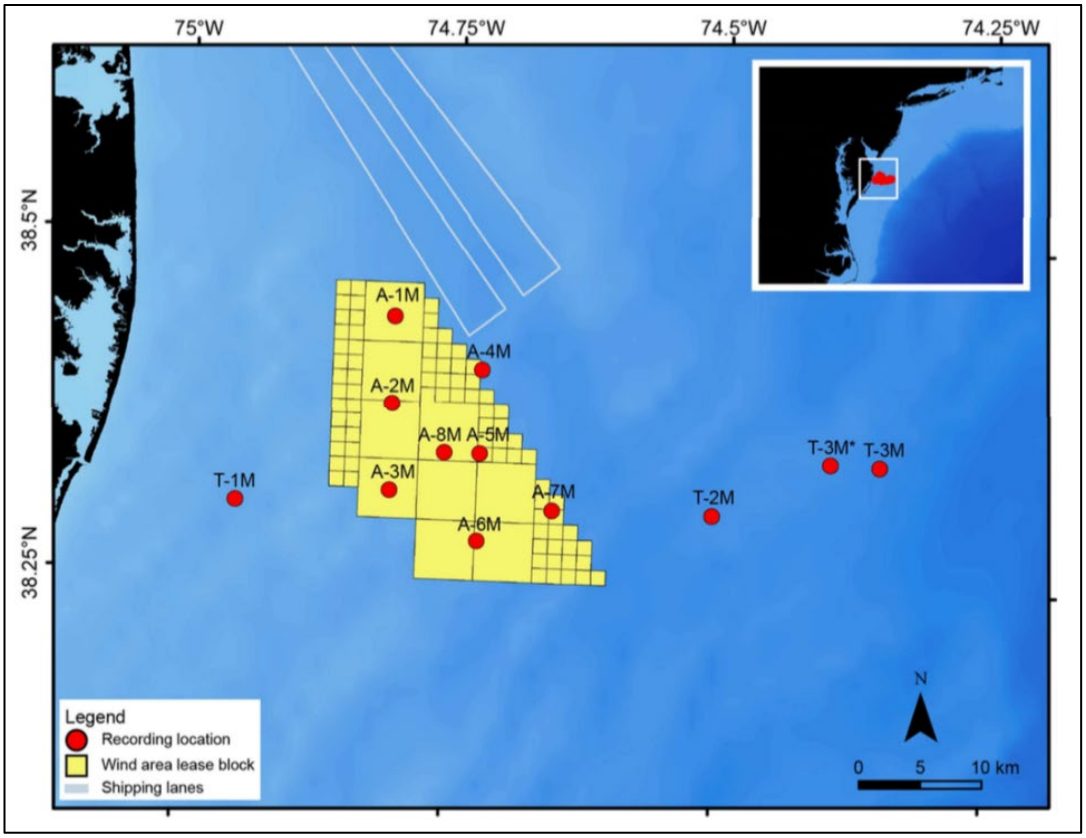

Figure 3-15. Location of recorders in the Maryland WEA passive acoustic study with the shipping lanes into Delaware Bay shown as white lines

Source: Bailey et al. (2018)

Table 3-19. Summary of broadband (1 to 1,000 hertz) ambient root-mean-square SPLs (in dB re 1 µPa) in the Maryland WEA

Site	Average Year 1	Average Year 2	Average Year 3	Median
T-1M	109.8	108.7	108.2	107.2
A-1M	111.7	110.7	111.3	110.5
A-2M	110.1	109.8	109.8	108.5
A-3M	110.7	109.1	109	108.1
A-4M	116.3	116	116.1	115.6
A-5M	114.9	113.5	114.4	113.8
A-6M	113.2	113.3	112.4	112.1
A-7M	116.9	116.3	116.7	116.1
A-8M	112.4	113	NA	111.4
T-2M	115.4	115.8	115	115.3
T-3M	NA	118.3	114.2	113.8
T-3M	113.8	112	NA	112

Source: Bailey et al. (2018)
NA = not applicable

3.2.1.1.5 Electromagnetic Field

The marine environment continuously generates ambient electromagnetic field (EMF) effects. The motion of electrically conductive seawater through 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. The magnitude of these EMF effects at a given time and location depends on the strength of the prevailing magnetic field, site, and time-specific ocean conditions. Other external factors such as electrical storms and solar events can also generate variable EMF effects. The strength of Earth's direct current (DC) magnetic field is approximately 549 milligauss (mG) (54.9 microteslas [μT]) in the vicinity of the Lease Area (NOAA n.d.). This is the static magnetic field of Earth oriented to magnetic north at a declination of approximately 26 degrees west (NOAA n.d.). 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 Earth's magnetic field is reported to be approximately 0.075 millivolts per meter (mV/m) or less (CSA Ocean Sciences Inc. and Exponent 2019). Following the methods described by Slater et al. (2010), a uniform current of 1 meter per second (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).

Submarine transmission or communication cables 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 meters) 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. No existing submarine transmission or communication cables have been identified within the Project area. Fiberoptic cables with optical repeaters would not produce EMF or significant heat effects.

3.2.1.1.6 Artificial Light

Vessel traffic and navigational safety lights on buoys and Met 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 Maryland and Delaware shoreline.

3.2.1.1.7 Vessel Traffic

The Project's Navigational Safety Risk Assessment (NSRA) assessed regional vessel traffic patterns and density in the Lease Area and surrounding 20 nautical miles (37 kilometers), hereafter referred to as the NSRA study area, using Automatic Identification System (AIS) data for 2019 (COP, Volume II, Appendix K1; US Wind 2023). Additionally, Vessel Monitoring System and Vessel Trip Report data were used to supplement the assessment of commercial fishing vessel activity in the NSRA study area (COP, Volume II, Appendix K1; US Wind 2023). The NSRA for the Project analyzed vessel traffic activity as transit counts (one-way crossings) per transect, which were selected to evaluate the areas of heaviest vessel traffic in the vicinity of the Lease Area.

Vessel traffic in and out of Delaware Bay is regulated by a TSS, which is 0.4 nautical miles (0.7 kilometers) from the closest proposed structure in the Lease Area. The TSS within the approach to Delaware Bay consists of four parts: an Eastern Approach, a Southeastern Approach, a Two-way Traffic Route, and a Precautionary Area (33 CFR 167.170). The Southeastern Approach of the TSS is adjacent to the northeastern boundary of the Lease Area and is primarily a shipping route for deep-draft vessels (COP, Volume II, Appendix K1; US Wind 2023).

Vessel traffic in the immediate vicinity of the Lease Area is mainly composed of deep-draft vessels, with a smaller proportion of fishing vessels based on the AIS data (COP, Volume II, Appendix K1; US Wind 2023). Cargo/carrier and tanker vessels mainly follow the designated TSS when entering and leaving Delaware Bay, which predominantly passes north of the Lease Area. However, vessel traffic at the southern terminus of the TSS spreads out and passes through the Lease Area, though this traffic is mainly limited to the easternmost offshore portion of the Lease Area and aligned in a north-south direction (COP, Volume II, Appendix K1; US Wind 2023). Commercial fishing and pleasure/recreational vessel activity within the Lease Area is sparce and mainly constitutes transits from Ocean City, Maryland, to fishing grounds east of the Lease Area. Other vessels (with AIS) that use the waters of the Lease Area include tug, cruise/ferry, and other non-categorized vessels.

The highest vessel traffic density in the NSRA study area occurred at the entrance to Delaware Bay, the Ocean City Inlet, and within the Delaware Bay Eastern and Southeastern Approaches) (COP, Volume II, Appendix K1; US Wind 2023). Directly north of the Lease Area is the entrance to Delaware Bay, which has the highest density of vessel traffic in the region. Vessels exiting the outbound lane and entering the inbound lane of the Delaware Bay Southeastern Approach pass along the northeastern edge of the Lease Area. Half of the transects in the NSRA study area had fewer than five transits per day and 86 percent had fewer than 10 transects per day (COP, Volume II, Appendix K1; US Wind 2023). The most heavily traveled transects include:

- Vessels entering and leaving Delaware Bay had the highest density of vessel traffic in the NSRA study area. A wide range of vessel types pass through this area, with the majority being cargo/carrier and tanker vessels traveling at an average speed between 12 and 15 knots (6.2 and 7.7 meters per second (m/s)); recreational and passenger vessels typically travel faster, with average speeds between 15 and 25 knots (7.7 and 12.9 m/s). This transect had 8,942 total transits in 2019, equivalent to 24.5 transits per day.
- Vessels transiting the inbound and outbound lanes of the Delaware Bay Southeastern Approach directly north of the Lease Area also resulted in a high density of vessel traffic. Most vessels passing through this area were cargo/carrier and tanker vessels, with an average speed between 12 and 15 knots (6.2and 7.7 m/s). These two transects had 3,991 total transits in 2019, equivalent to 10.9 transits per day.
- Vessels transiting from or to the Ocean City Inlet form a fan-like pattern originating in Ocean City and crossing the Lease Area, predominantly in the east-west direction. Most vessels passing through this area were recreational/pleasure vessels, with an average speed between 15 and 25 knots (7.7 and 12.9 m/s). This transect had 2,245 total transits in 2019, equivalent to 6.2 transits per day.

Approximately 3,547 vessel transits traversed the Lease Area in 2019, an average of 9.7 transits per day. The highest density of these transits occurred in the eastern portion of the Lease Area where cargo/carrier and tanker vessels were entering or leaving the Delaware Bay TSS (COP, Volume II, Appendix K1; US Wind 2023). These vessels traveled at an average speed of 12 to 15 knots (7.7 and 12.9 m/s) (COP, Volume II, Appendix K1; US Wind 2023). Fishing vessels crossing the Lease Area most commonly transit from Ocean City to fishing grounds east of the Lease Area at an average speed of 9 to 15 knots (4.63 to 7.7 m/s) (COP, Volume II, Appendix K1; US Wind 2023). When considering vessel traffic in the vicinity (within 4.3 nautical miles [8 kilometers]) of the Lease Area, 8,288 annual transits were recorded in 2019, equivalent to 22.7 transits per day (COP, Volume II, Appendix K1; US Wind 2023). The data indicate relatively high levels of regional baseline traffic in the vicinity of the Project area.

Importantly, recreational vessels and commercial fishing vessels less than 65 feet (19.8 meters) in length are not required to broadcast via AIS. Additionally, while Vessel Monitoring System data supplemented commercial fishing vessel activity in the NSRA, not all fishing vessels transmit Vessel Monitoring System signals. Based on these limitations, activity of these vessel classes in the NSRA study area is likely underrepresented in the data. As a result, the baseline vessel activity described in this BA is considered an underestimate of total vessel activity for the region.

Other offshore wind projects would generate comparable types and volumes of vessel traffic in ports and would require similar types of port facilities as the Proposed Action. The Proposed Action is anticipated to overlap in construction with seven offshore wind projects (Skipjack Wind I, Maryland Offshore Wind, Garden State Offshore Energy, Skipjack Wind II, Coastal Virginia Offshore Wind – Commercial, Kitty Hawk Wind North, and Kitty Hawk Wind South) from 2023 through 2030. The specific ports used by other projects are not known, and the total increase in vessel traffic would likely be distributed across multiple ports in the region. As a result, other offshore wind projects are likely to use the same ports as the Proposed Action, including the Port of Baltimore (Sparrows Point) facility, which is being constructed to support multiple offshore wind projects. As such, baseline vessel traffic not associated with the Proposed Action is expected to increase as a result of overlapping construction for the other offshore wind projects.

3.2.1.1.8 Climate Change

NMFS and the United States Fish and Wildlife Service (USFWS) list long-term climate changes as a threat for almost all marine species (Hayes et al. 2020, 2022; NMFS 2022a, 2023a; USFWS 2023a,b). Climate change is known to increase temperatures, alter ocean acidity, change ocean circulation patterns, raise sea levels, alter precipitation patterns, increase the frequency and intensity of storms, and increase freshwater runoff, erosion, and sediment deposition. These effects can alter habitat, modify species' use of existing habitats, affect migration and movement patterns, and affect an organisms' physiological condition (Love et al. 2013; USEPA 2023; Gulland et al. 2022; National Aeronautics and Space Administration [NASA] 2023).

An increase in ocean acidity has numerous effects on ecosystems, fundamentally resulting in a reduction in available calcium carbonate that many marine organisms use to build shells (Doney et al. 2016). This could alter the distribution and abundance of marine mammal and sea turtle prey items and result in feeding shifts within food webs (Love et al. 2013; USEPA 2023; NASA 2023). 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 kilometers) north (USEPA 2022c). These species also migrated an average of 21 feet (6.4 m) deeper (USEPA 2023). This effect is especially profound off the northeast U.S., where American lobster, red hake, and black sea bass have shifted, on average, 113 miles (182 kilometers) north since 1973 (USEPA 2023).

Climate change could affect the incidence or prevalence of infection and the frequency, severity, and magnitude of epizootics (Burge et al. 2014). Of the 72 established unusual mortality events identified for marine mammals between 1991 and 2022 in U.S. waters, 14 percent are attributed to infectious disease, though this has not been directly correlated with climate change (Hayes et al. 2023). However, infectious disease outbreaks are predicted to increase as a result of climate change (Burek et al. 2008).

Over time, climate change and coastal development will alter existing habitats, rendering some areas unsuitable for certain species and more suitable for others. For example, shifts in North Atlantic right whale (NARW) distribution patterns are likely in response to changes in prey densities, driven in part by climate change (Reygondeau and Beaugrand 2011; Meyer-Gutbrod et al. 2015, 2021; O'Brien et al. 2022). These long-term, high-consequence impacts could include increased energetic costs associated with altered migration routes; reduction of suitable breeding habitat, foraging habitat, or both; and reduced individual fitness.

Available data also suggest changing ocean temperatures and sea level rise may lead to changes in the sex ratio of sea turtle populations (e.g., green sea turtle [*Chelonia mydas*] population feminization predicted under Intergovernmental Panel on Climate Change scenarios by 2120; Booth et al. 2020), loss of nesting area, and a decline in population growth due to incubation temperature reaching lethal levels (Patrício et al. 2019; Varela et al., 2019). In addition to affecting nesting activity, increased sea surface temperatures could have physiological effects on sea turtles during migration (Marn et al. 2017). Higher temperatures in migratory corridors would be especially risky for metabolic rates of female sea turtles post-nesting, as they do not generally forage during breeding periods, and their body condition would not be expected to be optimal to withstand unexpected changes in water temperature in their migratory habitat (Hays et al. 2014).

Finfish and invertebrate migration patterns can be influenced by warmer waters, as can the frequency and magnitude of disease (Hare et al. 2016). Regional water temperatures that increasingly exceed the thermal stress threshold may affect recovery of the American lobster fishery off the U.S. East Coast (Rheuban et al. 2017). Ocean acidification driven by climate change is contributing to reduced growth, and, in some cases, decline of invertebrate species with calcareous shells. Increased freshwater input into nearshore estuarine habitats can result in water quality changes and subsequent effects on invertebrate species (Hare et al. 2016). Based on a recent study, marine, estuarine, and riverine habitat types were found to be moderately to highly vulnerable to stressors resulting from climate change (Farr et al. 2021). In general, rocky and mud bottom, intertidal, kelp, coral, and sponge habitats and special areas of conservation were considered the most vulnerable habitats to climate change in marine ecosystems (Farr et al. 2021). Similarly, estuarine habitats considered most vulnerable to climate change include intertidal mud and rocky bottom, shellfish, kelp, submerged aquatic vegetation, and native wetland habitats (Farr et al. 2021). Riverine habitats found to be most vulnerable to climate change include native wetland, sandy bottom, water column, and submerged aquatic vegetation habitats (Farr et al. 2021). As invertebrate habitat, finfish habitat, and essential fish habitat may overlap with these habitat types, marine life and habitats could experience dramatic changes and decline over time as impacts from climate change continue (Farr et al. 2021).

The extent of these effects is unknown; however, ESA-listed populations already stressed by other factors likely will be the most affected by the repercussions of climate change. The current effects from climate change are likely to result in long-term consequences to individuals or populations that are detectable and measurable and could result in population-level effects that compromise the viability of some species.

3.3 Proposed Avoidance, Minimization, Monitoring, and Reporting Measures

This section outlines the proposed mitigation, monitoring, and reporting conditions intended to minimize or avoid potential effects on ESA-listed species. The measures considered part of the Proposed Action, to the extent those measures are known, are described in Table 3-20.

US Wind has applied for an MMPA ITA. If issued, the MMPA ITA will authorize the incidental harassment of marine mammals when adhering to the terms and conditions included in the authorization. For the purpose of this consultation, the mitigation and monitoring measures included in the updated January 24, 2023, MMPA ITA application (Section 2.2.5.1) are described below in Table 3-20; however, the conditions as they may be amended in the final LOA will be included as a condition in the final ROD, and as they may apply to BOEM and BSEE’s authorities, will be required by BOEM in its final approval of the COP. The MMPA ITA application only covers mitigation and monitoring measures for marine mammals, including threatened and endangered whale species considered in this BA. Additional measures for ESA-listed whales may be required through ESA consultation in the final LOA. For consistency, where possible, some measures also apply to and provide minimization of potential impacts to listed sea turtle and fish species.

BOEM is proposing numerous measures to require as conditions of COP approval that are designed to avoid, minimize, or monitor effects of the action on ESA-listed species. In addition, BOEM may include additional measures as conditions of COP approval. The measures BOEM is proposing to include as conditions of COP approval are described in Table 3-20. When measures are not defined by BOEM, NMFS, BSEE, USACE or the applicant; the applicant will follow the most up-to date version of BOEM’s Best Management Practice (BMP) Development for Offshore Wind ESA Consultations. For this analysis, the BOEM and NMFS 2022 version is applicable.

Table 3-20. Mitigation, monitoring, and reporting measures under the Proposed Action

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Mitigation measure alignment with Letter of Authorization (LOA) and other permit conditions	US Wind will adhere to any additional requirements for the Proposed Action set forth by MMPA and ESA consultations, BOEM project design criteria (PDC) and best management practices (BMPs), and Record of Decision conditions.	1) The measures required by the final MMPA LOA will be incorporated by reference as appropriate into COP approval and Record of Decision conditions, and BOEM or BSEE will monitor compliance with these measures. 2) US Wind must comply with any special conditions and required mitigation associated with work authorized or permitted through Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act, and ESA terms and conditions landward of the Submerged Lands Act boundary. 3) US Wind must comply with all published BOEM BMPs and PDC that are applicable to the activities when not superseded by LOA, COP, or Record of Decision conditions. The following measure will be included as stated below or as modified by the Biological Opinion 4) US Wind must prepare and submit a Pile Driving Monitoring Plan to BOEM, BSEE, and NMFS for review and concurrence by all agencies at least 120 days before the start of pile driving. Pile driving will not commence without an approved plan. The plan will detail all plans and procedures for sound attenuation and monitoring for ESA-listed whales and sea turtles during all impact pile driving. The plan will also describe how BOEM and US Wind would determine the number of whales exposed to noise above the Level B harassment threshold during pile driving. US Wind must obtain concurrence with this plan prior to starting any pile driving. 5) US Wind must resolve all agency comments on the Pile Driving Monitoring Plan before operations can begin, and operations must be conducted according to the plan. A copy of the approved Pile Driving Monitoring Plan must be in the possession of the US Wind representative, protected species observers (PSOs), impact-hammer operators, and any other relevant designees operating under the authority of the approved COP and carrying out the requirements on site. The Pile Driving Monitoring Plan must: • Provide detailed information on all visual and passive acoustic monitoring (PAM) components of the monitoring, describing all equipment, procedures, and protocols, including staffing levels. • Ensure the full extent of the harassment distances from piles are monitored for marine mammals and sea turtles to document all potential take. Include a PAM plan, detailing 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. • Include an Alternative Monitoring Plan (AMP), detailing measures for enhanced monitoring capabilities in the event that poor-visibility conditions unexpectedly arise, and pile driving cannot be stopped. • Include a Communication Plan, detailing the chain of command, mode of communication, and decision authority. • Include a Vessel Plan, detailing how vessel strike avoidance will be maintained and monitored. • Include the number of PSOs or Native American monitors, or both, that will be used, the platforms or vessels upon which they will be deployed, and contact information for the PSO providers. • Include seasonal and species-specific clearance and shutdown zones including time-of-year requirements for North Atlantic right whales (NARWs).	Construction, O&M, decommissioning	Measures will be developed that reduce effects analyzed under forthcoming and ongoing agency consultations.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
General PSO standards	1) PSOs will be provided by a third-party provider. 2) PSO and PAM operators will have completed NMFS-approved PSO training and will undergo Project-specific operations and safety training prior to the start of Project activities.	In addition to the Applicant-proposed measures: 1) All PSOs must have completed a NMFS-approved PSO training program and received NMFS approval to act as a PSO for geophysical surveys. 2) Upon request, US Wind must provide BOEM with documentation of NMFS approval as PSOs for geophysical activities in the Atlantic and copies of the most recent training certificates of PSOs' successful completion of a commercial PSO training course with an overall examination score of 80 percent or higher.	Construction, O&M, decommissioning	This measure ensures PSOs are qualified and effective at monitoring for marine wildlife and the appropriate agencies are contacted in the event of an NARW sighting. Collectively, these measures minimize the potential for adverse effects on ESA-listed species by providing timely action for mitigation or reporting.
General PSO roles and responsibilities	1) A Lead PSO will be designated every shift and responsible for communication with the vessel team, PSO onshore support team, and US Wind compliance personnel. 2) The Lead PSO will monitor the NOAA Fisheries NARW Reporting Systems for the presence of NARWs at the start of each shift. This includes checking the Early Warning System, Sighting Advisory System, and Mandatory Ship Reporting System. 3) PSOs will be responsible for informing the captain, or designated personnel, if a protected species is heading toward or enters the clearance or shutdown zone around the sound-producing activity to minimize or reduce the chance of injuring a protected species. 4) PSOs will summarize daily monitoring efforts and submit data forms to the appropriate staff or database. 5) It will be the responsibility of the PSO team to report any visual or acoustic detections via the appropriate communication channels.	In addition to the Applicant-proposed measures, PSO data must be collected in accordance with standard data reporting, software tools, and electronic data submission standards approved by BOEM and BSEE for the particular activity.	Construction, O&M, decommissioning	This measure will ensure implementation of effective and standardized PSO monitoring and reporting measures.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Foundation installation: PSO visual monitoring protocols	1) PSOs will visually monitor 360 degrees as far as the eye can see, including the clearance and shutdown zones around the vessel (provided below in this table for each foundation type and HRG surveys), at all times for the presence of marine mammals and all other protected species. 2) No individual PSO will conduct more than 4 consecutive hours on watch as a visual observer. Break times of no less than 2 hours will be required before a PSO begins another visual monitoring watch rotation. 3) A team of six to eight dual-role PAM operators/PSOs supplied by a third-party PSO provider will be on board the construction vessel and the secondary support vessel, the locations of which will be determined in the final Pile Driving Monitoring Plan. These PAM operators/PSOs will be on duty throughout the 24-hour construction operations (impact piling of foundations) to undertake visual and acoustic watches, implement mitigation, and conduct data collection and reporting. 4) During pile driving, at least two PSOs will be on duty on the foundation-installation vessel. 5) PSOs will be equipped with binoculars with a minimum of 8× or 10× magnification, reticule binoculars that allow for range estimations to be made, and a single lens reflex (SLR) camera with a zoom lens during daytime operations. During nighttime operations, PSOs will be equipped with high-performance night vision goggles, (i.e., PVS-7 Generation 3 Pinnacle) and Nivisys Thermal Acquisition Clip-on System in addition to handheld infrared (IR) light-emitting diode (LED) spotlights. Due to the potential for reflectivity from bridge windows that could interfere with the use of the night vision optics, PSOs will be required to make nighttime observations from a platform with no visual barriers. 6) Because technology for visual monitoring is advancing rapidly, if new equipment becomes available during the LOA, US Wind will submit the equipment specifications and plans for use to BOEM, BSEE, and NMFS for review and concurrence that it is as protective or an improvement to equipment described in the Pile Driving Monitoring Plan.	In addition to the Applicant-proposed measures: 1) US Wind must demonstrate to BOEM, BSEE, and the USACE that PSO coverage is sufficient to reliably detect marine mammals and sea turtles at the surface in the identified clearance and shutdown zones to execute any pile driving delays or shutdown requirements. This will include a PSO/PAM team on the construction vessel and at least a visual monitoring team on two additional PSO vessels for monopile installation and on one additional PSO vessel for skirt pile installation (no additional PSO vessels are required for pin pile installation). 2) If, at any point prior to or during construction, the PSO coverage included in the Proposed Action is determined to be insufficient to reliably detect ESA-listed whales and sea turtles within the clearance and shutdown zones, additional PSOs, platforms, or both will be deployed. Determinations prior to construction will be based on review of the Pile Driving Monitoring Plan. Determinations during construction will be based on review of the weekly pile driving reports and other information, as appropriate. 3) The following equipment and personnel will be on each associated vessel: Construction vessel: o At least two visual PSOs on watch during foundation installation o 2 (7× or 10×) reticle binoculars calibrated for observer height off the water o 2 (25× or similar) "big eye" binoculars mounted 180 degrees apart o 1 PAM operator on duty o 1 mounted thermal/IR camera system o 1 monitoring station for a real-time PAM system o 2 handheld or wearable night vision devices (NVDs) with IR spotlights o 1 data-collection software system o 2 PSO-dedicated very high-frequency (VHF) radios o 1 digital single lens reflex camera equipped with a 300-millimeter lens Each additional PSO vessel: o 2 visual PSOs on watch o 2 (7× or 10×) reticle binoculars calibrated for observer height off the water o 1 (25× or similar) mounted "big eye" binoculars if vessel is deemed appropriate to provide a platform in which they would be effective o 1 mounted thermal/IR camera system o 1 handheld or wearable NVD with IR spotlight o 1 data collection software system o 2 PSO-dedicated VHF radios o 1 digital single lens reflex camera equipped with a 300-mm lens	Construction	This measure will increase detection probability of ESA-listed species and increase implementation probability of mitigation actions to reduce effects from pile driving noise.
High-resolution geophysical (HRG) survey: PSO visual monitoring protocols	1) A team of four to six PSOs supplied by a third-party PSO Provider will be on board each vessel conducting 24-hour survey operations to undertake visual watches, implement mitigation, and conduct data collection and reporting during geophysical operations. 2) A team of two to three PSOs supplied by a third-party PSO Provider will be on board each vessel conducting 12-hour, daylight-only survey operations to undertake visual watches, implement mitigation, and conduct data collection and reporting. 3) PSOs will be equipped with binoculars with a minimum of 8× or 10× magnification, reticule binoculars that allow for range estimations to be made, and an SLR camera with a zoom lens during daytime operations. During nighttime operations, PSOs will be equipped with high-performance night vision goggles, (i.e., PVS-7 Generation 3 Pinnacle) and Nivisys Thermal Acquisition Clip-on System in addition to handheld IR LED spotlights. Due to the potential for reflectivity from bridge windows that could interfere with the use of the night vision optics, PSOs will be required to make nighttime observations from a platform with no visual barriers.	In addition to the Applicant-proposed measures: US Wind must comply with all PDC and BMPs for protected species that are in effect at the time of the activity. US Wind must implement all PDC and BMPs incorporated in the Atlantic Data Collection Consultation for Offshore Wind Activities (BOEM 2021) to activities associated with the construction and O&M of the Project, as applicable.	Construction, O&M	This measure would ensure the effectiveness of the required mitigation and monitoring measures for HRG surveys.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
PAM protocols	1) US Wind anticipates using PAM during Project construction and installation activities. PAM Operators will use equipment that can detect all known species in the region. 2) Specifications of the PAM equipment to be used will be provided to NMFS for review prior to the start of Project activities. 3) The PAM system will operate in accordance with the pre-piling clearance timing. Deployment of the PAM system will be around the perimeter of the clearance zone prior to pile driving and sufficient to create an acoustic monitoring field around the installation sites. 4) PAM operators will monitor hydrophone signals visually (screen display of sound analysis software) and aurally (using headphones). PAM operators may be located onshore or on a separate vessel than the installation vessel.	In addition to the Applicant-proposed measures: 1) US Wind must prepare a PAM Plan describing 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. 2) The PAM Plan will be submitted to BOEM, BSEE, and NMFS for review and concurrence at least 120 days prior to the planned start of activities requiring PAM. Pile driving may not commence until the PAM plan is approved by all agencies.	Construction	This measure increases the scope of monitoring for NARWs and other ESA-listed marine mammal species. Early detection will improve mitigation implementation, which will reduce effects of pile driving.
Project reporting requirements	1) PSO documentation throughout Project operations would be consistent with data required for PSO data in Appendix B to Addendum C of the Lease, pending confirmation by NMFS and BOEM. 2) US Wind will provide NMFS with an annual report on April 1 every calendar year following commencement of Project construction and installation activities. A final report will be provided 90 days following the conclusion of Project activities. 3) PSO reports will include a summary of the raw data pertaining to Project activities, PSO sighting data, any incident reports, and an estimate of the number of ESA-listed marine mammals observed or taken during the Project activities for the preceding year. 4) US Wind will notify BOEM and NMFS at least 24 hours prior to commencement of Project activities and within 24 hours following completion of the activity.	In addition to the Applicant-proposed measures: 1) US Wind must submit data that is consistent with the most current permitting documents, and all reporting will meet the metadata standards established by BOEM, BSEE, and NMFS. 2) All PSO data will also be shared with BOEM and BSEE to ensure compliance with requirements. 3) During the construction phase and for the first year of operations, US Wind will 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), piles installed, and all observations of ESA-listed species. Monthly reports are due on the 15th of the month for the previous month. 4) Beginning in year 2 of operations, US Wind will 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 (e.g., the 2026 report is due by April 1, 2027). Upon mutual agreement of NMFS and BOEM, the frequency of reports can be changed. 5) By January 31 of each year, US Wind will submit to BSEE an annual report that describes its marine trash and debris awareness training process and certifies the training process has been followed for the previous calendar year.	Construction, O&M	This measure improves information transfer and compliance monitoring by establishing regular reporting for all related activities.
Dead or injured animal reporting requirements	US Wind will ensure any sightings of injured or dead marine mammals are reported to BOEM, NMFS, and the NMFS Greater Atlantic (Northeast) Region Fisheries Office (GARFO) Marine Mammal and Sea Turtle Stranding and Entanglement Hotline (866-755-NOAA [6622] or current). Sightings will be reported within 24 hours, regardless of whether the injury or death was caused by a vessel. In addition, if the injury or death was caused by a collision with a US Wind vessel, US Wind will notify BOEM and NMFS within 24 hours of the strike.	In addition to the Applicant-proposed measures: Any potential takes, strikes, strandings, entanglements, or occurrences of dead/injured protected species regardless of cause, will be reported by the vessel captain or the PSO onboard to the NMFS GARFO Marine Mammal and Sea Turtle Stranding and Entanglement Hotline (866-755-NOAA [6622] or current) and BSEE within 24 hours of a sighting. In addition, if the injury or death was caused by a collision with a Project-related vessel, US Wind will ensure NMFS GARFO and BSEE are notified of the strike within 24 hours. The notification will include date and location (latitude and longitude) of the strike, name of the vessel involved, and the species identification or a description of the animal, if possible. If the Project activity is responsible for the injury or death, US Wind will supply a vessel to assist in any salvage effort as requested by NMFS or BSEE.	Construction, O&M	This measure improves information transfer regarding potential impacts to ESA-listed species. This measure ensures monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate effects and potentially lead to additional mitigation measures, if required.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
NARW reporting	Any sighting of a NARW will be reported to NMFS within 24 hours of the observation and reported on the WhaleAlert application.	In addition to the Applicant-proposed measures: If an NARW is observed at any time by a PSO or project personnel during surveys or vessel transit, US Wind or the PSO must report sighting within 2 hours of occurrence, when practicable, and no later than 24 hours after occurrence. In the event of a sighting of an NARW that is dead, injured, or entangled, efforts must be made to report as quickly as possible to the appropriate regional NOAA stranding hotline (from Maine to Virginia, report sightings to 866-755-6622; from North Carolina to Florida to 877-942-5343). NARW sightings in any location may also be reported to the USCG via channel 16, to BSEE, and through the WhaleAlert application (http://www.whalealert.org/). Further information on reporting an NARW sighting can be found at: https://appsnefsc.fisheries.noaa.gov/psb/surveys/documents/20120919_Report_a_Rig ht_Whale.pdf The following information should also be reported with the NARW sighting: 1) The name of the project and lease associated with the sighting. 2) The activity occurring at the time of the sighting (e.g., HRG survey, cable installation, etc.). 3) Name of the person who made the sighting and initial report. 4) Name of the vessel from which the sighting was made. 5) The closest point of approach of the NARW to the vessel. 6) Any vessel strike avoidance maneuvers that were made in response to the sighting. 7) Was the sighting reported to the proper channels within the designated window or as soon as practicable? 8) Was the NARW sighting communicated to other project vessels operating in the area?	Construction, O&M	This measure improves information transfer and compliance monitoring for NARWs and improves situational awareness for this and other projects.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Vessel strike avoidance measures	1) Vessel operators and crews engaged in all Project activities will abide by all applicable regulations and US Wind's vessel strike avoidance measures to protect marine mammals from vessel strike. 2) Vessel operators and crews will maintain vigilant watch for marine mammals and will slow down or stop the vessel to avoid striking protected species. Vessel operators and crews will be briefed during vessel mobilization and crew changes regarding US Wind's vessel strike avoidance procedures. 3) Vessel strike avoidance measures will be in effect during all activities, except under extraordinary circumstances when complying with these requirements would risk the safety of the vessel or crew. 4) Trained observers will be present on crew vessels and other Project vessels without PSOs.	In addition to the Applicant-proposed measures: 1) As part of vessel strike avoidance, a vessel crew training program will be implemented. The training program will be provided to NMFS for review and approval prior to the start of surveys. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet. Signing the log sheet will certify the crew members understand and will comply with the necessary requirements throughout the survey event. 2) Vessel operators and crews must maintain vigilant watch for marine mammals and sea turtles by slowing down or stopping the vessels to avoid striking protected species. Vessel crew members responsible for navigation duties will receive site-specific training on marine mammal sighting/reporting and vessel strike avoidance measures. 3) Vessel operators will use all available sources of information of NARW presence, including daily monitoring of the Right Whale Sightings Advisory System, WhaleAlert application, and monitoring of USCG VHF channel 16 to receive notifications of NARW detections, Special Management Areas (SMAs), Dynamic Management Areas (DMAs), and Slow Zones to plan vessel routes to minimize the potential for co-occurrence with NARWs. 4) For all vessels operating north of the Virginia/North Carolina border; and year-round for all vessels operating south of the Virginia/North Carolina border, US Wind will have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. a. The trained lookout will communicate any sightings, in real time, to the captain so that vessel strike and minimum separation distances can be achieved. 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. b. The trained lookout will maintain a vigilant watch and monitor a Vessel Strike Avoidance Zone (1,640 feet [500 meters]) at all times to maintain minimize potential vessel strikes of ESA-listed sea turtle species. Alternative monitoring technology (e.g., night vision, thermal cameras) would be available to ensure effective watch at night and in any other low-visibility conditions. c. If the trained lookout is a vessel crew member, this would be their designated role and primary responsibility while the vessel is transiting. d. Any designated crew lookouts will receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. 5) If a vessel is carrying a PSO or trained lookout for the purposes of maintaining watch for NARWs, an additional lookout (as described in item 4, above) is not required; the PSO or trained lookout would maintain watch for marine mammals and sea turtles. 6) Vessel transits to and from the Project area that require PSOs will maintain a speed commensurate with weather conditions and effectively detecting sea turtles prior to reaching the 1,640-feet (500-meters) avoidance measure.	Construction, O&M, decommissioning	This measure reduces the potential for adverse effects on ESA-listed marine mammal and sea turtle species by increasing the effectiveness of mitigation and monitoring measures through educational and training materials and through avoiding vessel interactions with ESA-listed species.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Minimum separation distances	Vessels will maintain, to the extent practicable, separation distances of: o >1,640 feet (500 meters) from an NARW o >328 feet (100 meters) from non-delphinid cetaceans other than NARWs o >164 feet (50 meters) from delphinid cetaceans and pinnipeds, except if a marine mammal approaches the vessel Vessels will observe NMFS collision avoidance guidance, such as establishing minimum separation distances from sea turtles. If an animal is sighted within its respective separation distance, vessels must steer a course away from the animal at 10 knots (5.1 m/s) or slower until the minimum separation distance is established.	In addition to the Applicant-proposed measures: 1) If a NARW, or unidentified whale, is sighted within its designated separation distance (see below) while under way, the vessel will steer a course away from the whale at 10 knots (5.1 m/s) or less until the 1,640 feet (500 meters) minimum separation distance has been established. a. If a NARW is sighted within 328 feet (100 meters) of an underway vessel, the vessel operator will immediately reduce speed and promptly shift the engine to neutral. If the vessel is stationary, the operator will not engage engines until the NARW has moved beyond 328 feet (100 meters). 2) If a non-delphinid cetacean is sighted within 328 feet (100 meters) of an underway vessel, the vessel operator will immediately reduce speed and promptly shift the engine to neutral. The vessel operator will not engage the engines until the non-delphinid cetacean has moved beyond 328 feet (100 meters). If a vessel is stationary, the operator will not engage engines until the non-delphinid cetacean has moved beyond 328 feet (100 meters) 3) If a delphinid cetacean or pinniped approaches an underway vessel, the vessel will avoid excessive speed or abrupt changes in direction to avoid injury to these organisms. Additionally, vessels underway may not divert to approach any delphinid cetacean or pinniped. 4) If a sea turtle is sighted within 328 feet (100 meters) or less of the operating vessel's forward path, the vessel operator will slow down to a maximum of 4 knots (2.1 m/s) (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 knots (2.1 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. a. If a sea turtle is sighted within 164 feet (50 meters) of the forward path of the operating vessel, the vessel operator will shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots (2.1 m/s) or less. The vessel may resume normal operations once it has passed the turtle. 5) The only exception to these actions 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 and BSEE within 24 hours.	Construction, O&M, decommissioning	The measure would minimize the potential for adverse effects on marine mammals and sea turtles resulting from vessel interactions.
Vessel speed restrictions	1) Vessels 65 feet (19.8 meters) in length or greater would operate at speeds of 10 knots (5.1 m/s) or slower in NARW Special Management Areas (SMAs). Additionally, all vessels would operate at speed of 10 knots (5.1 m/s) or slower in Right Whale Slow Zones (i.e., DMAs) to protect visually or acoustically detected NARWs. US Wind will incorporate the proposed revision to the NARW vessel speed rule for vessels 35 to 65 ft (10.6 to 19.8 m) in length upon implementation. 2) All vessels will comply with NMFS regulations and speed restrictions as well as state regulations, as applicable for NARW. 3) All Project-related vessels of 65 feet (19.8 meters) in length or greater will comply with 10 knots (5.1 m/s) speed restrictions in any SMA, DMA, or Slow Zone. 4) All Project-related vessels of 65 feet (19.8 meters) in length or greater will reduce vessel speed to 10 knots (5.1 m/s) or slower when mother/calf pairs, pods, or larger assemblages of whales are observed near an underway vessel.	In addition to the Applicant-proposed measures: 1) Vessel captains/operators will 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 (2.1 m/s) while transiting through such areas. 2) All project vessels of 65 feet (19.8 meters) in length or greater will abide to speed restrictions.	Construction, O&M, decommissioning	This measure would minimize the potential for ship strikes and effects on marine mammals, and secondarily on sea turtles, by slowing speeds. Communication between project vessels would further reduce potentially adverse effects by alerting vessels to the presence of marine mammals in the area.
Crew training requirements	US Wind would defer to any crew training requirements set forth by agencies resulting from this consultation, MMPA ITA, and COP conditions of approval.	All vessel crew members will be briefed in the identification of sea turtles and in regulations and best practices for avoiding vessel collisions. Reference materials will 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) will 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 (i.e., the lookout or the vessel captain) as well as a communication channel and process for crew members to do so.	Construction, O&M, decommissioning	This measure will maximize visibility and detection probability for ESA-listed species so that mitigation measures may be implemented to reduce adverse effects from pile driving noise.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Communication protocols	1) At first detection of a protected species in the vessel's path, the PSO notifies the bridge of the animal's presence and distance from the vessel, in person, via VHF radio, or by phone and requests a Vessel Strike Avoidance. 2) During the sighting, the PSO continues to monitor the protected species to continue advising the bridge as to the effectiveness of the Vessel Strike Avoidance. The vessel operator must respond to the requested mitigation if it is safe for the vessel to do so, and the PSO team will document the decision of the vessel operator. 3) At first detection of a protected species inside its respective shutdown zone, the PSO or PAM Operator immediately notifies the onboard Party Chief/Project Manager via VHF radio/WhatsApp that a shutdown of operations is required. 4) The Party Chief/Project Manager will assess the ability to safely shutdown and communicate the decision to the PSO/PAM Operator. 5) During the detection, the PSO/PAM Operator will continue to monitor and record ongoing behavior of the detected animal(s). 6) From the time that the protected species is last detected inside the shutdown zone and the proper amount of time has passed, the PSO/PAM Operator informs the onboard Party Chief/Project Manager that it is safe to restart operations. 7) It will be the responsibility of the Lead PSO to report any visual sightings of NARWs as well as injured, dead, or entangled protected species using the designated reporting forms. The report will immediately be sent to the PSO Project Manager for review and submission to the appropriate regulatory agencies within the required time frame. 8) The vessel captain will call the USCG on channel 16 to report the detection.	In addition to the Applicant-proposed measures: US Wind must submit a Communication Plan that details the responsible parties and when/how communications are made during pre-clearance monitoring, noise attenuation system deployment and testing, PAM monitoring, detection events, shutdowns, and vessel operations.	Construction, O&M, decommissioning	This measure ensures ESA-listed species detections in the area are known as early as possible, which could lead to mitigation measures, if necessary, thus improving readiness for mitigation implementation.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Foundation pile driving time-of-year/day restrictions and Alternative Monitoring Plan (AMP)	1) Pile driving for any Project foundations would occur only between May and November of any construction phase. 2) No more than one monopile will be driven per day. 3) No simultaneous pile driving of Project foundations will occur. 4) Pile driving would occur during daylight hours only unless pile driving that started during daylight hours must be completed at night for safety or feasibility considerations. 5) Initiation of impact pile driving would not begin within 1.5 hours of civil sunset or in times of low visibility when the clearance and shutdown zones cannot be visually monitored, as determined by the Lead PSO on duty.	1) US Wind will submit an AMP to BOEM, BSEE and NMFS for review and approval at least 6 months prior to the planned start of all pile driving. The AMP may include deploying additional observers; alternative monitoring technologies such as night vision, thermal, and infrared technologies; or PAM, and it must demonstrate the ability to effectively maintain all clearance and shutdown zones during daytime. 2) US Wind 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 unless an acceptable AMP is submitted to and approved by BOEM, BSEE, and NMFS. 3) The AMP must include enhanced monitoring capabilities that will be utilized in the event that poor visibility conditions unexpectedly arise and pile driving cannot be stopped. The AMP must also include measures for deploying additional observers, using night vision devices or PAM, with the goal of ensuring the ability to maintain all clearance and shutdown zones in the event of unexpected poor-visibility conditions. 4) The AMP must include the following two standalone components: o 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 1 hour after civil sunrise to 1.5 hours before civil sunset. o Part 2 – Nighttime: Inclusive of weather conditions (e.g., fog, rain, sea state). Nighttime being defined as 1.5 hours before civil sunset to 1 hour after civil sunrise. 5) The AMP must include, at a minimum, the following information: o Identification of NVDs (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. o 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 capable of detecting marine mammals and sea turtles to the maximum extent of the clearance and shutdown zones will be acceptable. o 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). o Reporting procedures, contacts, and time frames. BOEM may request additional information, when appropriate, to assess the efficacy of the AMP.	Construction	Time-of-year restrictions for impact pile driving activities would minimize and avoid potential adverse effects on ESA-listed species, such as NARWs, that are more likely to occur in the area during that time period.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Noise mitigation systems	1) US Wind will employ noise attenuation through deployment of near- and far-field sound attenuation technologies: a. Near-field technologies could include AdBm Technologies Noise Mitigation System and using a damper between the hammer and sleeve to prolong the impact pulse. b. Far-field technologies could include a large double bubble curtain, deployed by a separate vessel mobilized to the installation location. 2) US Wind will implement sound attenuation technologies such as double bubble curtains and near-field sound attenuation devices to reduce underwater pile driving noise by 10 decibels, with a target of 20 decibels at the source.	In addition to the Applicant-proposed measures: 1) US Wind must implement noise attenuation device(s) during all pile driving of foundations. 2) If bubble curtains are used, construction contractors must submit an inspection/performance report for approval by US Wind within 72 hours following the performance test. Corrections to the bubble ring(s) to meet the performance standards must occur prior to impact pile driving of monopiles. 3) If sound field verification (SFV) measurements indicate the ranges to Level A and B harassment isopleths are larger than those permitted, US Wind must modify or apply additional noise attenuation measures (e.g., improve efficacy of bubble curtain, modify the piling schedule to reduce the source sound, install an additional noise attenuation device) before another pile is installed. Until SFV confirms the ranges to Level A and B harassment isopleths are less than or equal to those permitted, the shutdown and clearance zones must be expanded to match the measured ranges to the Level A and B harassment isopleths. 4) If the use of additional noise attenuation measures does not achieve ranges less than or equal to those permitted and no other actions can further reduce sound levels, US Wind must expand the clearance and shutdown zones according to those identified through SFV, in consultation with NMFS. 5) If the harassment zones are expanded beyond an additional 4,921 feet (1,500 meters), additional PSOs must be deployed on additional platforms, with each PSO responsible for maintaining watch in no more than 180 degrees and of an area with a radius no greater than 4,921 feet (1,500 meters).	Construction	The reduction in sound pressure levels would reduce the area of underwater noise effects on ESA-listed whales, sea turtles, fish, and the prey they feed upon during impact pile driving.
SFV measurement plan	US Wind would defer to any SFV requirements set forth by agencies resulting from this consultation, MMPA ITA, and COP conditions of approval.	1) US Wind must develop an impact pile driving SFV plan to confirm noise generated by foundation installation is below modeled ensonification levels used for estimating environmental impacts. 2) The plan must be reviewed and approved by BOEM, BSEE and NMFS. 3) The plan will include measurement procedures and results reporting that meet ISO standard 18406:2017 (Underwater acoustics – Measurement of radiated underwater sound from impact pile driving). 4) The submission of raw acoustic data or data products associated with SFV to BOEM may be required.	Construction	This measure ensures noise level data are consistently collected in the SFV at the highest possible standard using up-to-date methodology to minimize noise effects on marine mammal, sea turtle and ESA-listed fish species.
Adaptive mitigation zones	US Wind would defer to any adaptive mitigation zone requirements set forth by agencies resulting from this consultation, MMPA ITA, and COP conditions of approval.	1) US Wind must ensure that if the clearance and shutdown zones are expanded due to the results of the SFV from Project activities, PSO coverage is sufficient to reliably monitor the expanded clearance and shutdown zones. Additional observers will be deployed on additional platforms for every 4,921 feet (1,500 meters) that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification. 2) BOEM, BSEE, and the USACE may consider reductions in the shutdown zones for sei, fin, or sperm whales based on SFV of a minimum of three piles. Sound field verification of additional piles may be required based on results of actual measurements. However, the shutdown zone for sei, fin, and sperm whales will not be reduced to less than 3,281 feet (1,000 meters) or 1,640 feet (500 meters) for sea turtles. No reductions in the clearance or shutdown zones for NARWs will be considered regardless of the results of SFV of a minimum of three piles.	Construction	This measure allows for the shutdown zones to be modified to better represent actual risks to marine species from noise-generating activities once sufficient evidence is present to permit such a change.

<table>
<tr><th>Measure Description</th><th>Applicant Proposed</th><th>BOEM Proposed or Modified</th><th>Project Phase</th><th>Expected Effects Avoided or Minimized</th></tr>
<tr><td>Clearance and shutdown zones for monopile-installation pile driving</td><td>Clearance and shutdown zones for monopile installation:
<table>
<tr><th>Marine Mammal Hearing Group</th><th>Clearance Zone</th><th>Shutdown Zone</th></tr>
<tr><td>Low Frequency Cetaceans</td><td rowspan="4">5,250 m</td><td>2,900 m</td></tr>
<tr><td>Mid-frequency Cetaceans</td><td><50 m</td></tr>
<tr><td>High Frequency Cetaceans</td><td>250 m</td></tr>
<tr><td>Pinnipeds in Water</td><td>100 m</td></tr>
</table></td><td>In addition to the Applicant-proposed measures:
1) Shutdown of pile driving would occur for NARWs visually detected at any distance or acoustically detected within 5 km of the piling location.
2) BOEM and the USACE would ensure US Wind monitors the following zones for sea turtles in addition to those proposed by the Applicant for marine mammals:
a. A clearance zone of 820 feet (250 meters), which encompasses maximum the area in which noise would exceed the SPL of 175 dB re 1 μPa behavioral disturbance threshold for sea turtles, to be monitored for the duration of all pile driving activities and for 30 minutes following the cessation of pile driving activities and records all observations in order to ensure all take is documented. This clearance zone would encompass a portion of the TTS ranges.
b. A shutdown zone of 1,640 feet (500 meters), which covers the extent of the modeled range to the PTS threshold for the WTG monopile foundation will be implemented for sea turtles.</td><td>Construction</td><td>The establishment of clearance and shutdown zones would minimize the potential for adverse effects on protected species resulting from pile driving by ensuring marine mammals and sea turtles are not within or near threshold ranges at the start of pile driving and by reducing the occurrence, exposure levels, and exposure times that an animal might encounter during pile driving.</td></tr>
<tr><td>Clearance and shutdown zones for skirt pile driving</td><td>Clearance and shutdown zones for skirt pile installation:
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<tr><td>Low Frequency Cetaceans</td><td rowspan="4">5,250 m</td><td>1,400 m</td></tr>
<tr><td>Mid-frequency Cetaceans</td><td><50 m</td></tr>
<tr><td>High Frequency Cetaceans</td><td>100 m</td></tr>
<tr><td>Pinnipeds in Water</td><td>50 m</td></tr>
</table></td><td>In addition to the Applicant-proposed measures:
1) Shutdown of pile driving would occur for NARWs visually detected at any distance or acoustically detected within 5 km of the piling location.
2) BOEM and the USACE would ensure US Wind monitors the following zones for sea turtles in addition to those proposed by the Applicant for marine mammals:
a. A clearance zone of 820 feet (250 meters), which encompasses the area in which noise would exceed the SPL of 175 dB re 1 μPa behavioral disturbance threshold for sea turtles, to be monitored for the duration of all pile driving activities and for 30 minutes following the cessation of pile driving activities and records all observations in order to ensure all take is documented. This clearance zone would encompass a portion of the TTS ranges.
b. A shutdown zone of 1,640 feet (500 meters), which covers the extent of the modeled range to the PTS threshold for the OSS skirt pile foundation will be implemented for sea turtles.</td><td>Construction</td><td>The establishment of clearance and shutdown zones would minimize the potential for adverse effects on protected species resulting from pile driving by ensuring marine mammals and sea turtles are not within or near threshold ranges at the start of pile driving and by reducing the occurrence, exposure levels, and exposure times that an animal might encounter during pile driving.</td></tr>
<tr><td>Clearance and shutdown zones for pin pile driving</td><td>Clearance and shutdown zones for pin pile installation:
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<tr><td>Low Frequency Cetaceans</td><td rowspan="3">100 m</td><td>50 m</td></tr>
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<tr><td>High Frequency Cetaceans</td><td><50 m</td></tr>
<tr><td>Pinnipeds in Water</td><td></td><td><50 m</td></tr>
</table></td><td>In addition to the Applicant-proposed measures:
1) Shutdown of pile driving would occur for NARWs visually detected at any distance or acoustically detected within 5 km of the piling location.
3) BOEM and the USACE would ensure US Wind monitors the following zones for sea turtles in addition to those proposed by the Applicant for marine mammals:
a. A clearance zone of 820 feet (250 meters), which encompasses the area in which noise would exceed the SPL of 175 dB re 1 μPa behavioral disturbance threshold for sea turtles, to be monitored for the duration of all pile driving activities and for 30 minutes following the cessation of pile driving activities and records all observations in order to ensure all take is documented. This clearance zone would encompass a portion of the TTS ranges.
b. A shutdown zone of 1,640 feet (500 meters), which covers the maximum extent of the modeled range to the PTS threshold for the Met Tower pin pile foundation will be implemented for sea turtles.</td><td>Construction</td><td>The establishment of clearance and shutdown zones would minimize the potential for adverse effects on protected species resulting from pile driving by ensuring marine mammals and sea turtles are not within or near threshold ranges at the start of pile driving and by reducing the occurrence, exposure levels, and exposure times that an animal might encounter during pile driving.</td></tr>
</table>

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Clearance and shutdown zones for inshore pile driving for the O&M facility	US Wind will defer to measures required by agencies through ESA and MMPA consultations and any COP conditions of approval.	US Wind must implement a minimum 328-foot (100-meter) clearance zone for all marine mammals; a 164-foot (50-meter) shutdown zone for low-frequency cetaceans; and a <164-foot (50-meter) shutdown zone for all other marine mammals, based on the anticipated ranges to the PTS and behavioral disturbance thresholds for these pile types. Additionally, US Wind must monitor the full extent of the area where noise is estimated (by modeling or calculations) to exceed the SPL of 175 dB re 1 μPa behavioral disturbance threshold for sea turtles for the duration of all pile driving activities and for 30 minutes following the cessation of pile driving activities and records all observations in order to ensure all take is documented. Additionally, a 164-foot (50 meter) shutdown zone will be implemented for sea turtles to cover the extent of the anticipated ranges to the PTS and behavioral disturbance thresholds for these pile types.	Construction	The establishment of clearance and shutdown zones would minimize the potential for adverse effects on protected species resulting from pile driving by ensuring marine mammals and sea turtles are not within or near threshold ranges at the start of pile driving and by reducing the occurrence, exposure levels, and exposure times that an animal might encounter during pile driving.
HRG survey clearance and shutdown zones	Clearance zones: ○ NARWs: 1,640 feet (500 meters); All other marine mammals: 328 feet (100 meters) Shutdown zones: ○ NARWs: 1,640 feet (500 meters) ○ All other marine mammals: 328 feet (100 meters)	In addition to the Applicant-proposed measures: BOEM will require US Wind to comply with all the PDC and BMPs for protected species in effect at the time of the activity. BOEM would ensure all PDC and BMPs incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (BOEM and NMFS 2022) shall be applied to activities associated with Project construction and O&M, as applicable, including the following measure: ○ Before any noise-producing survey equipment that operates at frequencies below 180 kHz is deployed, the monitoring zones (1,640 feet [500 meters] for ESA-listed species and 656 feet [200 meters] for non-ESA-listed marine mammals) must be monitored for 30 minutes of pre-clearance observation. ○ A 328-foot (100-meter) shutdown zone will also be implemented for sea turtles. The clearance ranges for marine mammals will cover the area for PTS thresholds clearance zones for sea turtles.	Construction, O&M	This measure decreases the effects of HRG noise by ensuring marine mammals and sea turtles are not within or near threshold ranges at the start of the survey and reduces effects by minimizing the exposure time and sound levels if an ESA-listed species is detected within the shutdown zone.
Monitoring of clearance zones	1) Pile driving would be attempted only when sufficient visual and acoustic monitoring of the relevant clearance zone for that activity is feasible. 2) The clearance zone would be monitored for a minimum of 60 minutes, and the zone must be clear for 30 minutes before initiating soft-start procedures. 3) If a marine mammal or sea turtle is detected within the clearance zone prior to the soft-start procedure, pile driving would be delayed until the marine mammal exits the clearance zone or is no longer observed after 30 minutes.	In addition to the Applicant-proposed measures: Acceptable visibility will be determined by the Lead PSO, and monitoring of the clearance zone will be required following cessation of impact pile driving for 30 minutes or longer.	Construction	This measure decreases the effects of pile driving noise by ensuring marine mammals and sea turtles are not within or near threshold ranges at the start of pile driving.
Soft start for impact pile driving	Once the clearance zone is confirmed clear of marine mammals and sea turtles, pile driving would begin with minimum hammering at low energy for no less than 30 minutes.	Applicant proposed measures modified to: US Wind must implement soft-start techniques for impact pile driving. The soft start must include a minimum of 20 minutes of 4 to 6 strikes per minute at 10 to 20 percent of the maximum hammer energy. Soft start is required at the beginning of driving a new pile and any time following the cessation of impact pile driving for 30 minutes or longer.	Construction	Establishment of soft-start protocols would minimize the potential for adverse effects on animals close to the activity at the start of pile driving, allowing them time to leave the area before full hammer energy is reached.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Shutdowns for impact pile driving	1) Pile driving would halt if the shutdown zones cannot be effectively monitored visually or if the minimum visibility of 4,921 feet (1,500 meters) cannot be visually and acoustically monitored. 2) If a marine mammal is detected in the shutdown zone at any time during pile driving, the Lead PSO would call for an immediate shutdown of pile driving unless it is determined not feasible due to safety or technical reasons. 3) The offshore construction manager on duty would assess the safety of crew during a shutdown, whether the pile would be structurally compromised, and whether pile driving could not be successfully completed after shutdown and the process is restarted (clearance zone monitoring and soft-start implementation). If any of these conditions cannot be met safely, the offshore construction manager may call for a continuation of pile driving. 4) Following a shutdown, monitoring of the shutdown zone would continue and pile driving would resume after 30 minutes if the sighted animal has exited the shutdown zone or 30 minutes elapses with no marine mammal or sea turtle observed in the shutdown zone.	In addition to the Applicant-proposed measures: 1) Within 24 hours, the Lessee must report to BOEM (renewable_reporting@boem.gov) and BSEE (protectedspecies@bsee.gov) all marine mammals and sea turtles observed in the shutdown zone. In the report, the Lessee must include a detailed description of any instance where a shutdown was requested by the PSO but not implemented due to safety concerns, including a clear description of the safety concerns that prevented the pile driving hammer from shutting down and the reduction of hammer energy that occurred. In addition, the PSO Provider must submit the data report (raw data collected in the field), including the daily form with the date, time, species, pile identification number, GPS coordinates, time and distance of the animal when sighted, time the shutdown occurred, behavior of the animal, direction of travel, time the animal left the shutdown zone, time the pile driver was restarted or powered back up, and any photographs that may have been taken. 2) To ensure impact pile driving operations are carried out in a way that minimizes the exposure of ESA-listed sea turtles to noise that may result in injury or behavioral disturbance, PSOs will establish a 1,640-ft (500-m) shutdown zone for all pile driving activities. Adherence to the 1,640-ft (500-m) shutdown zone must be reflected in the PSO reports. Any visual detection of sea turtles in the shutdown zone must trigger the required shutdown of pile installation. Upon visual detection of a sea turtle entering or within the shutdown zone during pile driving, US Wind must shut down the pile driving hammer unless activities must proceed for human safety or for concerns of structural failure. 3) Visual detection of an NARW at any distance will result in a shutdown. 4) Acoustic detection of an NARW within 9,514 feet (2,900 meters) will result in a shutdown.	Construction	This measure would minimize the potential for adverse effects on ESA-listed marine mammals and sea turtles by minimizing the exposure time and sound levels if an ESA-listed species is detected within the shutdown zone.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Post-construction noise and species monitoring	US Wind has partnered with the University of Maryland Center for Environmental Science to perform a PAM study to detect large whales (e.g., NARWs) and dolphins. Utilizing a before-during-after gradient design, deployed devices will be used to characterize ambient noise levels and evaluate how marine mammals and other tagged species using receivers on the PAM array (i.e., fishes, sharks, rays, and turtles) respond to construction and installation of the Project. This study will help distinguish changes in marine mammal behavior due to Project activities versus natural interannual variation in the region.	In addition to the Applicant-proposed measures: 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 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 annually following year 1 of operations. Upon mutual agreement of NMFS and BOEM, the frequency of these meetings can be changed.	O&M	This measure would not minimize adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for impact pile driving.
	US Wind would defer to any post-construction noise and species monitoring requirements set forth by agencies resulting from this consultation, MMPA ITA, and COP conditions of approval.	The Lessee must conduct long-term monitoring of ambient noise, baleen whale, and marine fish vocalizations in the Lease Area before, during, and following construction. The Lessee must conduct continuous recording at least 30 days before conducting pile driving, during foundation pile driving, initial operation, and for at least 3 but no more than 10 full calendar years of operation to monitor for potential impacts. The Lessee must meet with BOEM and BSEE at least 60 days prior to conclusion of the third full calendar year of operation monitoring (and at least 60 days prior to the conclusion of each subsequent year until monitoring is concluded) to discuss: 1) monitoring conducted to-date, 2) the need for continued monitoring, and 3) if monitoring is continued, whether adjustments to the monitoring are warranted. Following this meeting, BOEM will make a determination as to continued monitoring requirements and inform the Lessee of any changes to monitoring requirements. The Lessee must independently deploy at least three devices within the Lease Area to maximize spatial coverage of the Lease Area based on 10- kilometer spacing between deployment locations or as otherwise agreed between BOEM and the Lessee. The devices(s) must be configured to identify the specific locations of vocalizing NARW within the Lease Area. The Lessee must coordinate the locations of the buoys with the Regional Wildlife Science Collaborative prior to the plan being submitted to BOEM and BSEE. The Lessee may move devices to new locations during the recording period, if existing PAM devices will be present in the Lease Area providing continuous recording. The archival recorders must have a minimum capability of continuously detecting and storing acoustic data on vessel noise, pile-driving, WTG operation, baleen whale vocalizations, and marine fish vocalizations in the Lease Area.	O&M	This measure would not minimize adverse effects but would identify behavioral changes in ESA-listed species due to wind turbine structure presence and O&M activity.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Post-construction noise and species monitoring (cont'd)	Continued from above	No later than 180 days before buoy deployment, the Lessee must submit to BOEM and BSEE the long-term PAM plan, which must describe all proposed equipment, deployment locations, detection review methodology, and other procedures and protocols related to the required use of PAM for monitoring. The PAM plan must detail mooring best practices, data management, storage, measurement, and data processing best practices that are required by BOEM for long-term PAM monitoring. Refer to Regional Wildlife Science Collaborative for Offshore Wind Data Management & Storage Best Practices for Long-term and Archival PAM Data. The Lessee should detail other best practices consistent with COP approval in the plan. The long-term PAM Plan must include the proposed equipment, sample rate (the sampling rate (minimum 10 kHz) of the recorders should prioritize baleen whale detections but must also have a minimum capability to record noise from vessels, pile-driving, and WTG operation in the Lease Area), mooring design, deployment locations, methods for baleen whale and marine fish detections, and metrics for ambient noise analysis. The Lessee must submit the long-term PAM plan to BOEM and BSEE for review and concurrence. BOEM and BSEE will review the long-term PAM Plan and provide comments, if any, on the plan to the Lessee within 45 days, but no later than 90 days of its submittal. The Lessee's plan must satisfy all outstanding comments to BOEM's and BSEE's satisfaction. The Lessee will receive written concurrence from BOEM and BSEE upon acceptance of the final long-term PAM plan. If BOEM and BSEE do not provide comments on the long-term PAM Plan within 90 days of its submittal, the Lessee may conclusively presume BOEM and BSEE's concurrence with the long-term PAM Plan. The Lessee must provide long-term PAM monitoring results to BOEM and BSEE within 180 days of buoy collection and again within 180 days of the annual anniversaries of each the PAM device deployments. The Lessee must send all raw data to NCEI for archiving no later than 6 months following the date of each recorder recovery. As an alternative to conducting long-term PAM in the Lease Area, the Lessee may opt to meet the monitoring requirement described above each year monitoring remains required through an annual economic contribution to BOEM's Environmental Studies Program in support of its Partnership for an Offshore Wind Energy Regional Observation Network (POWERON) initiative, the terms of which will be specified in a separate agreement between BOEM and the Lessee. At the Lessee's request, BOEM's Environmental Studies Program will estimate the amount of the economic contribution to be included in the separate agreement based on a share of the expected costs of the POWERON program. Under this option, the Lessee will be expected to cooperate with the POWERON team to facilitate deployment and retrieval of instruments within the Lease Area. If necessary, the Lessee may request temporary withholding of the public release of acoustic data that has been collected within its Lease Area.		
Ramp-up of HRG survey equipment	1) When technically feasible, electromechanical survey equipment will be ramped up at the start (or restart) of HRG survey activities. These procedures will allow marine mammals in the vicinity of survey activities time to vacate the area prior to the generation of maximum sound source levels due to equipment use. 2) Ramp-up will begin with the power of the smallest acoustic equipment for the HRG survey at its lowest power output. When technically possible, power output will be gradually increased and other acoustic sources added in such a way that the source level would increase in steps not exceeding 6 decibel per 5-minute period. 3) If a marine mammal enters the shutdown zone during ramp-up, the procedure will be delayed until the animal exits the shutdown zone or no further sightings are reported for 60 minutes.	In addition to the Applicant-proposed measures: US Wind must comply with all PDC and BMPs for protected species in effect at the time of the activity. BOEM would ensure all PDC and BMPs incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (BOEM and NMFS 2022) shall be applied to activities associated with Project construction and O&M, as applicable.	Construction, O&M	Establishment of ramp-up protocols would minimize the potential for adverse effects on animals close to the activity at the start of the survey, allowing them time to leave the area before full acoustic power is reached.
Monitoring of HRG survey clearance zones	Prior to the initiation of ramp-up procedures described above, the clearance zone will be assessed to be clear of marine mammals for 60 minutes by PSOs.	In addition to the Applicant-proposed measures: US Wind must monitor the clearance zone for the presence of sea turtles for 30 minutes prior to the initiation of ramp-up procedures.		

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Shutdowns for HRG surveys	1) Immediate shutdown of HRG survey equipment will occur if a non-delphinoid cetacean is sighted in the shutdown zone. The vessel operator will comply immediately with such a call by the Lead PSO. Any disagreement or discussion between the Lead PSO and vessel operator will occur only after shutdown. Subsequent restart of the electromechanical survey equipment may only occur following clearance of the shutdown zone and implementation of ramp-up procedures. 2) If a delphinoid cetacean or pinniped is sighted in the shutdown zone, HRG survey equipment will be powered down to the lowest power output that is technically feasible. The vessel operator will comply immediately with such a call by the Lead PSO, with any disagreement or discussion occurring only after power-down. Subsequent power-up of the electromechanical survey equipment will use ramp-up procedures and may occur after: a. The shutdown zone is clear of delphinoid cetaceans and pinnipeds; or b. A determination by the Lead PSO after a minimum of 10 minutes of observation that the delphinoid cetacean or pinniped is approaching the vessel or towed equipment at a speed and vector that indicates voluntary approach to bow-ride or chase towed equipment. 3) If the HRG sound sources shut down for reasons other than encroachment into the shutdown zone by a non-delphinoid cetacean (e.g., mechanical or electronic failure) for more than 20 minutes, restart of the HRG survey equipment will proceed following ramp-up procedures after clearance of the shutdown zone. 4) If the shutdown is less than 20 minutes in duration, the HRG equipment may be restarted as soon as practicable at its operational level as long as visual surveys were continued throughout the silent period and the shutdown zone remained clear of marine mammals. 5) If visual surveys were not continued during a pause of 20 minutes or less, restart of the HRG survey equipment will follow ramp-up procedures after clearance of the shutdown zone.	In addition to the Applicant-proposed measures: US Wind must comply with all PDC and BMPs for protected species in effect at the time of the activity. BOEM would ensure all PDC and BMPs incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (BOEM and NMFS 2022) shall be applied to activities associated with Project construction and O&M, as applicable.	Construction, O&M	This measure reduces adverse effects on protected species by minimizing the time exposed to threshold level noise.
Injured and dead protected species reporting	US Wind will ensure any sightings of injured or dead marine mammals are reported to BOEM, NMFS OPR, and the NMFS GARFO Marine Mammal and Sea Turtle Stranding and Entanglement Hotline (866-755-NOAA [6622] or current). Sightings will be reported within 24 hours, regardless of whether the injury or death was caused by a vessel. In addition, if the injury or death was caused by a collision with a Project vessel, US Wind will notify NMFS OPR, NMFS GARFO, and BOEM within 24 hours of the strike. US Wind will use the form provided in Appendix A to Addendum C of the Lease to report the sighting or incident. If Project activities are responsible for the injury or death, US Wind will supply a vessel to assist in any salvage effort requested by NMFS.	In addition to the Applicant-proposed measures: US Wind will also ensure any sighting of injured or dead marine mammals are reported to BSEE at ProtectedSpecies@BSEE.gov within 24 hours of the sighting.	Construction, O&M, decommissioning	This measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate effects and potentially lead to additional mitigation measures, if required.
Take notification for ESA-listed species during construction, O&M, and decommissioning	US Wind will ensure the PSOs report any observations concerning impacts on ESA-listed marine mammals to BOEM and NMFS within 48 hours. US Wind will report any injuries or mortalities using the Incident Report provided in the Lease. Any observed takes of ESA-listed marine mammals resulting in injury or mortality will be reported within 24 hours to BOEM and NMFS.	In addition to the Applicant-proposed measures: US Wind must ensure sea turtle and ESA-listed fish observations are reported in the same manner as ESA-listed marine mammal observations. 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 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, O&M, decommissioning	

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Take notification for ESA-listed species during fisheries surveys	US Wind will defer to measures required by agencies through ESA and MMPA consultations and any COP conditions of approval.	1) NMFS GARFO Protected Resources Division (PRD) would be notified as soon as possible of all observed takes of sea turtles and ESA-listed fish species occurring as a result of any fisheries survey. Specifically: 2) GARFO PRD would be notified within 24 hours of any interaction with a sea turtle or ESA-listed fish (nmfs.gar.incidental-take@noaa.gov). The report will include at a minimum: o Survey name and applicable information (e.g., vessel name, station number) o GPS coordinates describing the location of the interaction (in decimal degrees) o Gear type involved (e.g., bottom trawl, gillnet, longline) o Soak time, gear configuration, and any other pertinent gear information o Time and date of the interaction o Identification of the animal to the species level Additionally, the email will transmit a copy of the NMFS Take Report Form 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). 3) 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 will be submitted as soon as possible; late reports will be submitted with an explanation for the delay. 4) At the end of each survey season, a report will be sent to NMFS that compiles all information on any observations and interactions with ESA-listed species. This report will also contain information on all survey activities that occurred during the season, including location of gear set, duration of soak/trawl, and total effort. The report on survey activities will be comprehensive of all activities, regardless of whether ESA-listed species were observed.	Fisheries surveys	Establish procedures for immediate reporting of sea turtle/Atlantic sturgeon take
Marine debris awareness training	US Wind will defer to measures required by agencies through the ESA and MMPA consultations and any COP conditions of approval.	1) US Wind must ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. 2) The training consists of two parts: a. Viewing a marine trash and debris training video or slide show (described below); and b. 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. Operators engaged in marine survey activities will continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures their employees and contractors are trained. The training process will include the following elements: o Viewing of either a video or slide show by the personnel specified above; o An explanation from management personnel that emphasizes their commitment to the requirements; o Attendance measures (initial and annual); and o Record keeping.	All phases	Decrease the loss of marine debris, which may represent entanglement and ingestion risk.
EMF mitigation	US Wind will defer to measures required by agencies through the ESA and MMPA consultations and any COP conditions of approval.	US Wind must comply with all PDC and BMPs for protected species in effect at the time of the activity. BOEM would ensure all PDC and BMPs incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (BOEM and NMFS 2022) shall be applied to activities associated with Project construction and O&M, as applicable, including: o Use of standard underwater cables that have electrical shielding to control the intensity of electromagnetic fields.	Construction, O&M	Decrease area of electromagnetic field effects on marine mammals, sea turtles, and ESA-listed fish species.
Project design envelope evaluation	US Wind will defer to measures required by agencies through the ESA and MMPA consultations and any COP conditions of approval.	US Wind should evaluate marine mammal use of the proposed Action Area and 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	Avoid effects with early planning.

Measure Description	Applicant Proposed	BOEM Proposed or Modified	Project Phase	Expected Effects Avoided or Minimized
Gear utilization mitigation and monitoring	US Wind will utilize ropeless EdgetTech devices for all their commercial pot survey gear.	In addition to the Applicant-proposed measures: US Wind must comply with all PDC and BMPs for protected species in effect at the time of the activity. BOEM would ensure all PDC and BMPs incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (BOEM and NMFS 2022) shall be applied to activities associated with Project construction and O&M, as applicable.	Fisheries surveys	Establish requirement for monitoring and reporting of lost monofilament and other fishing gear around WTGs and promote recovery of lost gear.
Handling of sea turtle and sturgeon species	US Wind will defer to measures required by agencies through the ESA and MMPA consultations and any COP conditions of approval.	US Wind must ensure that any sea turtle or sturgeon species taken incidentally during the course of fishing or scientific research activities will be handled with due care to prevent injury, observed for activity, resuscitated if comatose or inactive, and returned to the water according to the procedures provided in NOAA's sea turtle and Atlantic and shortnose sturgeon handling and resuscitation guidelines.	Fisheries surveys	Improves survivability of sea turtles or sturgeon incidentally captured during fisheries surveys.
Navigational traffic mitigation	A 1 nautical mile (1.8-kilometers) setback from the Traffic Separation Scheme from Delaware Bay would remove seven WTG locations along the eastern edge of the Lease Area.	BOEM-proposed mitigation for navigational safety is consistent with that proposed by US Wind.	Operations	This would allow more space for vessel traffic to move between WTG foundations, which could indirectly reduce overlap between ESA-listed species and vessel traffic.

DMA = Dynamic Management Area; GPS = global positioning system; ISO = International Organization for Standardization; PDC = Project Design Criteria; SMA = Special Management Area

4 ESA-listed Species and Critical Habitat in the Action Area

4.1 ESA-listed Species in the Action Area

Table 4-1 presents all ESA-listed species and associated designated critical habitat that occur within the Action Area.

Table 4-1. ESA-listed species and designated critical habitat that may be affected by the Proposed Action

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Blue whale (*Balaenoptera musculus*)	E–35 FR 18319	-- --	FR Not Available 07/1998 11/2020
Fin whale (*Balaenoptera physalus)*	E–35 FR 18319	-- --	75 FR 47538 07/2010
Humpback whale (*Megaptera novaeangliae*) – Cape Verde Islands/Northwest Africa DPS	E (F)–81 FR 62259	-- --	FR Not Available 11/1991
North Atlantic right whale (*Eubalaena glacialis*)	E–73 FR 12024	81 FR 4837	70 FR 32293 08/2004
Rice's whale (*Balaenoptera ricei)*	E–84 FR 15446	-- --	09/2020[1]
Sei whale (*Balaenoptera borealis*)	E–35 FR 18319	-- --	FR Not Available 12/2011
Sperm whale (*Physeter macrocephalus*)	E–35 FR 18319	-- --	75 FR 81584 12/2010
Sea Turtles			
Green turtle (*Chelonia mydas*) – North Atlantic, South Atlantic DPSs	T–81 FR 20057	63 FR 46693	FR Not Available 10/1991–U.S. Atlantic
Hawksbill turtle (*Eretmochelys imbricata*)	E–35 FR 8491	63 FR 46693	57 FR 38818 08/1992–U.S. Caribbean, Atlantic, and Gulf of Mexico
Kemp's Ridley turtle (*Lepidochelys kempii*)	E–35 FR 18319	-- --	FR Not Available 09/1991–U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback turtle (*Dermochelys coriacea*)	E–35 FR 8491	44 FR 17710[2]	FR Not Available 10/1991–U.S. Caribbean, Atlantic, and Gulf of Mexico
Loggerhead turtle (*Caretta caretta*) – Northwest Atlantic Ocean, Northeast Atlantic Ocean, South Atlantic Ocean DPSs	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 salmon (*Salmo salar*) – Gulf of Maine DPS	E–74 FR 29344 and 65 FR 69459	74 FR 39903	70 FR 75473 11/2005 FR Not Available 02/2019
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Chesapeake Bay and New York Bight DPSs	E–77 FR 5913	82 FR 39160	03/2018[1]
Giant manta ray (*Manta birostris*)	T–83 FR 2916	-- --	12/2019[1]
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)	T–56 FR 49653	68 FR 13369	FR Not Available 09/1995
Nassau grouper (*Epinephelus striatus*)	T–81 FR 42268	*Proposed:* 87 FR 62930	08/2018[1]
Oceanic whitetip shark (*Carcharhinus longimanus*)	T–83 FR 4153	-- --	09/2018[1]
Scalloped hammerhead shark (*Sphyrna lewini*) – Eastern Atlantic (F) and Central & Southwest Atlantic DPSs	E (F)–79 FR 38213 T–79 FR 38213	-- --	No Recovery Plan available
Shortnose sturgeon (*Acipenser brevirostrum*)	E–32 FR 4001	-- --	63 FR 69613 12/1998
Smalltooth sawfish (*Pristis pectinata*) – U.S. DPS	E–68 FR 15674	74 FR 45353	74 FR 3566 01/2009
Corals			
Boulder star coral (*Orbicella franksi*)	T–79 FR 53851	*Proposed*: 85 FR 76302	03/2015[1]
Elkhorn coral (*Acropora palmata*)	T–79 FR 53851	73 FR 72209	80 FR 12146 03/2015
Lobed star coral (*Orbicella annularis*)	T–79 FR 53851	*Proposed*: 85 FR 76302	03/2015[1]
Mountainous star coral (*Orbicella faveolata*)	T–79 FR 53851	*Proposed*: 85 FR 76302	03/2015[1]
Pillar coral (*Dendrogyra cylindrus*)	T–79 FR 53851	*Proposed*: 85 FR 76302	03/2015[1]
Rough cactus coral (*Mycetophyllia ferox*)	T–79 FR 53851	*Proposed*: 85 FR 76302	03/2015[1]
Staghorn coral (*Acropora cervicornis*)	T–79 FR 53851	73 FR 72209	80 FR 12146 03/2015

-- -- = not applicable; DPS = distinct population segment; E = endangered; F = foreign; FR = *Federal Register*; T = Threatened

[1] No Recovery Plan is available for this species. However, NMFS has developed a Recovery Outline to serve as interim guidance for this species until a full Recovery Plan is developed.

[2] A second critical habitat designation for the leatherback sea turtle (77 *Federal Register* 4169) is limited to North Pacific waters along the U.S. West Coast.

4.2 ESA-listed Species Considered but Excluded from Further Analysis

Several species have broad ranges that may include the Action Area but are not likely to be affected by the Proposed Action. The following ESA-listed species were considered for their potential to occur in the Action Area but were excluded from further analysis: blue whale (*Balaenoptera musculus*), humpback whale (*Megaptera novaeangliae*) – Cape Verde Islands/Northwest Africa DPS, Rice's whale (*Balaenoptera ricei*), hawksbill sea turtle (*Eretmochelys imbricata*), Atlantic salmon (*Salmo salar*) – Gulf of Maine DPS, Gulf sturgeon (*Acipenser oxyrinchus desotoi*), Nassau grouper

(*Epinephelus striatus*), smalltooth sawfish (*Pristis pectinata*) – U.S. DPS, oceanic whitetip shark (*Carcharhinus longimanus*), and scalloped hammerhead shark (*Sphyrna lewini*). These 10 species are all considered likely to occur within the Action Area and may overlap with some of the activities described under the Proposed Action, but they do not occur in the main Project area where construction will occur, and the only Project activity these species are expected to encounter would be vessel transits as described further in Sections 4.2.1.1 through 4.2.3.6. Because the encounters between Project vessels and these species are expected to be limited and the likelihood of Project activities effecting these species is extremely unlikely and therefore **discountable**.[2]

Seven species of coral (boulder star coral [*Orbicella franksi*], elkhorn coral [*Acropora palmata*], lobed star coral [*Orbicella annularis*], mountainous star coral [*Orbicella faveolata*], pillar coral [*Dendrogyra cylindrus*], rough cactus coral [*Mycetophyllia ferox*], and staghorn coral [*Acropora cervicornis*]) are also likely to occur within a portion of the Action Area in the Gulf of Mexico. However, in the Gulf of Mexico the only activities included under the Proposed Action are vessel transits to support Project construction, and because the vessels would be transiting and no anchoring or other such activities that would interact with the sea floor are anticipated, **no effect**[3] is expected for any of these species from the Proposed Action.

Brief descriptions of each of the species unlikely to occur or expected to have limited occurrence within the Action Area as well as the full discussion of why this BA discounted potential effects for these species are provided in the following subsections. Species that are likely to occur in the Project area and face a higher risk of adverse effects resulting from the Proposed Action are discussed in more detail in Section 5.

4.2.1 Marine Mammals

4.2.1.1 Blue Whale (Endangered)

The documented range of blue whales in the North Atlantic 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, Northeast U.S., 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; Sears and Calambokidis 2002; Sears and Larsen 2002; Wenzel et al. 1988). The largest concentrations of blue whales are found in the lower St. Lawrence Estuary (Comtois et al. 2010; Lesage et al. 2007), which is outside of the Action 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. 2012). Sightings and strandings data indicate that blue whales occur along the U.S. east coast only rarely because their primary habitat is offshore eastern Canada (Reeves et al. 1998; Kraus et al. 2016a; Hayes et al. 2020). Blue whales primarily feed on krill, but fish and copepods may also be a part of their diet (Hayes et al. 2023).

Blue whales have been listed as endangered under the ESA Endangered Species Conservation Act of 1969, with a recovery plan published in 2018 (63 *FR* 56911) that was revised in 2020 (NMFS 2020).

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[2] *Discountable* effects are those that are extremely unlikely to occur, which supports a *not likely to adversely affect* determination. 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 would be an adverse effect if it did impact an ESA-listed species), but it is extremely unlikely to occur.

[3] A *no effect* determination indicates the Project would have no impacts, positive or negative, on ESA-listed species or designated critical habitat. Generally, this means the species or critical habitat would not be exposed to the Project and its environmental consequences.

Blue whales are separated into two major populations (the north Pacific and north Atlantic population) and further subdivided into stocks. The North Atlantic Stock includes mid-latitude (North Carolina coastal and open ocean) to Arctic waters (Newfoundland and Labrador). The population size of blue whales off the eastern coast of the United States is not known; however, a catalogue count of 402 individuals from the Gulf of St. Lawrence is the minimum population estimate (Hayes et al. 2020). There are no recent confirmed records of anthropogenic mortality or serious injury to blue whales in the U.S. Atlantic EEZ or in Atlantic Canadian waters (Henry et al. 2020). As a result, the total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant and approaching zero (Hayes et al. 2020). No critical habitat has been designated for blue whales in the Action Area.

Historical observations indicate that the blue whale has a wide range of distribution throughout the North Atlantic, 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. Blue whales in the North Atlantic appear to target high-latitude feeding areas and may also use deep-ocean features such as sea mounts outside the feeding season (Pike et al. 2009; Lesage et al. 2017, 2018). Given their reported occurrence and habitat preferences, their presence in the Action Area is uncommon (Hayes et al. 2020). Additionally, sightings and strandings data indicate that blue whales occur along the U.S. East Coast continental shelf rarely, typically exhibiting a more pelagic distribution (Kraus et al. 2016a; Lesage et al. 2017). As such, blue whales are expected to be rare in the Action Area.

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).

Given their pelagic distribution, blue whales could be encountered along vessel transit paths in the Action Area from ports in Europe but are not expected to be encountered in Project Area although their distribution indicates that they can occur. The low density of blue whales and low numbers of Project vessels originating from Europe results in a very low anticipated rate of co-occurrence. All Project vessels will maintain a 328-foot (100-meter) separation distance from large whales and vessel operators will maintain vigilant watch for marine mammals and will slow down or stop the vessel to avoid striking protected species (Table 3-20). Based on the unexpected co-occurrence of blue whales and Project vessels in the Action Area and the mitigation measures to avoid vessel strikes, no strikes or disturbance are expected to occur and therefore, any effects to blue whales are extremely unlikely to occur and are **discountable**. BOEM therefore concludes that the Proposed Action is **not likely to adversely affect** the blue whale.

4.2.1.2 Humpback Whale – Cape Verde/Northwest Africa DPS (Endangered)

The humpback whale can be found worldwide in all major oceans from the equator to subpolar latitudes. In the summer, humpback whales are found in high-latitude feeding grounds, while during the winter months, individuals migrate to tropical or subtropical breeding grounds to mate and give birth (Hayes et al. 2020). North Atlantic humpback whales feed during the summer in various cooler, temperate regions, including the Gulf of Maine, Newfoundland/Labrador, the Gulf of St. Lawrence, Greenland, Iceland, and Norway, including Svalbard (Wenzel et al. 2020). Available photo-identification and genotyping data indicate humpbacks from all these feeding grounds migrate to the primary winter breeding ground in the Dominican Republic (Wenzel et al. 2020). However, smaller numbers have been observed wintering around the Cape Verde Islands (Cooke 2018; Wenzel et al. 2020). The designation of the Cape Verde/Northwest Africa distinct population segment (DPS) was based on genetic evidence indicating a second breeding ground occupied by humpback whales feeding primarily off Norway and

Iceland (Bettridge et al. 2015; Wenzel et al. 2020). Surveys conducted between 2010 and 2018 estimated 272 non-calf whales in the Cape Verde/Northwest Africa DPS using photo-identification survey methods (Wenzel et al. 2020). Although the population abundance for this DPS remains unknown, resighting rates suggest a small population size (Wenzel et al. 2020). Humpback whales were subject to significant removals by pre-modern whalers, especially in their wintering grounds in the West Indies and Cape Verde Islands (Smith and Reeves 2003). Whaling in the Cape Verde Islands occurred primarily during 1850 to 1912, with a total estimated kill of about 3,000 animals (Reeves et al. 2002). Humpback whales from the Cape Verde/Northwest Africa DPS potentially occurring in the Action Area would be limited to individuals within or around summer feeding grounds off Norway and Iceland where they may encounter Project vessels originating from ports in Europe. However, given this DPS is primarily present in European waters during the summer, interactions with Project vessels in Europe would be limited to the whales migrating to and from feeding/breeding grounds in the summer and only a minimal number of transits would be expected to occur throughout the life of the Project originating in European ports (Section 3.1.1.6). Additionally, all Project vessels will maintain a 328-foot (100-meter) separation distance from large whales and vessel operators will maintain vigilant watch for marine mammals and will slow down or stop the vessel to avoid striking protected species (Table 3-20) to further reduce the likelihood of a vessel strike occurring or resulting in a serious injury or mortality such that it is extremely unlikely to occur. Based on the unexpected co-occurrence of this DPS and Project vessels in the Action Area and the mitigation measures to avoid vessel strikes, any effects to the Cape Verde/Northwest African DPS of humpback whales are extremely unlikely to occur and are **discountable**. BOEM therefore concludes that the Proposed Action is **not likely to adversely affect** the Cape Verde/Northwest Africa humpback whale DPS.

4.2.1.3 Rice's Whale (Endangered)

The Rice's whale has been consistently located in the northeastern Gulf of Mexico, where it is the only resident baleen whale. In 2021, scientists determined the Rice's whale was a unique species, genetically and morphologically distinct from the Bryde's whale (*Balaenoptera brydei*) (NMFS 2021). In response, NMFS revised the common and scientific names of the ESA-listed entity originally designated for the Gulf of Mexico Bryde's whale in 2019 to Rice's whale and classification to species to reflect the new scientifically accepted taxonomy and nomenclature of the species (Hayes et al. 2023). The most recent abundance estimate from 2017 and 2018 surveys in the northeastern Gulf of Mexico is approximately 51 individual Rice's whales (Hayes et al. 2023). Rice's whales in U.S. waters of the Gulf of Mexico are primarily located in the northeastern Gulf of Mexico along the OCS in water depths between 328 and 1,312 feet (100 and 400 meter). A single Rice's whale was observed in the western Gulf of Mexico off the coast of Texas, suggesting their distribution may occasionally include waters elsewhere in the Gulf of Mexico. The Rice's whale is one of the few types of baleen whales to prefer warmer, tropical waters and that does not make long-distance migrations. They remain in the Gulf of Mexico year-round. Given their limited distribution, the only overlap with the Action Area would be with potential Project vessel transits that occur from ports in the Gulf of Mexico to the Project area. However, as discussed in Section 3.1.1.6, a minimal number of transits (i.e., one transit during year two of construction) would be expected to occur throughout the life of the Project from vessels originating in the Gulf of Mexico. Additionally, all Project vessels will maintain a 328-foot (100-meter) separation distance from large whales and vessel operators will maintain vigilant watch for marine mammals and will slow down or stop the vessel to avoid striking protected species (Table 3-20) and all Project vessels would adhere to any future vessel strike avoidance guidelines for Rice's whale conservation that may be introduced to further reduce the likelihood of a vessel strike occurring or resulting in a serious injury or mortality. Based on the unexpected co-occurrence of Rice's whales and Project vessels in the Action Area and the mitigation measures to avoid vessel strikes, any effects to Rice's whales are extremely unlikely to occur and are **discountable**. BOEM therefore concludes that the Proposed Action is **not likely to adversely affect** the Rice's whale.

4.2.2 Sea Turtles

4.2.2.1 Hawksbill Sea Turtle (Endangered)

The hawksbill sea turtle is listed as endangered throughout its range (USFWS 1970). Though hawksbill sea turtles have been documented in OCS waters of the northwest Atlantic Ocean, they typically prefer tropical habitats and are exceedingly rare north of Florida (Lee and Palmer 1981; Keinath et al. 1991; Parker 1995; Plotkin 1995; USFWS 2001; GARFO 2022). Only two confirmed detections of hawksbill sea turtles were made during aerial surveys off the coasts of Maryland, Delaware, and Virginia between 2012 and 2014 (Williams et al. 2015). Hawksbill sea turtle occurrence in the Project area is therefore considered rare.

Hawksbill sea turtles regularly occur in the Gulf of Mexico and could occur in the portion of the Action Area associated with vessel transits to and from this region. This species of sea turtle has been recorded in waters of all Gulf Coast states and is regularly observed in the Florida Keys (Lund 1985; NMFS and USFWS 1993; Meylan and Redlow 2006). Hawksbill sea turtles generally inhabit nearshore foraging grounds and are often associated with coral reefs (NMFS 2022b). However, as discussed previously, only a minimal number of transits would be expected to occur throughout the life of the Project from vessels originating in the Gulf of Mexico (Section 3.1.1.6), and all Project vessels will maintain a 328-foot (100-meter) separation distance from sea turtles and vessel operators will slow down or stop the vessel to avoid striking protected species (Table 3-20) to further reduce the likelihood of a vessel strike. Based on the unexpected co-occurrence of hawksbill sea turtles and Project vessels in the Action Area and the mitigation measures to avoid vessel strikes, any effects to hawksbill sea turtles are extremely unlikely to occur and are **discountable**. BOEM therefore concludes that the Proposed Action is **not likely to adversely affect** the hawksbill sea turtle.

4.2.3 Marine Fishes

4.2.3.1 Atlantic Salmon – Gulf of Maine DPS (Endangered)

The Gulf of Maine DPS of Atlantic salmon is the species' only DPS listed under the ESA that may occur within the Action Area. They were originally listed in December 2000 (65 *Federal Register* 69459), and the listing was updated in June 2009 to expand the range of the Gulf of Maine DPS listed under the ESA (74 *Federal Register* 29343). The geographic range of the Gulf of Maine DPS is the Dennys River watershed to the Androscoggin River (74 *Federal Register* 29343). Freshwater habitats in the Gulf of Maine provide spawning habitat and thermal refuge for adults; overwintering and rearing areas for eggs, fry, and parr; and migration corridors for smolts and adults (Bardonnet and Bagliniere 2000). Atlantic salmon in the Gulf of Maine are known to migrate long distances in the open ocean to feeding areas in the Davis Strait between Labrador and Greenland, approximately 2,485 miles (4,000 kilometers) from their natal rivers (Danie et al. 1984; Meister 1984). Approximately 90 percent of Atlantic salmon from the Gulf of Maine return after spending two winters at sea; usually less than 10 percent return after spending one winter at sea and approximately 1 percent of returning salmon are repeat spawners or have spent three winters at sea (Baum 1997). Atlantic salmon in the Action Area would only potentially be encountered during vessel transits from Brewer, Maine and Europe. However, as discussed in Section 3.1.1.6, a minimal number of transits would be expected to occur throughout the life of the Project from vessels originating in Maine and Europe. The likelihood of Project vessels encountering Atlantic salmon during transits is very low, there are currently no reported vessel strikes for this species. Furthermore, vessels would not transit within any freshwater habitats where spawning occurs. Based on the unexpected co-occurrence of Atlantic salmon and Project vessels in the Action Area, no strikes or disturbance are expected to occur and therefore any effects to Atlantic salmon are extremely unlikely to occur and are

discountable. BOEM therefore concludes that the Proposed Action is **not likely to adversely affect** the Gulf of Maine Atlantic salmon DPS.

4.2.3.2 Gulf Sturgeon (Threatened)

The Gulf sturgeon is a subspecies of the Atlantic sturgeon and can be found from the Mississippi River in Louisiana, east to the Suwannee River in Florida (USFWS and Gulf States Marine Fisheries Commission 1995). Gulf sturgeon were listed as threatened under the ESA (56 *Federal Register* 49653) after their regional populations were greatly reduced due primarily to overfishing, dam construction, and habitat degradation. Gulf sturgeon, an anadromous species, migrate into Gulf of Mexico brackish and saltwater areas during the fall and remain there, typically feeding, throughout the winter months (Florida Fish and Wildlife Conservation Commission 2023). In the spring, they migrate into freshwater rivers and remain there through the summer months; spawning occurs near the bottom of their natal rivers (Wakeford 2001; Florida Fish and Wildlife Conservation Commission 2023). Gulf sturgeon, like other sturgeon species, are benthic feeders that consume crabs, lancets, brachiopods, and marine worms in their brackish and saltwater habitats; they are reported to eat very little while in freshwater rivers (Florida Fish and Wildlife Conservation Commission 2023). The likelihood of Project vessels encountering Gulf sturgeon during transits is very low. Furthermore, vessel would not transit within any freshwater habitats where spawning occurs. Based on the unexpected co-occurrence of Gulf sturgeon and Project vessels in the Action Area, no strikes or disturbance are expected to occur and therefore any effects to Gulf sturgeon are extremely unlikely to occur and are **discountable**. BOEM therefore concludes that the Proposed Action is **not likely to adversely affect** the Gulf sturgeon.

4.2.3.3 Nassau Grouper (Threatened)

The Nassau grouper is a moderately large reef fish and a member of the sea bass family (Serranidae). Nassau grouper, listed as threatened under the ESA (81 *Federal Register* 42268), occur in southern coastal Florida, the Florida Keys, Bermuda, the Yucatan, and the Caribbean Sea (NMFS 2023c). The species still occupies its historical range but overutilization as a valued fishery resource has reduced the number of individuals, which in turn has reduced the number and size of spawning aggregations (81 *Federal Register* 42268). Nassau grouper are generally found near hard-bottom reef habitats from inshore to a maximum depth of approximately 330 feet (100 meters). There is no evidence of distinct subpopulations of Nassau grouper based on genetic analysis; the species is therefore considered a single connected population within its existing range. The likelihood of project vessels encountering Nassau grouper during transits is very low, and based on the unexpected co-occurrence of Nassau grouper and Project vessels in the Action Area, no strikes or disturbance are expected to occur and therefore, any effects to Nassau grouper are extremely unlikely to occur and are **discountable**. BOEM therefore concludes that the Proposed Action is **not likely to adversely affect** the Nassau grouper.

4.2.3.4 Smalltooth Sawfish (Endangered)

Smalltooth sawfish—belonging to a group of fish called elasmobranchs that includes rays, skates, and sharks—live in tropical seas and estuaries of the Atlantic Ocean. The smalltooth sawfish was the first marine fish to receive federal protection when the U.S. DPS was listed as endangered under the ESA in 2003 (74 *Federal Register* 45353). Smalltooth sawfish were a prominent component of the marine fish community in the southeastern U.S., with a historical range in the Gulf of Mexico from Texas to Florida and along the Atlantic coast from Florida to North Carolina (NMFS 2023d). Smalltooth sawfish populations declined significantly during the latter part of the 20th century due to habitat loss associated with coastal development and accidental capture from fishery activities (NMFS 2023d). Their distribution has decreased greatly in U.S. waters over the past century. Since the 1990s, the species distribution in the U.S. has been generally restricted to coastal Florida, mainly from Charlotte Harbor to Florida Bay (NMFS 2023d). Smalltooth sawfish use a variety of coastal habitats depending on life stage, with utilization of estuaries and shallow portions of bays, lagoons, and rivers as juveniles and deeper coastal habitats as adults. The likelihood of project vessels encountering smalltooth sawfish during transits is very low, and based on the unexpected co-occurrence of smalltooth sawfish and Project vessels in the Action Area, no strikes or disturbance are expected to occur and therefore, any effects to smalltooth sawfish are extremely unlikely to occur and are **discountable**. BOEM therefore concludes that the Proposed Action is **not likely to adversely affect** the smalltooth sawfish.

4.2.3.5 Oceanic Whitetip Shark (Threatened)

The oceanic whitetip shark, listed as threatened in 2018 (83 *Federal Register* 4153), can be found globally in tropical and warm-temperate waters. The species is typically found in water temperatures between 59°F and 82°F (15°C and 28°C), though is most common in waters warmer than 68°F (20°C) (Bonfil et al. 2008; Carlson and Gulak 2012; Tolotti et al. 2015; NMFS 2023e). It is a pelagic species with a preference for open ocean waters but can also be found on the OCS or around oceanic islands in waters deeper than 604 feet (184 meters) (NMFS 2023e). Oceanic whitetip sharks typically are found in open ocean waters between 10° N and 10° S, but can be found in decreasing numbers out to latitudes of 30° N and 30° S, with abundance decreasing with greater proximity to continental shelves. In the Western Atlantic Ocean, oceanic whitetip sharks occur from Maine to Argentina, including the Caribbean and Gulf of Mexico. In the Northwest Atlantic Ocean, they are most commonly observed south of Virginia, though records of occurrence include the Mid-Atlantic and northeast U.S. (Kohler et al. 1998; Young and Carlson 2020; Vaudo et al. 2022). The overall range of the species in the North Atlantic Ocean expands northward during the summer and fall in response to seasonally warmer temperatures and increased prey availability (Vaudo et al. 2022). Oceanic whitetip sharks may be encountered in the Action Area; however, occurrences would be rare given their preference for warm open ocean waters. Thus, BOEM concludes that any effects are extremely unlikely to occur; therefore all effects are **discountable** and the Proposed Action is **not likely to adversely affect** the oceanic whitetip shark.

4.2.3.6 Scalloped Hammerhead Shark (Endangered, Threatened)

Scalloped hammerhead sharks are moderately large sharks with a global distribution. Individuals from the Eastern Atlantic DPS (endangered; foreign), which occur in the Eastern Atlantic and Mediterranean Sea, and the Central and Southwest Atlantic DPS (threatened), which typically range as far north as central Florida (79 *Federal Register* 38213), may occur in the Action Area but are not expected within the Project area. While scalloped hammerhead sharks have been found as far north as New Jersey, they are rarely found in waters cooler than 72°F (22°C) (Miller et al. 2014). They are apex opportunistic predators that feed on mackerel, herring, sardines, cephalopods, rays, and smaller sharks (National Marine Sanctuary Foundation 2018). The primary factors responsible for the decline of the ESA-listed scalloped hammerhead shark DPSs are overutilization, due to catch and bycatch of these sharks in fisheries, and inadequate regulatory mechanisms for protecting these sharks, with illegal fishing identified as a significant problem (79 *Federal Register* 38213). ESA-listed scalloped hammerhead sharks in the Action Area would only be encountered by a limited number of Project vessels transiting from ports in Europe or the Gulf of Mexico. Thus, BOEM concludes that any effects are extremely unlikely to occur; therefore all effects are **discountable** and the Proposed Action is **not likely to adversely affect** the scalloped hammerhead shark.

4.2.4 Corals

There are seven species of Caribbean hard corals listed as threatened under the ESA (79 *Federal Register* 53851) that occur within the Action Area: boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, and staghorn coral. All the ESA-listed corals within the Action Area occur in continental U.S. waters offshore coastal Florida; none occur within the Project area. Within U.S. continental waters, elkhorn coral, staghorn coral, pillar coral, and rough cactus coral are exclusive to offshore coastal Florida. Boulder star coral, mountainous star coral, and lobed star coral occur offshore coastal Florida and within the Flower Garden Banks in the northwest Gulf of Mexico (NMFS 2022c). Like most corals, the threatened Caribbean corals require hard-bottom substrates, including dead coral skeletons, for larval settlement and subsequent colony development. These hermatypic zooxanthellid coral ecosystems exist in a narrow band of environmental conditions that facilitate coral growth through calcium carbonate deposition. High-growth conditions for reef-building corals include clear, warm waters with abundant light and low levels of nutrients, sediments, and fresh water (NMFS 2022c). The current range and relatively isolated habitat utilization of these species of threatened hard corals preclude interactions with any Action Area activities. Based on the unexpected co-occurrence of ESA-listed corals and any of the activities included under the Proposed Action in the Action Area, **no effects** are expected for ESA-listed corals from the Proposed Action.

4.3 Critical Habitat Considered but Excluded from Further Analysis

BOEM has determined that designated the Proposed Action would have no effect on critical habitat for the Gulf sturgeon and smalltooth sawfish as there is no overlap with the Project area for either critical habitat, and the only Project activity likely to occur in these critical habitats are vessel transits which would not use any anchors or other gear that would disturb or alter the essential features of these habitats (discussed further in Section 4.3.4). The potential effects from the Proposed Action on the designated critical habitat for North Atlantic right whale (*Eubalaena glacialis*), loggerhead sea turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS, and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) – all DPSs were determined to be discountable as the only Project activities which will overlap with these areas are vessel transits which are extremely unlikely to have any adverse effects on the essential features of these habitats (discussed further in Sections 4.3.1, 4.3.2, and 4.3.3).

4.3.1 North Atlantic Right Whale Critical Habitat

In 1994, NMFS designated critical habitat for the Northern right whale population in the North Atlantic Ocean (59 *Federal Register* 28805). This critical habitat designation included portions of Cape Cod Bay, Stellwagen Bank, the Great South Channel, 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 northern right whales.

In 2016, NMFS revised designated critical habitat for the North Atlantic right whale (NARW) with two new expanded areas. The areas designated as critical habitat contain approximately 29,763 square nautical miles (102,084 square kilometers) of marine habitat in the Gulf of Maine and Georges Bank region (Unit 1) (Figure 4-1) and off the southeastern U.S. coast (Unit 2) (Figure 4-2).

The physical and biological features (PBFs) essential to conservation of NARWs that provide foraging area functions in Unit 1 are: (1) the physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that distribute and aggregate the copepod *Calanus finmarchicus* for NARW foraging, namely prevailing currents and circulation patterns, bathymetric features (e.g., basins, banks, channels), oceanic fronts, density gradients, and temperature regimes; (2) low flow velocities in the Jordan, Wilkinson, and Georges basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer, thus retaining the copepods in the basins; (3) late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region; and (4) diapausing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region.

The PBFs essential to conservation of NARWs that 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 between 45°F and 63°F (7°C and 17°C); and (3) water depths of 19.7 to 91.9 feet (6 to 28 meters) where the first two PBFs simultaneously co-occur over contiguous areas of at least 231 square nautical miles

(792 square kilometers) of ocean waters from November through April. When these features are available, they are selected by NARW cows and calves in dynamic combinations that are suitable for calving nursing and rearing; combinations vary, within the ranges specified, depending on factors such as weather and age of the calves (81 *Federal Register* 4838).

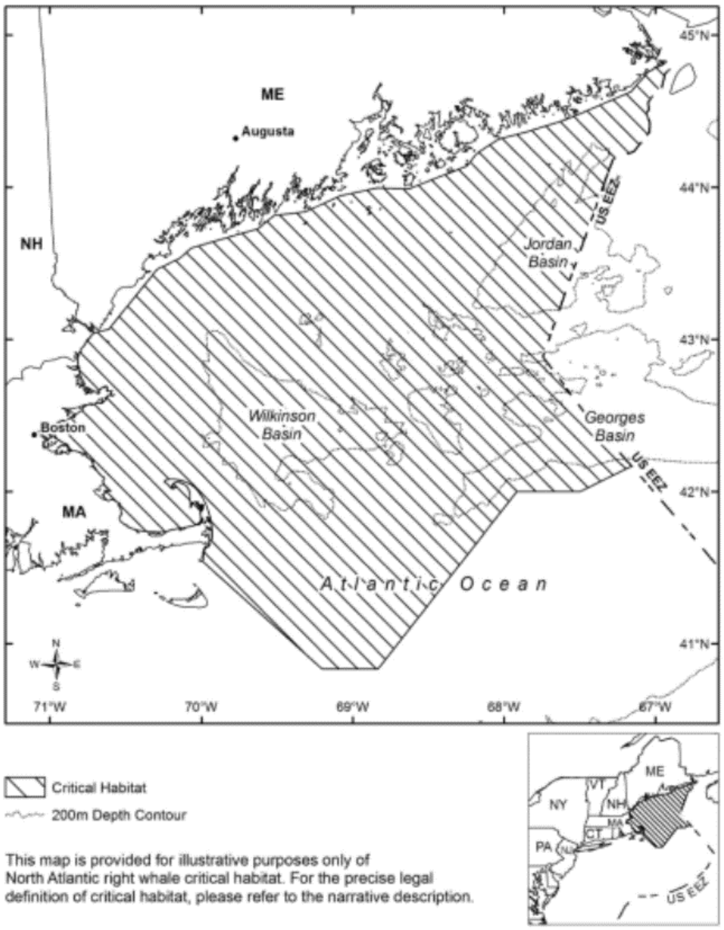

Figure 4-1. Map identifying designated critical habitat in the northeastern foraging area, Unit 1, for the NARW

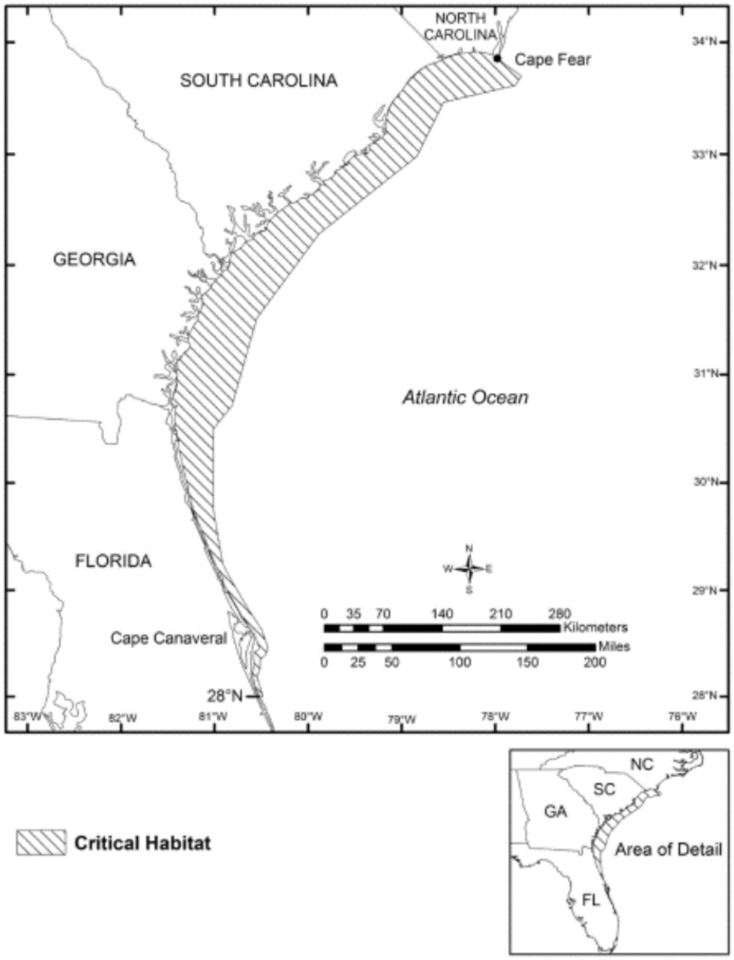

Figure 4-2. Map identifying designated critical habitat in the southeastern calving area, Unit 2, for the NARW

Units 1 and 2 are outside of the Project area, but do overlap with the broader Action Area. Utilization of the port in Brewer, Maine would require vessel transits through Unit 1 of NARW critical habitat. However, only four vessel trips originating in Maine are expected under the Proposed Action over the three-year construction schedule. No ports have been identified adjacent to Unit 2 and no vessel transits through Unit 2 are anticipated. Vessels originating from the Gulf of Mexico or European ports are expected to take direct oceanic routes and use established shipping lanes, which would not intersect with any portion of NARW critical habitat.

Vessel transits through Unit 1 as a result of the Proposed Action would not affect or modify the biological or physical oceanographic conditions associated with foraging area functions (i.e., the distribution and aggregations of *C. finmarchicus*). Additionally, all aforementioned monitoring and vessel strike avoidance measures would continue to be implemented. As a precaution, and required by federal regulations, all vessels must maintain 1,640 ft (500 m) or greater from any sighted NARW (Section 3.3). Compliance with this measure aids in ensuring that the ability of whales to select an area with the co-occurrence of these essential features is not adversely affected. It is not anticipated that any proposed Project-related vessel transits or Project activities would disrupt NARW feeding behaviors or foraging resources to any appreciable or measurable level given the low frequency of these transits over the total activity period under the Proposed Action.

In addition, vessel noise can also affect the existing acoustic soundscape which would encompass Unit 1 of the NARW critical habitat. However, NARWs forage using skim feeding techniques rather than relying on acoustic cues to detect prey like odontocetes (Section 5.1.1.2). Additionally, NARW vocal behaviors appear to be inversely correlated with foraging behaviors (Matthews and Parks 2021). Therefore, any acoustic masking resulting from Project-related noise would not be expected to limit any NARW ability to find prey or successfully forage within their critical habitat.

Minimal data are available for zooplankton responses to anthropogenic sound. A 2022 study (Guihen et al. 2022) found an avoidance of Antarctic krill species to the presence of an autonomous glider carrying a single beam echosounder. However, these disturbances had small ranges (i.e., the observed avoidance response extended approximately 66 to 131 feet [20 to 40 meters] as the glider passed) and may be the result of several factors not limited to acoustic avoidance, including visual cues, wake and bow wave turbulence, and simulated bioluminescence (Guihen et al. 2022). Given this, any disturbances resulting from Project activities on the essential features and foraging resources within Unit 1 of the NARW critical habitat would be limited and temporary and are not likely to result in biologically significant effects.

The presence of a small number of vessels transiting through Unit 1 of NARW critical habitat is extremely unlikely to disturb or alter any essential PBFs within designated critical habitat. Therefore, BOEM concludes that any adverse effects from the Proposed Action would be **discountable,** and the Proposed Action is not likely to adversely affect NARW critical habitat.

4.3.2 Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS Critical Habitat

NMFS and the USFWS designated critical habitat for the threatened Northwest Atlantic Ocean DPS of loggerhead sea turtle on July 18, 2013, followed by the Final Rule on July 10, 2014 (79 *Federal Register* 39855). The designation includes 38 marine areas within portions of the northwest Atlantic Ocean and the Gulf of Mexico (Figure 4-3). Each area consists of one or more of the following habitat types: nearshore reproductive habitat (directly off high-density nesting beaches out to 1 mile [1.6 kilometers]), wintering habitat, breeding habitat, constricted migratory corridors, and *Sargassum* habitat. These habitat types support key life history phases of the loggerhead sea turtle and are essential to species conservation. Loggerhead sea turtle critical habitat is defined by (1) PBFs of the habitat that are vital for species conservation, and (2) the primary constituent elements (also referred to as “essential features”) that support the PBFs (Table 4-2).

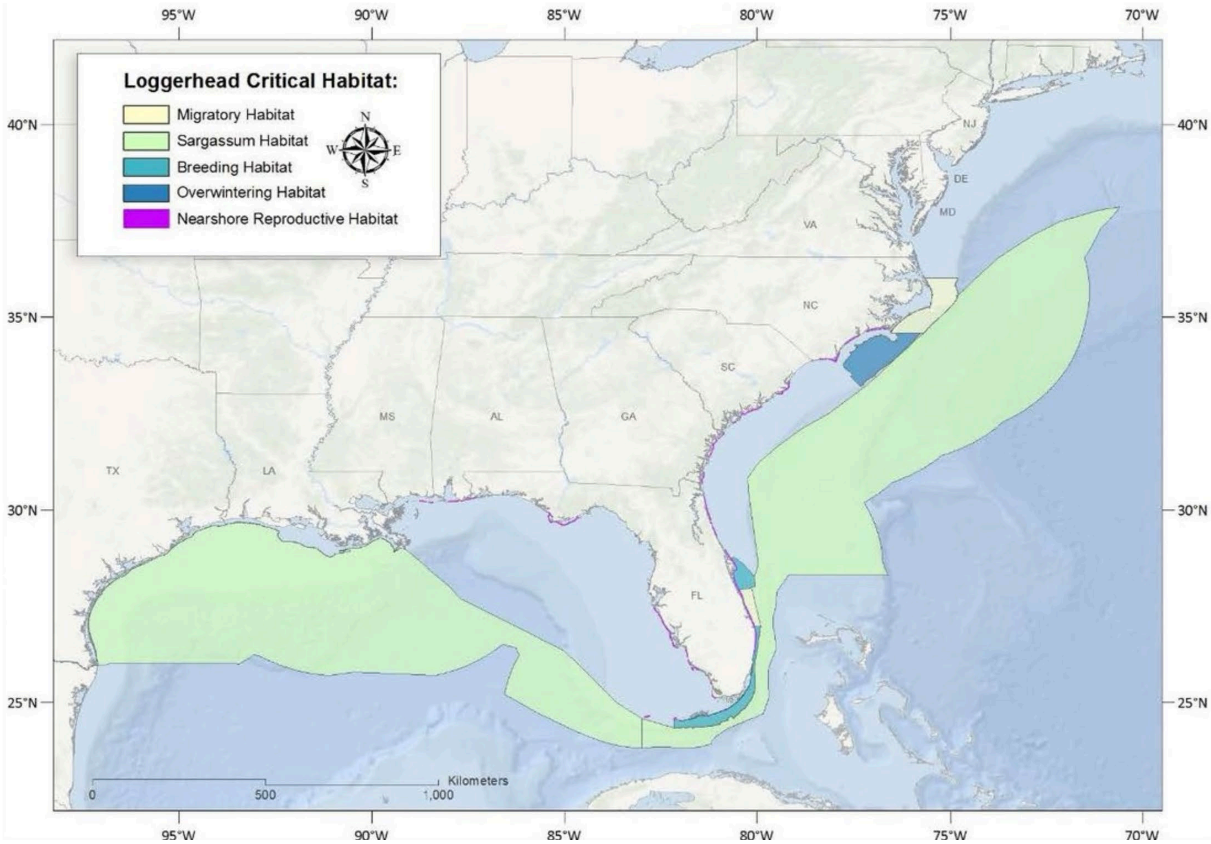

Figure 4-3. Map identifying designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtle

Table 4-2. Summary of essential features for the Northeast Atlantic Ocean DPS of loggerhead sea turtle critical habitat

Nearshore Reproductive Habitat (1) Nearshore waters directly off the highest-density nesting beaches and adjacent beaches, as identified in 50 CFR 17.95(c) to 1 mile (1.6 kilometers) offshore; (2) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone out toward open water; and (3) Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, or create excessive longshore currents.
Foraging Habitat (1) Sufficient prey availability and quality, such as benthic invertebrates, including crabs (spider, rock, lady, hermit, blue, horseshoe), mollusks, echinoderms, and sea pens; and (2) Water temperatures to support loggerhead sea turtle inhabitance, generally above 50°F (10°C).
Winter Habitat (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 66 and 328 feet (20 and 100 meters).
Breeding Habitat (1) High densities of reproductive male and female loggerhead sea turtles; (2) Proximity to primary Florida migratory corridor; and (3) Proximity to Florida nesting grounds.
Migratory Habitat (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 foraging areas.
***Sargassum* Habitat** (1) Convergence zones, surface-water downwelling areas, the margins of major boundary currents (i.e., the Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for optimal growth of *Sargassum* and inhabitance of loggerhead sea turtles; (2) *Sargassum* in concentrations that support adequate prey abundance and cover; (3) Available prey and other material associated with *Sargassum* habitat, including plants, 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 loggerhead sea turtles (i.e., less than 33 feet [10 meters] deep).

While there is no overlap with the Project area, loggerhead sea turtle critical habitat overlaps with potential vessel transit routes from the Gulf of Mexico and, thus, the Action Area. Though exact ports in the Gulf of Mexico that may be used are currently unknown, a minimal number of transits would be expected to occur throughout the life of the Project (Section 3.1). Additionally, no anchoring or other activities that could disturb the seafloor are likely to occur in the Gulf of Mexico or anywhere along transit routes. All vessels operating in U.S. EEZ waters will have trained lookouts on board to monitor for sea turtle strike prevention and to avoid transiting through areas of visible jellyfish aggregations or floating *Sargassum* lines or mats, which will further ensure no adverse effects on the ability of sea turtles to select an area with the co-occurrence of essential PBFs. The presence of a small number of vessels transiting through loggerhead sea turtle critical habitat is extremely unlikely to disturb or alter any essential PBFs within designated critical habitat. Therefore, BOEM concludes that any adverse effects from the Proposed Action would be **discountable,** and the Proposed Action is not likely to adversely affect loggerhead sea turtle critical habitat.

4.3.3 Atlantic Sturgeon Critical Habitat – New York Bight DPS Critical Habitat and Chesapeake Bay DPS Critical Habitat

Five separate DPSs of Atlantic sturgeon were listed under the ESA in 2012 (77 *Federal Register* 5880; 77 *Federal Register* 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 in 2017 (82 *Federal Register* 39160). Included in this rule are 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 conservation of Atlantic sturgeon could not be identified.

The critical habitat designation (82 *Federal Register* 39160) for all DPSs is for habitats that support successful Atlantic sturgeon reproduction and recruitment. The physical features essential for Atlantic sturgeon reproduction and recruitment (NMFS 2017) include: (1) hard-bottom substrate (e.g., rock, cobble, gravel, limestone, boulder) in low-salinity waters (0.0 to 0.5 parts per thousand [ppt]) 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 ppt up to 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 free of physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, 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; and (4) water quality conditions between the river mouth and spawning sites, especially in the bottom 3 feet (1 meter) of the water column, with temperature, salinity, and oxygen values that support spawning; annual and interannual adult, subadult, larval, and juvenile survival; and larval, juvenile, and subadult growth, development, and recruitment (e.g., 55°F to 79°F [13°C to 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).

Critical habitat designations for the Atlantic sturgeon Gulf of Maine DPS encompasses five rivers in Maine, New Hampshire, and Massachusetts. The New York Bight Atlantic sturgeon DPS critical habitat includes four rivers: the Connecticut, Housatonic, Hudson, and Delaware rivers. The Chesapeake Bay DPS critical habitat includes six rivers: the Nanticoke, Marshyhope Creek, Potomac, Rappahonnock, York/Mattaponi/Pamunkey, and James rivers. The Carolina DPS critical habitat includes nine rivers in North and South Carolina. The South Atlantic DPS critical habitat includes seven rivers in South Carolina, Georgia, and Florida (Figure 4-4).

Project vessel transits throughout the Action Area do not include any rivers identified for the Carolina, or South Atlantic DPS critical habitats. Vessels from the Gulf of Mexico or Europe would only transit offshore waters in these areas. Vessel ports in Delaware Bay are in the vicinity of the New York Bight DPS Delaware River designated critical habitat. Utilization of the port in Brewer, Maine would require vessel transits through a portion of the Penobscot River critical habitat. However, only four vessel trips originating in Brewer, Maine are expected under the Proposed Action over the three-year construction schedule. Vessels transiting between the Lease Area and the proposed staging facility in Baltimore (Sparrows Point), Maryland may utilize routes through Chesapeake Bay or Delaware Bay via the C & D Canal; vessels are anticipated to travel to the Lease Area using the Chesapeake Bay route and return to port using the C & D Canal route (Figure 3-8). Vessels that utilize the C & D canal route will enter the Atlantic sturgeon New York Bight DPS Delaware River (Unit 4) critical habitat area (Figure 4-5); each transit would cover 10.25 miles (16.50 kilometers) of critical habitat where the Delaware River meets Delaware Bay. Project activities are not expected to disturb or alter any essential PBFs within this critical habitat as vessels present in this area would only be transiting and would therefore not be expected to do any anchoring or other activities that would adversely affect this habitat.

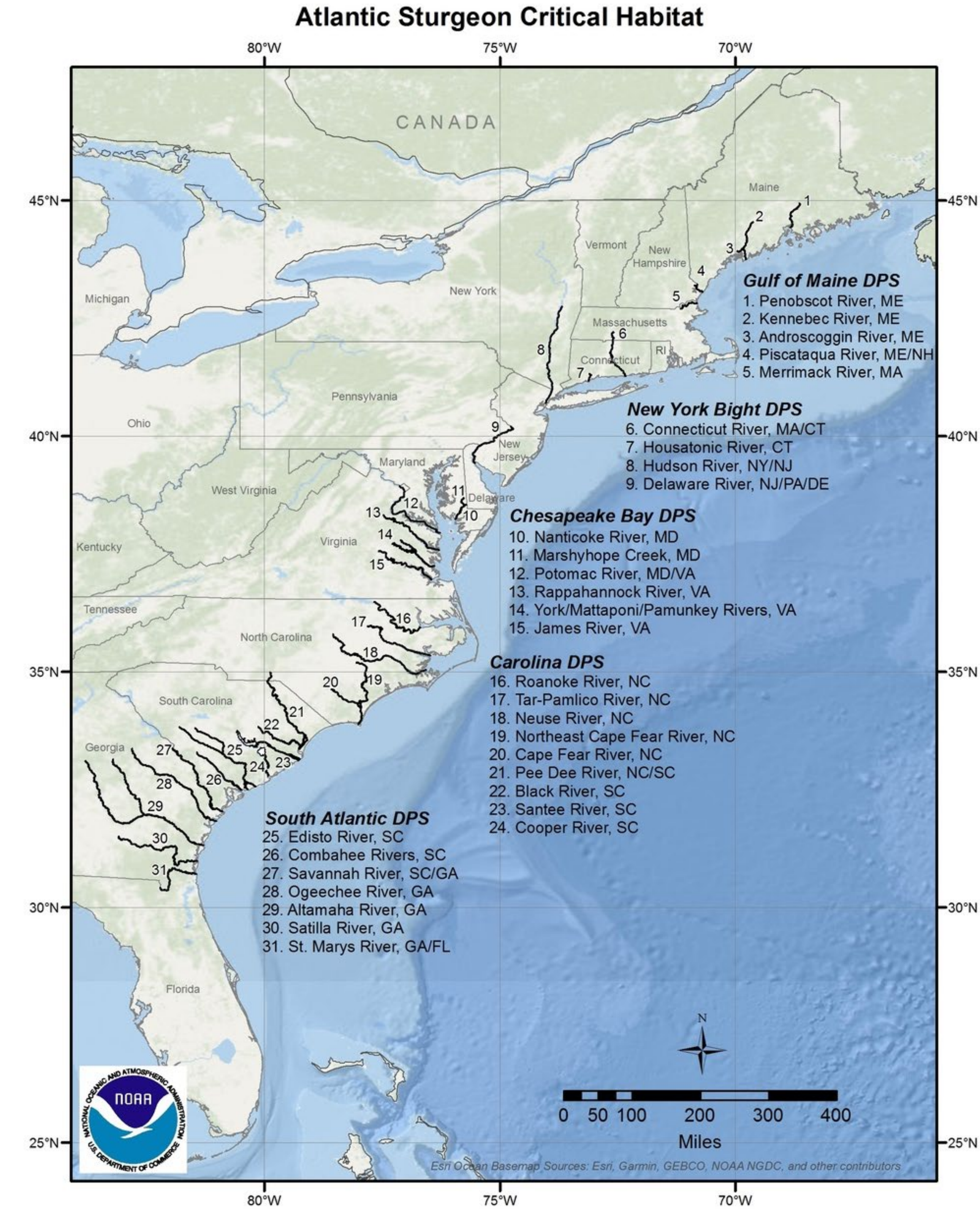

Figure 4-4. Map identifying designated critical habitat for the Atlantic sturgeon

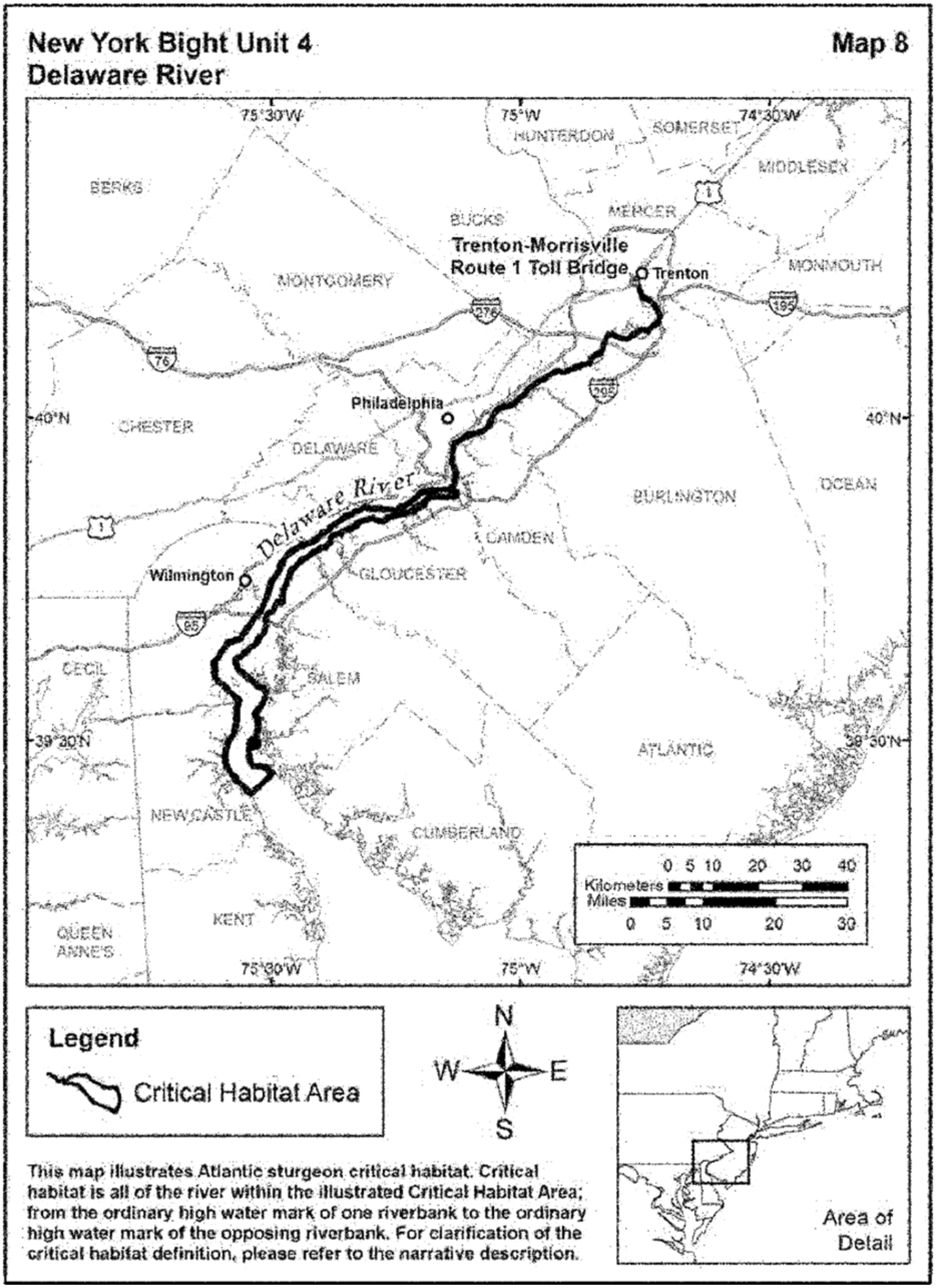

Figure 4-5. Atlantic sturgeon New York Bight DPS Delaware River critical habitat
Source: 82 *Federal Register* 39160

Vessel ports in Chesapeake Bay are in the vicinity of the Chesapeake Bay DPS rivers designated as critical habitat. However, vessel transits are not expected to enter or transit within these rivers; any ports used in this area would be outside the critical habitat boundaries. Additionally, no construction, O&M, or decommissioning activities would occur within or adjacent to any rivers with designated Atlantic sturgeon critical habitat, and no anchoring would occur in critical habitat. Therefore, vessel activities are extremely unlikely to adversely affect any essential PBFs in any designated Atlantic sturgeon critical habitat. BOEM concludes that any adverse effects from the Proposed Action would be **discountable,** and the Proposed Action is not likely to adversely affect Atlantic sturgeon critical habitat.

4.3.4 Critical Habitat in the Gulf of Mexico

Critical habitat within the U.S. Gulf of Mexico includes: (1) Gulf sturgeon critical habitat (68 *Federal Register* 13370) which comprises 14 geographic areas, including freshwater rivers and tributaries and nearshore marine and estuarine habitats between the mouth of the Mississippi River and the Suwannee River in Florida; (2) smalltooth sawfish critical habitat designated in two coastal areas of South Florida: the Charlotte Harbor Estuary and the Ten Thousand Islands/Everglades (74 *Federal Register* 45353); and (3) breeding, overwintering, nearshore reproductive, and *Sargassum* habitat for the northwest Atlantic Ocean DPS of loggerhead sea turtles (79 *Federal Register* 9855). Loggerhead sea turtle critical habitat is discussed in Section 4.3.2 and not further considered in this section. The only potential Project activities that would occur in the Gulf of Mexico would be vessel transits. Though exact ports that may be used are currently unknown, Project vessels in the Gulf of Mexico would be limited to small support vessels and a minimal number of transits would be expected to occur throughout the life of the Project. Additionally, no anchoring or other activities that could disturb the seafloor are likely to occur in the Gulf of Mexico, and no activities would occur that would disturb any essential PBFs within the designated critical habitats. Therefore, it was determined that the Proposed Action will have **no effect** on Gulf sturgeon and smalltooth sawfish critical habitat in the Gulf of Mexico.

5 Description of Species Considered for Further Analysis

5.1 ESA-listed Species Likely to be Adversely Affected (Species Considered for Further Analysis)

BOEM has determined that the following species are likely to be adversely affected by the Proposed Action and thus require further analysis: fin whale (*Balaenoptera physalus*); NARW; sei whale (*Balaenoptera borealis*); sperm whale (*Physeter macrocephalus*); green sea turtle – North Atlantic DPS; Kemp's ridley sea turtle (*Lepidochelys kempii*); leatherback sea turtle (*Dermochelys coriacea*); loggerhead sea turtle – Northwest Atlantic Ocean DPS; Atlantic sturgeon – all DPSs; and giant manta ray (*Manta birostris*). The following subsections discuss the habitat, foraging preferences, acoustic behavior, status, and occurrence of each ESA-listed species considered for further analysis.

5.1.1 Marine Mammals

5.1.1.1 Fin Whale (Endangered)

Fin whales are a globally distributed baleen whale species found in temperate to polar regions in all ocean basins (Edwards et al. 2015). The western North Atlantic population is concentrated in the U.S. and Canadian Atlantic EEZs from Cape Hatteras to Nova Scotia (Hayes et al. 2020) and is 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 percent of all sightings in aerial surveys conducted from 1978 to 1982 (CETAP 1982; Hayes et al. 2018) and the majority of large whale sightings in recent aerial and shipboard surveys (Kraus et al. 2016a; Northeast Fisheries Science Center [NEFSC] and Southeast Fisheries Science Center [SEFSC] 2018). They have been observed in every season throughout most of their range, though densities vary seasonally (Edwards et al. 2015). 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 the second largest cetacean, with adults in the North Atlantic reaching lengths up to 78.7 feet (24 meters). 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). Individuals return annually to established feeding areas and fast 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 the distribution and movements of fin whales along the U.S. East Coast are influenced by the availability of sand lance (Kenney and Winn 1986; Payne et al. 1990). Waters off New England and within the Gulf of St. Lawrence represent the main feeding grounds for fin whales, and some level of site fidelity among females and their feeding grounds likely exists (Clapham and Seipt 1991; Agler et al. 1993; Schleimer et al. 2019). While fin whales likely migrate into Canadian waters, deep offshore areas, or tropical latitudes, distinct, population-wide annual migrations are unlikely (Hayes et al. 2022). Data suggest calving may occur from October through January in the Mid-Atlantic region (Hain et al. 1992), though calving, mating, and wintering patterns for the majority of the population remain unknown. The fin whale's ecological role and influence on ecosystem processes surpasses that of all other cetacean species in the Western North Atlantic due to their large population size and prey requirements (Hain et al. 1992; Kenney et al. 1997). A biologically important area (BIA) for feeding has been delineated for the area east of Montauk Point, New York, to the west boundary of the Rhode Island/Massachusetts Lease

Areas between the 49- and 164-ft (15- and 50-m) depth contour from March to October (LaBrecque et al. 2015).

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 hertz to 35 kilohertz (NMFS 2018). The predicted best hearing sensitivity of fin whales is believed to range from 20 hertz to 20 kilohertz (Erbe 2002; Southall et al. 2019).

5.1.1.1.1 Current Status

Fin whales have been listed as endangered under the ESA since the act's passage in 1973 (35 *Federal Register* 8491), and critical habitat has not been designated. The best available abundance estimate for the Western North Atlantic DPS is 6,802 individuals, with a minimum population estimate of 5,573 individuals based on shipboard and aerial surveys conducted in 2016 and the 2016 NEFSC and Fisheries and Oceans Canada surveys (Hayes et al. 2022). 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. 2022). The best available information indicates the gross annual reproduction rate is 8 percent, with a mean calving interval of 2.7 years (Hayes et al. 2022). From 2015 through 2019, the minimum annual rate of human-caused (i.e., vessel strike and entanglement in fishery gear) mortality and serious injury was 1.85 per year (Hayes et al. 2022).

5.1.1.1.2 Potential Occurrence Within the Action Area

Fin whales are one of the most commonly sighted large whales in OCS waters from the Mid-Atlantic coast of the U.S. to Nova Scotia, principally from Cape Hatteras, North Carolina, northward (Sergeant 1976; Sutcliffe and Brodie 1977; CETAP 1982, Hain et al. 1992; NMFS 2019). Fin whales are distributed throughout the continental shelf in the Mid-Atlantic region, but data indicate highest densities near the shelf break offshore the Maryland and Delaware WEAs (Barco et al. 2015; BOEM 2012; CETAP 1982; Palka et al. 2021; Roberts et al. 2022). Surveys conducted around the Delaware and Maryland WEAs show observations of fin whales in this region are highest during winter and spring, though low abundance year-round presence is likely (Palka et al. 2021). Acoustic analyses indicate heightened presence from November to March (Bailey et al. 2018), which is corroborated by 10 years of passive acoustic monitoring (PAM) data collected by Davis et al. (2020). Bailey et al. (2018) further reported that fin whales are the most frequently detected vocalizing cetacean species, with the majority of detections offshore of the Maryland WEA.

Habitat-based marine mammal density data indicate the highest densities in the vicinity of the Project area would most likely occur in January and the lowest in August (Roberts et al. 2022). Fin whales are also present throughout the North Atlantic (NMFS 2022d), including within the Action Area in the vicinity of vessel transit lanes from ports in Europe and Maine. The occurrence of fin whales in latitudes south of Cape Hatteras is much lower than in more northern waters, so their presence along vessel transit lanes from ports in the Gulf of Mexico is considered unlikely.

5.1.1.2 North Atlantic Right Whale (Endangered)

The North Atlantic right whale (NARW) (*Eubalaena glacialis)* 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 (63.5 metric tonnes) at maturity, with females being larger than males. The primary habitat for this species is coastal or OCS waters ranging from calving grounds off the southeastern U.S. to feeding grounds off the northeastern U.S. (NMFS 2023g). Important feeding habitats include coastal waters off southern New England, Gulf of Maine, Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence.

There are two critical habitat areas for NARWs in Canadian waters (Brown et al. 2009) and two in U.S. waters; all U.S. waters within the Gulf of Maine are designated as a foraging area critical habitat, while waters off the southeastern U.S. are designated as a calving area critical habitat (81 *Federal Register* 4837; NMFS 2023g). The Mid-Atlantic OCS between the two U.S. critical habitat areas has been identified as a principal migratory corridor and thus an important habitat for NARWs as they travel between breeding and feeding grounds (CETAP 1982; NMFS 2023g). This migratory pathway is considered a BIA for the species (LaBrecque et al. 2015). While some individuals undergo yearly migrations between northern feeding grounds in the summer and southern breeding grounds in the winter, the location of most individuals throughout much of the year is poorly understood. Year-round presence of NARW in all habitat areas has been recorded, including off the Mid-Atlantic coast (Davis et al. 2017; Bailey et al. 2018). In addition, long-range movements are apparent in some individuals who have been observed covering long distances over short time periods (NMFS 2023g).

Foraging habits of NARWs show a clear preference for the late juvenile developmental stage of the zooplanktonic copepod, *C. finmarchicus* (Mayo et al. 2001). This species occurs in dense patches and demonstrates diel and seasonal vertical migration patterns (Baumgartner et al. 2011). NARW distribution and movement patterns within their foraging grounds are highly correlated with prey concentration and distribution, which exhibit high variability within and between years (Pendleton et al. 2012). Due to the heightened energetic requirements of pregnant and nursing females, yearly reproductive success of the population is directly related to foraging success and the abundance of *C. finmarchicus* (Meyer-Gutbrod et al. 2015), which in turn is correlated with decadal variability in climate and ocean patterns (Greene and Pershing 2000).

Skim-feeding is an important activity identified in effects assessments because it demonstrates a critical behavior (feeding) that could be disrupted by external stressors. 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 percent 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). Similarly, NARWs spend extended periods of time at the water's surface actively socializing in what are known as surface active groups (SAGs). SAGs have been documented in all habitat regions and during all seasons, involve all age classes, and include mating behaviors, play, and the maintenance of social bonds (Parks et al. 2007). The extensive and biologically critical surface behaviors of NARWs (i.e., skim-feeding and SAGs) represent a vulnerable time for right whales as they are exposed to an increased risk for ship strike.

The diversity of zooplankton across the northeastern U.S. OCS is relatively high (more than 100 species), though seasonal and interannual trends in abundance differ among species (NEFSC n.d.; Johnson et al. 2014; Department of Fisheries and Oceans Canada 2017). Seasonal trends in overall zooplankton abundance have been detected over the shelf waters of southern New England, ranging from relatively low densities (0.73 to 1.4 cubic inches per 2.4 cubic mile) in January through February to relatively high densities (greater than 3.36 cubic inches per 2.4 cubic mile) during May through August (NEFSC n.d.). These trends are also present for *C. finmarchicus*, which is an important food source for many species, including NARWs. On average, *C. finmarchicus* is most abundant during spring and summer (March through August), with a peak density in May through June along the northeastern U.S. OCS (NEFSC n.d.). Average zooplankton densities have been remarkably consistent over the past 20 years, though interannual variability is present. Mean total density for *C. finmarchicus* along the northeastern U.S. OCS varied greatly from year to year, commonly halving or doubling from one year to the next

(NEFSC n.d.). Results from Runge et al. (2015) and Ji et al. (2017) specify that predicting fluctuations in abundance or circumstances for disappearance of *C. finmarchicus* in the northwestern Atlantic Ocean would require models that address the roles of local production and advection.

NARW distribution and pattern of habitat use has shifted spatially and temporally since 2010 (Davis et al. 2017). Meyer-Gutbrod and Greene (2018) recorded NARW sightings in several traditional feeding habitats beginning to decline in 2012, causing speculation that a shift in NARW habitat use was occurring (Pettis et al. 2022). An increased presence of NARWs in the Gulf of St. Lawrence beginning in 2015 further supports a shift in habitat use, potentially in response to shifting prey resources as a result of climate change (Crowe et al. 2021; Meyer-Gutbrod et al. 2015, 2021). Additionally, a recent increase in habitat use and year-round presence in the southern New England region, including Nantucket Shoals, indicates the area is an increasingly important NARW habitat (O'Brien et al. 2022). These data and literature collectively suggest that NARW habitat use, including changes in their distribution patterns linked to prey resources, is dynamic and likely related to climate change processes.

NARW and other baleen whales belong to the LFC marine mammal hearing group, which has a generalized hearing range of 7 hertz to 35 kilohertz (NMFS 2018). NARW vocalizations most frequently observed during PAM studies include upsweeps rising from 30 to 450 hertz, often referred to as "upcalls," and broadband (30 to 8,400 hertz) pulses, or "gunshots," with sound levels between 172 and 187 dB re 1 µPa m (Erbe et al. 2017). However, recent studies have shown that mother-calf pairs reduce the amplitude of their calls in calving grounds, possibly to avoid detection by predators (Parks et al. 2019). Modeling conducted using right whale ear morphology suggests the best hearing sensitivity for this species is between 16 hertz and 25 kilohertz (Ketten et al. 2014; Southall et al. 2019).

5.1.1.2.1 Current Status

NARWs in U.S. waters belong to the Western Atlantic population. The NARW is listed as endangered under the ESA and critically endangered by the International Union for Conservation of Nature (IUCN) Red List (Cooke 2020; NMFS 2023g). Right whales are considered one of the most critically endangered large whale species in the world (NMFS 2023g). The Western North Atlantic population size was estimated to be 338 individuals in the most recent draft 2022 stock assessment report (NMFS 2023g), which used a hierarchical, state-space Bayesian open population model of sighting histories from the photo-identification recapture database through November 2022. Between 2011 and 2020, overall population abundance declined 29.7 percent, further evidenced by the decreased abundance estimate from 451 individuals in 2018 to the current 2021 estimate of 338 individuals (NMFS 2023g). This decline in abundance follows a previously positive population trend from 1990 to 2011 of a 2.8 percent increase per year from an initial abundance estimate of 270 individuals in 1998 (NMFS 2023g). Over time, there have been periodic swings of per capita birth rates (NMFS 2023g), although current birth rates continue to remain below expectations (Pettis et al. 2022), with an approximately 40 percent decline in reproductive output for the species since 2010 (Kraus et al. 2016b). Eighteen new calves were sighted during the 2021 calving season (Pettis et al. 2022), an increase from 10 calves observed in 2020, and 12 new calves have been sighted so far for the 2023 calving season (NMFS 2023f). Although the increasing birth rate is a good sign, it is still significantly below what is expected, and the rate of mortality is still higher than what is sustainable (Pettis et al. 2022; NMFS 2023f). A reduction in adult female survival rates relative to male survival rates has caused a divergence between male and female abundance. In 1990, there were an estimated 1.15 males per female, and by 2015, estimates indicated 1.46 males per female (Pace et al. 2017).

Net productivity rates do not exist as the Western North Atlantic population lacks any definitive population trend (NMFS 2023g). The average annual human-related mortality/injury rate exceeds that of the calculated potential biological removal level of 0.7, and due to its listing as endangered under the ESA, this population is classified as strategic and depleted under the MMPA (NMFS 2023g). Estimated human-caused mortality and serious injury between 2016 and 2020 was 8.1 whales per year, of which

5.7 whales per year are attributed to fisheries interactions and the remainder 2.4 whales per year cause by vessel strike (NMFS 2023g). However, it is likely that not all mortalities are documented; it is estimated that only one-third of mortalities are actually recorded (NMFS 2023g). Modeling suggests the mortality rate from 2014 to 2018 may be up to 27.4 animals (Pace 2021; NMFS 2023g). There have been elevated numbers of mortalities reported since 2017, which prompted NMFS to designate an Unusual Mortality Event for NARWs (NMFS 2023g). These elevated mortalities have continued into 2023, totaling 36 mortalities, 34 serious injuries, and 51 sublethal injuries or illness (NMFS 2023g). Based on the mortalities for which the carcasses could be examined, preliminary analyses indicate all mortalities are likely human-caused, predominantly from- entanglement in fishing gear or vessel collisions (NMFS 2023g). Of the 36 mortalities, 12 have been identified as resulting from vessel strikes and 9 from entanglements (NMFS 2023g). Although many of the mortalities have occurred in Canadian waters, the U.S. population is not separated from those in Canada; therefore, the effects of mortality affect the population considered in the assessment process. While vessel strikes and entanglements in fishing gear represent the most significant threat to NARWs, other risks to the population include acoustic disturbance and masking, climate change, and climate-driven shifts in prey species (Hayes et al. 2023).

To mitigate the potential for vessel strikes, NMFS designated certain nearshore waters along the U.S. East Coast as Seasonal Management Areas (73 *Federal Register* 60173). These management areas are in effect seasonally and established such that all vessels longer than 65 feet (19.8 meters) must operate at speeds of 10 knots (5.1 m/s) or slower within these areas. The Mid-Atlantic Seasonal Management Areas include a 20-nautical mile (37-kilometer) radius of ports and bays along the NARW migratory route. Some Mid-Atlantic Seasonal Management Areas overlap with vessel transit routes identified under the Proposed Action. These include:

- Entrance to Delaware Bay: effective November 1 to April 30
- Entrance to Chesapeake Bay: effective November 1 to April 30

Amendments to this rule are proposed that would decrease the length of vessels required to comply to 35 feet (10.7 meters) and expand the geographic areas to regional sections rather than immediately surrounding ports and transit corridors (87 *Federal Register* 46921). The Project area would fall within the Atlantic Zone, which would be in effect from November 1 to May 30, if the amendments are adopted.

5.1.1.2.2 Potential Occurrence Within the Action Area

The offshore waters of Maryland and Delaware, including waters within the Project area, are used as a migration corridor for NARWs and are considered a BIA for migration (NOAA 2023). Long-term PAM results presented by Davis et al. (2017) indicate NARWs are present along the entire eastern seaboard of North America year-round. These data also indicate NARW distribution started to shift in 2010 from previously prevalent northern grounds, such as the Bay of Fundy and greater Gulf of Maine, to more time spent in mid-Atlantic regions year-round. Past visual surveys led to the assumption that most NARWs migrated between winter calving grounds in the south and summer feeding grounds in the north. The location of the remaining members of the population was not known. Davis et al. (2017) indicated NARWs are present nearly year-round across their entire habitat range, particularly north of Cape Hatteras, North Carolina, suggesting not all of the population undergoes the annual north-to-south migration. Non-migrating whales could be mobile individuals occupying a broader, more diffused geographic area through the year, but these potential cohort-specific behaviors require additional study (Davis et al. 2017).

Aerial and PAM surveys suggest NARWs are more common in the Mid-Atlantic region during winter and spring; however, recent analysis of detections from PAM indicate some year-round presence (Davis et al. 2017; Bailey et al. 2018). Barco et al. (2015) reported pulses of NARW sightings during winter months offshore the Maryland and Delaware WEAs, with some individuals observed with open mouths, potentially indicating feeding behaviors. The species has been detected acoustically in every month of the year in the vicinity of the Maryland WEA, though the highest presence occurred from November through April (Bailey et al. 2018). A higher acoustic occurrence was noted for the species after 2010 in the Mid-Atlantic region, likely due to broad-scale distribution shifts in prey species (Davis et al. 2017).

Based on these data, NARWs are most likely to occur offshore Maryland and Delaware during seasonal movements north or south between important feeding and breeding grounds (Knowlton et al. 2002; Firestone et al. 2008; NMFS 2023g). The highest relative abundance and density of NARWs are expected during January, February, and March, though year-round presence in the vicinity of the Project area is possible (Roberts et al. 2022). The species is less commonly observed in the region during July, August, and September when they are more likely to be in northern feeding grounds such as the Gulf of Maine, Bay of Fundy, and Gulf of St. Lawrence (Pendleton et al. 2012; Kraus et al. 2016a; Leiter et al. 2017; Crowe et al. 2021). Vessels transiting from Brewer, Maine may encounter NARWs. However, only four transits originating in Maine are expected throughout the entire three-year construction schedule and monitoring and mitigation measures (Section 3.3) would be in place during these transits to reduce the co-encounter risk between NARWs and Project vessels.

Vessels transiting to and from Europe may encounter NARWs within the Action Area. However, given the overall low density of NARWs in the North Atlantic and the low number of vessel transits from non-local ports, the likelihood of an encounter outside of U.S. EEZ waters is likely very low. Vessels transiting to and from the Gulf of Mexico may also encounter NARWs within the Action Area. The most likely region of encounter would be off the southeastern U.S. during the winter when NARWs are present in their calving grounds. However, vessels transiting from the Gulf of Mexico to the Project area are not anticipated to transit coastal, nearshore waters where the highest congregations of NARWs are most likely to occur. NARW presence elsewhere along European or Gulf of Mexico oceanic transits is expected to be diffuse given their small population size and habitat preferences; the species is unlikely to be encountered during these transits.

5.1.1.3 Sei Whale (Endangered)

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. 2022).

This species is highly mobile, and there is no indication that any population remains in a particular area year-round (NMFS 2011). Sei whale occurrence in any particular feeding ground is considered unpredictable or irregular (Schilling et al. 1992) but may be correlated to incursions of relatively warm waters related to broadscale oceanographic circulation patterns (Hayes et al. 2022). Olsen et al. (2009) also indicated that sei whales' movements appear to be associated with oceanic fronts, thermal boundaries, and specific bathymetric features. NMFS (2011) indicated climate change may affect sei whale habitat and food availability, as migration, feeding, and breeding locations may be affected by ocean currents and water temperature.

Sei whales usually travel alone or in small groups of two to five animals, occasionally in groups as large as 10 animals (Hayes et al. 2022). 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 *C. finmarchicus*, over all other zooplankton species (Christensen et al. 1992; NMFS 2011; Prieto et al. 2014). Data indicate that sei whales have 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). They also feed on small schooling fish and cephalopods, including squid. Sei whales prefer to feed at dawn and may exhibit unpredictable behavior while foraging and feeding on prey (NMFS 2023h). Their feeding behaviors include gulping, skimming, and lunging at the surface.

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 U.S. 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.

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

5.1.1.3.1 Current Status

Sei whales have been listed under the ESA as endangered at the species level since the passage of the act in 1973 (35 *Federal Register* 8491). Sei whales occurring in the U.S. Atlantic EEZ belong to the Nova Scotia population, which range from the northeastern U.S. coast to south of Newfoundland throughout continental shelf waters (Hayes et al. 2022). The current best abundance estimate for this population is 6,292 individuals (Hayes et al. 2022). Between 2015 and 2019, the average annual minimum human-caused mortality and serious injury was 0.8 sei whales per year (Hayes et al. 2022). Threats to sei whales include vessel strike and entanglement in fisheries gear. A population trend is not available for the Nova Scotia sei whale population because of insufficient data (Hayes et al. 2022). This population is listed as strategic and depleted under the MMPA due to its endangered status (Hayes et al. 2022). The potential biological removal level for this population is 6.2, and annual human-caused mortality and serious injury from 2015 to 2010 was estimated to be 0.8 per year (Hayes et al. 2022). No critical habitat has been designated for sei whales in the Action Area.

5.1.1.3.2 Potential Occurrence Within the Action Area

Sei whales are typically distributed in deep waters in association with the shelf edge throughout their range, though incursions into shallower OCS waters occurs, generally in response to oceanographic patterns and prey availability (Hain et al. 1985; Hayes et al. 2022). Sei whales are present seasonally in the offshore waters of the Project area, though they have been observed year-round near the continental slope (Palka et al. 2021). Available data suggest sei whales primarily occur offshore near the shelf break, only occasionally traveling closer to shore to feed (Palka et al. 2021; Hayes et al. 2022).

PAM analyses indicate sei whales had a higher acoustic occurrence after 2010 in the Mid-Atlantic, likely due to distributional shifts in their prey (Davis et al. 2020). Sei whales were not detected during recent acoustic and visual surveys in the vicinity of the Delaware and Maryland WEAs (Barco et al. 2015; Bailey et al. 2018). Habitat-based marine mammal density data indicate the highest densities in the vicinity of the Project area would most likely occur in April and the lowest in August (Roberts et al. 2022). As the species is unlikely to occur south of Cape Hatteras, North Carolina, sei whales are not likely to be encountered by vessels transiting to and from the Gulf of Mexico. Sei whales are also present throughout the North Atlantic (NMFS 2023h), including within the Action Area in vessel transit lanes from ports in Europe and Maine. The majority of sei whale sightings in the Action Area are most likely concentrated in offshore waters between 328 and 3,280 feet (100 and 1,000 meters) deep. Given the number of vessels likely originating from Maine and foreign ports, encounters along these transit routes would be uncommon.

5.1.1.4 Sperm Whale (Endangered)

The sperm whale is the largest member of the order Odontocetes, or toothed whales, with adults ranging from 39 to 59 feet (12 to 18 meters) in length. Sperm whales occur throughout the world's oceans. They can be found near the edge of the ice pack in both hemispheres and are also common along the Equator. The North Atlantic population of sperm whales is distributed mainly along the OCS edge, over the continental slope, and mid-ocean regions, where they prefer water depths of 1,969 feet (600 meters) or more and are less common in waters shallower than 984 feet (300 meters) deep (Perry et al. 1999; Hayes et al. 2020). The population exhibits a distinct seasonal cycle in U.S. Atlantic EEZ waters (Perry et al. 1999; Stanistreet et al. 2018). During the winter, sperm whales are observed east and northeast of Cape Hatteras, predominantly past the OCS edge (Hayes et al. 2020). In the spring, sperm whale distribution shifts north and they are more widely distributed throughout the Mid-Atlantic Bight and southern portions of George's Bank (Hayes et al. 2020). Their summer distribution is similar to the spring, but with heightened occurrence inshore of the 328-ft (100-m) isobath south of New England and in the Mid-Atlantic region (Hayes et al. 2020). Sperm whale occurrence on the OCS in areas south of New England is at its highest in the fall, while occurrence in the Mid-Atlantic Bight is along the shelf edge (Hayes et al. 2020). The observed seasonality is likely driven by the distribution of their preferred prey (cephalopods), which may aggregate along distinct oceanographic features such as Gulf Stream eddies and temperature fronts in association with bathymetric features of the shelf edge (Waring et al. 1993; Jaquet and Whitehead 1996; Griffin 1999).

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 population, but insufficient data are available to determine a definitive population structure (Waring et al. 2015).

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 meters per second [m/s]) (Aoki et al. 2007). The species preferentially targets squid, which make up at least 70 percent of the whale's typical diet (Kawakami 1980; Pauly et al. 1998). Sperm whales are also known to prey on bottom-oriented organisms such as octopus, fish, shrimp, crab, and sharks (Leatherwood et al. 1982; 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 hertz to 160 kilohertz (NMFS 2018). Peak hearing sensitivity of sperm whales ranges from 5 to 20 kilohertz 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 kilohertz, with most sound energy generated between 2 and 9 kilohertz (Lohrasbipeydeh et al. 2013).

5.1.1.4.1 Current Status

Sperm whales have been listed as endangered under the ESA since the initial passage of the act (35 *Federal Register* 18319). The population structure of the Atlantic population of sperm whales is poorly understood. It is not clear whether the western North Atlantic population is discrete from the eastern North Atlantic population (Hayes et al. 2020). However, the portion of the population found within the U.S. EEZ likely belongs to a larger population in the western North Atlantic. 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 following 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 population is 4,349 individuals; between 1,000 to 3,400 of these individuals occur in U.S. waters (Hayes et al. 2020). There were no reports of fishery-related mortality or serious injury between 2013 and 2017; while there were 12 strandings documented during this period, none showed indications of human interaction (Hayes et al. 2020). No critical habitat has been designated for sperm whales in the Action Area.

5.1.1.4.2 Potential Occurrence Within the Action Area

Sperm whales are commonly observed near the continental shelf edge, continental slope, and mid-ocean regions in association with bathymetric features, though they also occur on the continental shelf in some regions (Hayes et al. 2020). In the Mid-Atlantic, sperm whales have been observed spending a significant amount of time near Norfolk Canyon and in waters more than 6,000 feet (1,800 meters) deep (U.S. Department of the Navy 2017). Sperm whales have been known to concentrate off Cape Hatteras during winter months, with a northward migration to Virginia and Delaware (Costidis et al. 2017). Predictive density mapping based on long-term survey data indicates sperm whales are strongly associated with the continental shelf edge throughout much of the year, entering shelf waters in the Mid-Atlantic generally during the late spring to early fall (Roberts et al. 2022).

Sperm whale detections within the Delaware and Maryland WEAs are limited, with records generally limited to the shelf break region and occasionally in deeper waters off the Mid-Atlantic Bight (Garrison 2020; Palka et al. 2021). While sperm whales are generally uncommon on the continental shelf in the Mid-Atlantic region, data suggest highest relative seasonal densities could be expected in the summer (Williams et al. 2015; Curtice et al. 2019; Palka et al. 2021). Habitat-based marine mammal density data indicate the highest densities in the vicinity of the Project area would most likely occur in May and the lowest in August through October (Roberts et al. 2022). Given their habitat preferences, sperm whales are considered relatively uncommon in shelf waters in the vicinity of the Project area. Sperm whales are also present throughout the North Atlantic and Gulf of Mexico (NMFS 2023i), including within the Action Area in vessel transit lanes from ports in Europe, Maine, and the Gulf of Mexico; however, given the number of vessels likely originating from these ports, encounters along these transit routes would be relatively uncommon. The risk of vessel strikes with the Gulf of Mexico population of sperm whales is extremely unlikely given the proposed vessel strike avoidance measures provided in Table 3-20 and the low number of vessels originating from ports in this region; therefore, the potential for adverse effects from the Proposed Action is **discountable** for the Gulf of Mexico population of sperm whales and they will not be discussed further in this BA.

5.1.2 Sea Turtles

5.1.2.1 Green Sea Turtle – North Atlantic Distinct Population Segment (Threatened)

Green sea turtles have a worldwide distribution and can be found in tropical and subtropical waters (NMFS and USFWS 1991; NatureServe 2023). They are 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 kilograms [kg]) (NMFS and USFWS 1991). In the Western North Atlantic Ocean, the species can be found from Massachusetts to Texas as well as in waters off Puerto Rico and the U.S. Virgin Islands (NMFS and USFWS 1991). Depending on life stage, green sea turtles inhabit high-energy oceanic beaches, convergence zones in pelagic habitats, and benthic feeding grounds in shallow protected waters (NMFS and USFWS 1991). 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). Green sea turtles are known to make long-distance migrations between their nesting and feeding grounds. Individuals display fidelity for specific nesting habitats, which are concentrated in lower latitudes, well south of the Project area. The primary breeding areas in the U.S. are in southeastern Florida (NMFS and USFWS 1991). Nesting also occurs annually in Georgia, South Carolina, North Carolina, and Texas (NMFS 2022e). Hatchlings occupy pelagic habitats and are omnivorous. Juvenile foraging habitats include coral reefs, emergent rocky bottoms, *Sargassum* mats, lagoons, and bays (USFWS 2023a). Once mature, green sea turtles leave pelagic habitats and enter benthic foraging grounds, primarily feeding on seagrasses and algae (Bjorndal 1997), although they will occasionally feed on sponges and invertebrates (NMFS 2022e).

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 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 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). During the 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), and may be present throughout the Project area.

Bartol and Ketten (2006) measured the auditory evoked potentials of two Atlantic green sea turtles and six subadult Pacific green sea turtles. Subadults were found to respond to stimuli between 100 and 500 hertz, with maximum sensitivity between 200 and 400 hertz. Juveniles responded to stimuli between 100 and 800 hertz, with maximum sensitivity between 600 and 700 hertz. Piniak et al. (2016) found the auditory evoked potentials of juvenile green sea turtles were between 50 and 1,600 hertz in water and 50 and 800 hertz in air, with ranges of maximum sensitivity between 50 and 400 hertz in water and 300 and 400 hertz in air.

5.1.2.1.1 Current Status

The green sea turtle was originally listed under the ESA in 1978 as threatened across its range on the basis of significant population declines resulting from egg harvesting, incidental mortality in commercial fisheries, and nesting habitat loss. The listing was subsequently updated in 2016 (81 *Federal Register* 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). Individuals occurring within the Action Area belong to the North Atlantic DPS, which is listed as threatened (81 *Federal Register* 20057). The primary nesting beaches for the North Atlantic DPS of green sea turtles are Costa Rica, Mexico, Florida (U.S.), and Cuba. 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 2015a). Critical habitat has not been designated.

5.1.2.1.2 Potential Occurrence Within the Action Area

Hatchling green sea turtles occupy pelagic habitats. Juveniles, upon reaching a carapace length of 7.9 to 9.8 inches (20 to 25 centimeters), move to foraging habitats such as coral reefs, emergent rocky bottoms, *Sargassum* mats, lagoons, and bays (Waring et al. 2012 USFWS 2023a). Once adults, green sea turtles will leave pelagic habitats and enter benthic foraging grounds (Bjorndal 1997). Available tagging and sighting data suggest green sea turtles prefer shallower waters, but in the Mid-Atlantic, they are often observed farther offshore as they travel along the Gulf Stream (Palka et al. 2021). Off the coast of Maryland and Delaware, green sea turtles can be seen predominantly in the summer and fall along the continental shelf with some sightings in the spring (Waring et al. 2012; Palka et al. 2021).

Data from the NMFS sea turtle stranding and salvage network show 14 strandings of green sea turtles in Maryland and Delaware between January 1, 2013, and May 1, 2023, largely the result of traditional stranding[4] reasons (NMFS 2022f). In 2011, the first green sea turtle was reported nesting on the beaches of Cape Henlopen State Park, Delaware, laying 194 eggs at Herring Point (Egger 2011). No nesting has been observed within Maryland. Given this, nesting green sea turtles can occur within the Project area; however, it is expected to be rare. Additionally, from 2018 to 2021, only four stranded green sea turtles have been reported in Delaware (NMFS 2022f).

Though green sea turtles may be found as far north as Nova Scotia, they prefer warmer, shallower waters (NMFS and USFWS 1991) and therefore are not likely to be encountered by vessels originating from Europe or Maine. However, the species' range overlaps with vessels transiting from the Gulf of Mexico, where they are more likely to be encountered.

5.1.2.2 Kemp's Ridley Sea Turtle (Endangered)

The Kemp's ridley sea turtle is the smallest 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 centimeters) in length (NMFS and USFWS 2007b). 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). The species is coastally oriented, rarely venturing into waters deeper than 160 feet (50 meters). Kemp's ridley sea turtles are 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 2022g) and nearshore waters less than 120 feet (36.6 meters) deep (Shaver et al. 2005; Shaver and Rubio 2008), although it can also be found in deeper offshore waters. The species is primarily associated with mud- or sand-bottomed habitats, where its primary prey species are found (NMFS and USFWS 2007b).

In late fall, Atlantic juveniles and subadults travel northward to forage in the coastal waters off Georgia through New England, then return southward for the winter (Stacy et al. 2013; NMFS 2022g). Nesting typically occurs from April to July, and, unlike most other sea turtles, the species nests during the daytime. 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 (NMFS 2022g).

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 (Byles 1988; Carr and Caldwell 1956; Schmid 1998). However, the preferred diet of Kemp's ridley sea turtles is crabs (NMFS and USFWS 2007b). 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 kilohertz, with the greatest hearing sensitivity between 100 and 700 hertz, varying by species. Bartol and Ketten (2006) determined that Kemp's ridley hearing is more limited, ranging from 100 to 500 hertz, with greatest sensitivity between 100 and 200 hertz.

[4] A "traditional stranding" is defined as when a dead, sick, or injured sea turtle is found washed ashore, floating, or underwater, and when it is not an incidental capture, a post-hatchling, or a cold-stunning. Traditional strandings do not involve healthy, uninjured sea turtles (NMFS 2022f).

5.1.2.2.1 Current Status

The Kemp's ridley sea turtle was listed as endangered at the species level with the passage of the ESA in 1973 (35 *Federal Register* 18319). All Kemp's ridley sea turtles belong to a single population. 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 markedly declined (NMFS and USFWS 2015b). Potential explanations for this trend, including the *Deepwater Horizon* oil spill in 2010, have proven inconclusive, suggesting 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 of and entanglement in marine debris, and vessel strikes (NMFS and USFWS 2015b).

The Kemp's ridley sea turtle 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 (Bevan et al. 2016; NMFS and USFWS 2015b). Recent estimates of the total population of age 2 years and older is 248,307 individuals; however, recent models indicate a persistent reduction in survival or recruitment, or both, in the nesting population, suggesting the population is not recovering to historical levels (NMFS and USFWS 2015b). A record high number of Kemp's ridley 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 percent decrease from 2018, and a 54.89 percent decrease from 2017. This decline is typical due to the reproduction biology of the species, as females nest approximately every 1 to 3 years (National Park Service [NPS] 2023). Using the standard IUCN protocol for sea turtle assessments, the number of mature animals was recently estimated at 22,341 individuals; the assessment concluded the current population trend is unknown (Wibbels and Bevan 2019). There is no designated critical habitat for Kemp's ridley sea turtles.

5.1.2.2.2 Potential Occurrence Within the Action Area

Kemp's ridley sea turtles primarily inhabit the Gulf of Mexico, although large juveniles and adults travel along the U.S. Atlantic coast. Once the turtles enter the juvenile phase, they enter nearshore waters along the U.S. East Coast from Florida to New England, where they spend the summer in shallow foraging areas, including sounds, bays, estuaries, tidal passes, shipping channels, and beachfront waters. Kemp's ridley sea turtles inhabit coastal waters around Cape Canaveral, Florida up to Cape Hatteras, North Carolina during the winter (Waring et al. 2012). Adult Kemp's ridley sea turtles undergo this seasonal migration each year in the Atlantic, starting their journey to northern foraging grounds in spring and traveling back to southern habitat in the fall (Waring et al. 2012). Individuals are expected to reach Maryland and Delaware waters between May and June and be present until early November (Waring et al. 2012). Sightings of Kemp's ridley sea turtles in the Mid-Atlantic are relatively sparse, though this may be because their small size makes them more difficult to observe during visual surveys. However, the sightings validate the predicted seasonal migrations with higher abundances offshore Maryland and Delaware in the summer, few individuals observed in the spring and fall, and no apparent sightings in winter (Waring et al. 2012; Barco et al. 2015; Palka et al. 2021).

Data from the NMFS sea turtle stranding and salvage network show 58 strandings of Kemp's ridley sea turtles in Maryland and Delaware between January 1, 2013, and May 1, 2023, largely the result of traditional stranding reasons (NMFS 2022f). No Kemp's ridley sea turtle nesting events have been recorded in Maryland or Delaware; the nearest reported nesting site was one nest in Virginia in 2012, the first ever Kemp's ridley sea turtle nest in that state (USFWS 2012). Nesting in the mid-Atlantic, including within the Project area, is considered very rare. Stranding data between 2018 and 2021 show the species is less common in this region, as only 10 stranded Kemp's ridley sea turtles have been reported in Delaware (NMFS 2022f).

Though Kemp's ridley sea turtles may be found as far north as New England, they prefer warmer, nearshore coastal waters (NMFS 2022g) and therefore are not likely to be encountered by vessels originating from Europe and Maine. However, the species' range overlaps with vessels transiting from the Gulf of Mexico, where they are more likely to be encountered.

5.1.2.3 Leatherback Sea Turtle (Endangered)

The leatherback sea turtle is primarily a pelagic species distributed in temperate and tropical waters worldwide. The leatherback is the largest, deepest diving, most migratory, widest ranging, and most pelagic of the sea turtles (NMFS 2022h). Adults can reach up to 2,000 pounds (900 kg) and be more than 6 feet (2 meters) long (NMFS and USFWS 2013; NMFS 2022h). Adult leatherback sea turtles forage in temperate and subpolar regions in all oceans. Satellite-tagged adults reveal migratory patterns in the North Atlantic that can include a circumnavigation of the North Atlantic Ocean basin, following ocean currents that make up the North Atlantic gyre, and preferentially targeting warm-water mesoscale ocean features such as eddies and rings as favored foraging habitats (Hays et al. 2006).

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 (Eckert et al. 2012; NMFS and USFWS 2020). Unlike other predatory sea turtles with crushing jaws, the leatherback has evolved a sharp-edged jaw for consuming soft-bodied oceanic prey (NMFS 2022h). They are also known to feed on sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed (NMFS 2022h; USFWS 2023b).

James et al. (2006) studied leatherbacks' migratory behavior using satellite tags and observed the timing of southerly migration ranges widely, extending from mid-August to mid-December, 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. (2016a), 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 of 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 oceanographic features such as mesoscale eddies, convergence zones, and areas of upwelling attracted foraging leatherback sea turtles because these features are often associated with jellyfish aggregations. Unlike the other three sea turtle species discussed earlier, the leatherback sea turtle does not use shallow waters to prey on benthic invertebrates or seagrasses.

Nesting beaches in the U.S. are concentrated in southeastern Florida from Brevard County south to Broward County (NMFS and USFWS 2013, 2020; USFWS 2023b). Leatherback sea turtles are a pelagically oriented species, but they are often observed in coastal waters along the U.S. continental shelf (NMFS and USFWS 2020). Individuals have been sighted along the entire coast of the eastern U.S. from the Gulf of Maine to Puerto Rico, the Gulf of Mexico, and the U.S. Virgin Islands (NMFS and USFWS 2020).

Dow Piniak et al. (2012) determined the hearing range of leatherback sea turtles extends from approximately 50 to 1,200 hertz in water and 50 and 1,600 hertz in air, which is comparable to the general hearing range of sea turtles across species groups. The leatherback sea turtle's greatest hearing sensitivity is between 100 and 400 hertz in water and 50 and 400 hertz in air.

5.1.2.3.1 Current Status

Leatherback sea turtles in the Action Area belong to the Northwest Atlantic population, which is one of seven leatherback populations globally. The species was listed as endangered Part 17 to title 50 CFR (as it was at that time) (35 *Federal Register* 8491), inclusive of all populations[5]. The breeding population (total number of adults) estimated in the North Atlantic is 34,000 to 94,000 individuals (NMFS and USFWS 2013; Turtle Expert Working Group 2007). NMFS and USFWS (2020) concluded the Northwest Atlantic population has a total index of nesting female abundance of 20,659 females, with a decreasing nest trend at 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 Action 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).

5.1.2.3.2 Potential Occurrence Within the Action Area

In the Northwest Atlantic, leatherback sea turtles are widely dispersed. They are a highly mobile species, inhabiting open ocean environments as hatchlings and adults, although pelagic distribution of hatchling or juvenile leatherback sea turtles is largely unknown (NMFS and USFWS 1992). Adult leatherbacks are highly migratory and would be expected to remain farther offshore relative to other sea turtle species, including waters beyond the shelf break (NMFS and USFWS 1992). Tagged turtles have been documented migrating over large distances (more than 4,350 miles [7,000 kilometers]) to foraging grounds located around the Atlantic (Palka et al. 2017, 2021). Atlantic Marine Assessment Program for Protected Species data show leatherback sea turtles occur in the Mid-Atlantic during all seasons except winter, with peak occurrence in the summer (Barco et al. 2015; Palka et al. 2021). Most observations of leatherbacks offshore Maryland and Delaware have been concentrated along the continental shelf edge or open ocean waters, but tagging data indicate some individuals may travel closer to shore (Sea Turtle Conservancy 2023; Palka et al. 2021).

Data from the NMFS sea turtle stranding and salvage network show 31 strandings of leatherback sea turtles in Maryland and Delaware between January 1, 2013, and May 1, 2023, largely the result of traditional stranding reasons, though six were the result of incidental capture (NMFS 2022f). There have been no recorded leatherback sea turtle nesting events in the Mid-Atlantic. Stranding data between 2018 and 2021 reported only five leatherback sea turtles in Delaware (NMFS 2022f).

Leatherback sea turtles are a pelagic species known for making large-scale movements, which can sometimes cross the Atlantic Ocean basin (Dodge et al. 2014; Lalire and Gaspar 2019). Given this distribution, leatherback sea turtles may be present in vessel transit lanes in the Action Area for transits between ports in Europe, Maine, and the Gulf of Mexico.

5.1.2.4 Loggerhead Sea Turtle – Northwest Atlantic Ocean Distinct Population Segment (Threatened)

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 these individuals belong to the Northwest Atlantic Ocean DPS. Most loggerhead sea turtles nesting in the

[5] NMFS and the 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, the USFWS and NMFS (2020) identified seven leatherback populations that meet the discreteness and significance criteria of the DPS Policy, including the Northwest Atlantic population.

eastern U.S. occurs from North Carolina through southwestern Florida. Some nesting also occurs in southern Virginia and along the Gulf of Mexico coast westward into Texas (NMFS and USFWS 2008). Foraging loggerhead sea turtles range widely; they have been observed along the entire Atlantic coast of the U.S., as far north as the Gulf of Maine (Shoop and Kenney 1992) and into Canadian waters.

Female loggerhead sea turtles in the western North Atlantic nest from late April through early September. Individual females might nest several times within one season and usually nest at intervals of 2 to 3 years. For their first 7 to 12 years of life, loggerhead sea turtles inhabit pelagic waters near the North Atlantic Gyre and are called pelagic immatures. When loggerhead sea turtles reach 15.7 to 23.6 inches (40 to 60 centimeters) in straight-line carapace length, they begin recruiting to coastal inshore and nearshore waters of the OCS through the U.S. Atlantic and Gulf of Mexico and are referred to as benthic immatures. Benthic immature loggerheads have been found in waters from Cape Cod, Massachusetts, to southern Texas. Most recent estimates indicate the benthic immature stage ranges from ages 14 to 32 years. Loggerhead sea turtles reach sexual maturity at approximately 20 to 38 years of age. Loggerhead sea turtles are largely present year-round in waters south of North Carolina but will forage during summer and fall as far north as the northeastern U.S. and Canada and migrate south as water temperatures drop. Prey species for omnivorous juveniles include crabs, mollusks, jellyfish, and vegetation at or near the surface. Coastal subadults and adults feed on benthic invertebrates, including mollusks and decapod crustaceans (Turtle Expert Working Group 2009).

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 are the primary food items for juvenile loggerheads (Burke et al. 1993). Although loggerhead sea turtles are dietary specialists, the species demonstrates the ability to adjust its diet in response to changes in prey availability in different geographies (Plotkin et al. 1993; Ruckdeschel and Shoop 1988). In Chesapeake Bay, Virginia, these sea turtles 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 100 hertz to 1,100 hertz, with greatest hearing sensitivity between 200 and 400 hertz.

5.1.2.4.1 Current Status

The Northwest Atlantic Ocean DPS of loggerhead sea turtle was listed as threatened under the ESA in 2011 (76 *Federal Register* 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 individuals; NEFSC and SEFSC 2011). The three largest nesting subpopulations responsible for most of the production in the western North Atlantic (peninsular Florida, northern U.S., and Quintana Roo, Mexico) have been declining since at least the late 1990s, indicating a downward trend for this population (Turtle Expert Working Group 2009). While some progress has been made since publication of the 2008 Loggerhead Sea Turtle Recovery Plan (NMFS and USFWS 2008), the recovery units have not met most of the critical benchmark recovery criteria (NMFS and USFWS 2023).

Critical habitat for Northwest Atlantic Ocean DPS of loggerhead sea turtles was designated in 2014 (79 *Federal Register* 39755; 79 *Federal Register* 51264). The designated critical habitat units are nesting beaches in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi (Section 4.3.2). No designated critical habitat occurs within the Project area. 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, 2023). 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, 2023).

5.1.2.4.2 Potential Occurrence Within the Action Area

Loggerhead sea turtles inhabit nearshore and offshore habitats, ranging, in the Northwest Atlantic, as far north as Newfoundland (NMFS 2022i). Loggerhead sea turtles are known to occur throughout the continental shelf in the Mid-Atlantic (Palka et al. 2021). Post-hatchling loggerhead sea turtles have been found to inhabit areas characterized by linear accumulations of *Sargassum* near nearshore, localized downwellings (NMFS and USFWS 2008). Winton et al. (2018) reported loggerhead sea turtles tagged within the Northwest Atlantic primarily restrict their summertime distribution to OCS waters and occasionally make excursions inshore to bays and estuaries. Core habitat includes sea surface temperatures from 59.0°F to 82.4°F (15°C to 28°C) and depths between 26 and 302 feet (8 and 92 meters), with the highest probability of occurrence in regions with sea surface temperatures from 63.9°F to 77.5°F (17.7°C to 25.3°C) and at depths between 85 and 243 feet (26 and 74 meters) (Patel et al. 2021). Studies have indicated the Mid-Atlantic Bight of the Atlantic OCS, where the Project area occurs, is an important seasonal foraging ground for approximately 40,000 to 60,000 juvenile and adult loggerhead sea turtles during the summer (NEFSC and SEFSC 2011). Satellite telemetry data indicate potentially 30 to 50 percent of loggerhead sea turtles that nest and reside along the U.S. East Coast seasonally forage within the Mid-Atlantic Bight (Winton et al. 2018; Patel et al. 2021).

Atlantic Marine Assessment Program for Protected Species data from tagged loggerhead sea turtles and visual surveys indicate this species occurs throughout the U.S. Atlantic OCS in the summer and fall, with a shift towards the southeastern U.S. in the winter and spring (Palka et al. 2021). In the Mid-Atlantic, loggerhead sea turtles are most likely to occur in the summer, followed by fall and spring, with a low likelihood of occurrence in the winter (Barco et al. 2015; Williams et al. 2015; Palka et al. 2021). Additionally, an analysis of tagged loggerhead sea turtles showed the Mid-Atlantic is an important summer foraging habitat for this species (Winton et al. 2018). Previous surveys conducted in the Mid-Atlantic indicate loggerheads are one of the most commonly observed sea turtles during visual surveys (Barco et al. 2015; Palka et al. 2021). Spatial models developed by Winton et al. (2018) based on satellite-tagged turtles demonstrate the Project area occurs within an area of medium to high relative density of loggerheads from May through October; higher densities are predicted to occur farther offshore to the east of the Project area (Northeast Regional Ocean Council 2023).

Data from the NMFS sea turtle stranding and salvage network show 458 strandings of loggerhead sea turtles in Maryland and Delaware between January 1, 2013, and May 1, 2023, largely the result of traditional stranding reasons (NMFS 2022f). Loggerhead sea turtles are commonly documented nesting on southern beaches in Virginia (Funk 2020; USFWS 2012). The first successful loggerhead nesting event was documented in Maryland in 2017 when approximately 100 hatchlings emerged from a nest in Assateague Island National Seashore (Helf 2017; NPS 2017). According to the Maryland Park Service, loggerhead sea turtle nesting north of Virginia is rare, and though sea turtles have made attempts in the past to nest on Assateague's beach, this is the first reported group of hatchlings to make it to the water (Helf 2017). Loggerhead sea turtles have also nested in Delaware; the first loggerhead nesting event was documented in July 2018 on Fenwick Island, Delaware (DNREC 2018). However, nesting events in Maryland and Delaware are considered rare as the primary nesting sites for this population are typically located in Florida and Mexico; there are no comprehensive nesting data available for Maryland or Delaware given the uncommon occurrence of sea turtle nests (Ryan 2018). Additionally, from 2018 to 2021, there have been 79 reported strandings of loggerhead sea turtles in Delaware, 56 of which were reported in inshore waters (NMFS 2022f).

Loggerhead sea turtles have been documented crossing the North Atlantic Ocean basin as they are thought to passively follow oceanic currents or travel to find food resources (McCarthy et al. 2010). Loggerhead sea turtles may be present in vessel transit lanes in the Action Area for transits between ports in Europe. The species' range also overlaps with vessels transiting from the Gulf of Mexico and, to a lesser extent, Maine.

5.1.3 Marine Fish

5.1.3.1 Atlantic Sturgeon – All Distinct Population Segments (Endangered; Threatened)

The Atlantic sturgeon is a large, long-lived, benthic fish found from Canada to Florida in river, estuarine, coastal marine, and OCS habitats. Individuals may be up to 13 feet (4 meters) long, can reach up to 600 pounds (272 kg), and live up to 60 years. Atlantic sturgeon are anadromous, meaning they are born in fresh water, migrate to sea, and then return to fresh water to spawn. Historically, Atlantic sturgeon were present in approximately 38 rivers in the U.S. from St. Croix, Maine, to the Saint Johns River, Florida, of which 35 rivers have been confirmed to have had a historical spawning population (Atlantic Sturgeon Status Review Team [ASSRT] 2007). There are 22 rivers along the U.S. East Coast that currently host spawning Atlantic sturgeon (NMFS 2023a). Spawning in rivers from Delaware to Canada occurs from spring to early summer; some rivers may support a second fall spawning population, though supporting data are limited (NMFS 2023a). Spawning occurs in the late summer and fall in rivers from Georgia to Chesapeake Bay (NMFS 2023a). Juveniles typically remain in their natal river for 2 to 3 years before migrating into coastal and ocean waters (NMFS 2023a). Subadults move out to estuarine and coastal waters in the fall; adults inhabit fully marine environments and migrate through deep water when not spawning (ASSRT 2007). While individuals are most common near their natal river, extensive migrations within the marine environment have been documented for adults and subadults, with some individuals traveling thousands of miles/kilometers from their natal rivers (Kazyak et al. 2021). Their distribution and abundance vary by season; they are found in shallow coastal waters during the summer and move to deeper waters in the 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 seafloor. They appear to congregate in areas providing favorable foraging conditions (Stein et al. 2004a,b), exhibit dietary flexibility, and 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). In a modeled study, Breece et al. (2018) discovered that spring migration takes place in shallower nearshore waters and, conversely, fall migration occurs in deeper offshore waters. Five DPSs make up the U.S. East Coast population; the Project area falls within the New York Bight DPS, and the Action Area also includes the Gulf of Maine DPS. However, given the species' proclivity to migrate, with extensive movements up and down the U.S. East Coast and into Canadian waters, Atlantic sturgeon encountered within the Project area and Action Area may originate from any of the five DPSs (Kazyak et al. 2021).

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 percent 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, accounting for up to 3.6 percent of diet in some years. In contrast, Guilbard et al. (2007) observed small fish accounted for up to 38 percent of subadult Atlantic sturgeon diet in the St. Lawrence River estuarine transition zone during the summer, but less than 1 percent in the 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. The Acipenseridae (sturgeon) family has a well-developed inner ear that is independent of the swim bladder; sturgeon do have a swim bladder, but it is not involved in hearing (Popper et al. 2014). Lovell et al. (2005a) and Meyer et al. (2010) studied the auditory system morphology and hearing ability of lake sturgeon (*Acipenser fulvescens*), a closely related species. The results of these studies indicate a generalized hearing range from 50 to 700 hertz, with greatest sensitivity between 100 and 300 hertz. Popper (2005) summarized studies measuring the physiological responses of the ear of European sturgeon (*Acipenser sturio*). The results of these studies suggest sturgeon are likely capable of detecting sounds from below 100 hertz to approximately 1 kilohertz.

5.1.3.1.1 Current Status

All five DPSs of Atlantic sturgeon are listed under the ESA; the Gulf of Maine DPS is listed as threatened, while the other DPSs (New York Bight, Chesapeake Bay, Carolinas, and South Atlantic) are endangered (77 *Federal Register* 5880, 77 *Federal Register* 5914). The 2017 Atlantic sturgeon stock assessment reported that all DPSs remain depleted relative to historical distributions (Atlantic States Marine Fisheries Commission 2017). Though these DPSs represent distinct geographic populations along the U.S. East Coast, individuals from all DPSs migrate along the coast and are not easily distinguished visually from one another. Therefore, any Atlantic sturgeon encountered in the Project area is considered endangered for the purpose of this analysis. In 2017, critical habitat was designated for all five DPSs of Atlantic sturgeon (82 *Federal Register* 39160); these critical habitat designations are riverine (Section 4.3.3).

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 impacted by unique stressors, such as habitat impediments and apparent ship strikes (ASSRT 2007). Historically, the Delaware River is thought to have supported the largest population of Atlantic sturgeon; recent studies estimate the current breeding population size is likely less than 250 adults, representing a greater than 99 percent decline since the late 1800s (USGS 2022). Indices from the New York Bight and Carolina DPSs indicated a greater than 50 percent chance of population increase since 1998, although the index from the Chesapeake Bay DPS only had a 36 percent chance of population increase across the same time frame (Atlantic States Marine Fisheries Commission 2017).

Recently, Kahn et al. (2019) used a closed population mark-recapture model to estimate the population of Atlantic sturgeon from 2013 to 2018 in the York River, Virginia, based on data collected from acoustic tags. Population estimates ranged from 73 to 222 individuals across the study. Because Atlantic sturgeon do not spawn every year, the trends in these estimates do not suggest a recovering or declining population but a variability in the number of adults that return to spawn each year. Adult sex ratios from these data are estimated to approximately 0.51 indicating an almost equal proportion of reproductive-aged males and females in this population (Kahn et al. 2021).

5.1.3.1.2 Potential Occurrence Within the Action Area

Atlantic sturgeon, characterized as long lived, late maturing, estuarine dependent, and anadromous, could be present throughout the Action Area depending on the various life history developmental stages. In the mid-Atlantic, mature females generally spawn every 1 to 5 years by migrating upriver from April to May and depositing more than 400,000 eggs on gravel or other hard substrates (USACE 2015). In non-spawning years, adults remain in marine waters year-round (Smith and Clugston 1997). Larvae develop into juveniles as they migrate downstream; juveniles remain in brackish waters until they grow to 30 to 35 inches (75 to 90 centimeters) and move into nearshore coastal waters (Stein et al. 2004a; Erickson et al. 2011). Once suitably developed, Atlantic sturgeon move to marine waters with salinity greater than 30 ppt), marking the beginning of the subadult life stage. They typically occur within the 164-feet (50-meter) depth contour when in the marine environment (NMFS 2023a).

The species is present in multiple rivers that feed into Chesapeake Bay, with spawning occurring in the James and York rivers; this region provides important habitat for the Chesapeake Bay DPS (Virginia Institute of Marine Science 2022) and is closest to the Project area. Spawning and non-spawning fish are known to inhabit Chesapeake Bay, with females and males arriving as early as late February to early March and departing as late as the end of January. Peak occupation ranges from April to August and again from mid-October to early December. Females tend to remain in Chesapeake Bay longer than males before spawning but leave sooner than males after spawning (Fulling 2023). Spawning also occurs in the Delaware River, which provides important habitat for the New York Bight DPS (82 *Federal Register* 39160).

Adult and subadult Atlantic sturgeon migrate through Delaware's coastal waters in mid- to late March through mid-May and early September through mid-December (DNREC 2017). In 2011, telemetered Atlantic sturgeon were detected in nearshore waters off the coast of Maryland, along the southern end of the Delmarva Peninsula. Atlantic sturgeon were observed in shallow, well-mixed, relatively warm fresh water near the 82-ft (25-m) isobath and appeared to be associated with a water mass tied to Delaware Bay (Oliver et al. 2013). Additionally, acoustically tagged Atlantic sturgeon were detected at mid-range depths in the Lease Area during the fall and shallower regions within and outside the Lease Area in the spring (Secor et al. 2020). Their occurrence within the Lease Area is most likely as transients using a migration corridor. Based on these studies, Atlantic sturgeon would be more likely to occur near the coast rather than farther offshore in the Lease Area from fall to early spring.

In the pelagic marine environment, Atlantic sturgeon range as far north as eastern Canada and occupy shelf waters up to a depth of 246 feet (75 meters). Though their range overlaps with vessel transit routes from the Gulf of Mexico, Maine, and Europe, encounters are considered unlikely as they are a predominantly benthic-dwelling species.

5.1.3.2 Shortnose Sturgeon (Endangered)

The shortnose sturgeon is an anadromous species, spawning and growing in fresh water 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 Ocean 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. The species typically forages on invertebrates, including mollusks, worms, insects, and crustaceans in the sandy and muddy bottom of rivers. Because of threats such as habitat degradation, water pollution, dredging, water withdrawals, fishery bycatch, and habitat impediments (e.g., dams), the species was listed as endangered in 1967 (32 *Federal Register* 4001) throughout the entire population range.

Shortnose sturgeon are found in large rivers and estuaries along the North American eastern seaboard from the Indian River in Florida to the Saint John River in New Brunswick, Canada. Generally, spawning occurs far upstream in their natal rivers, with individuals moving downriver to the estuaries to feed, rest, and spend most of their time. They are a primarily benthic species and are rarely known to leave their natal freshwater rivers (Kieffer and Kynard 1993); therefore, their presence in the marine environment is uncommon (Baker and Howsen 2021). Movement of shortnose sturgeon between rivers is rare, though there have been some reported migrations between the Connecticut and Hudson Rivers (Shortnose Sturgeon Status Review Team [SSSRT] 2010). Acoustic tagging studies conducted in the Delaware River indicate the existence of an overwintering area in the lower portion of the river, below Wilmington, Delaware (SSSRT 2010). A tagging study conducted by Welsh et al. (2002) also indicates that shortnose sturgeon may use the Chesapeake and Delaware (C&D) Canal to travel between Chesapeake Bay and the Delaware River. Welsh et al. (2002) tagged 13 fish from Chesapeake Bay and 26 from the Delaware River, and of these tagged individuals, three of the 13 fish from Chesapeake Bay were relocated either in the C&D Canal or in the Delaware River, providing evidence that this species may use that canal to move between the two rivers.

5.1.3.2.1 Current Status

There is no current total population estimate for shortnose sturgeon rangewide. Information on populations and metapopulations is presented below. In general, populations in the Northeast are larger and more stable than those in the Southeast (SSSRT, 2010). Population size throughout the species' range is considered to be stable; however, most riverine populations are below the historic population sizes and most likely are below the carrying capacity of the river (Kynard, 1996).

There are 19 documented populations of shortnose sturgeon ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. There is a large gap in the middle of the species range with individuals present in the Chesapeake Bay separated from populations in the Carolinas by a distance of more than 400 km. Currently, there are significantly more shortnose sturgeon in the northern portion of the range.

Developments in genetic research as well as differences in life history support the grouping of shortnose sturgeon into five genetically distinct groups, all of which have unique geographic adaptations (see Grunwald et al., 2008; Grunwald et al., 2002; King et al., 2001; Waldman et al., 2002b; Walsh et al., 2001; Wirgin et al., 2009; Wirgin et al., 2002; SSSRT, 2010). These groups are: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast. The Gulf of Maine, Delaware/Chesapeake Bay and Southeast groups function as metapopulations. The other two groups (Connecticut/Housatonic and the Hudson River) function as independent populations.

While there is migration within each metapopulation (i.e., between rivers in the Gulf of Maine and between rivers in the Southeast) and occasional migration between populations (e.g., Connecticut and Hudson), interbreeding between river populations is limited to very few individuals per generation; this results in morphological and genetic variation between most river populations (see Walsh et al., 2001; Grunwald et al., 2002; Waldman et al., 2002; Wirgin et al., 2005). Indirect gene flow estimates from mtDNA indicate an effective migration rate of less than two individuals per generation. This means that while individual shortnose sturgeon may move between rivers, very few sturgeon are spawning outside their natal river; it is important to remember that the result of physical movement of individuals is rarely genetic exchange.

Summary of Status of Northeast Rivers

In NMFS' Greater Atlantic Region, shortnose sturgeon are known to spawn in the Kennebec, Androscoggin, Merrimack, Connecticut, Hudson, and Delaware Rivers. Shortnose sturgeon are also known to occur in the Penobscot and Potomac Rivers; although it is unclear if spawning is currently occurring in those systems.

Hudson River Population

The Hudson River population of shortnose sturgeon is the largest in the United States. Studies indicate an extensive increase in abundance from the late 1970s (13,844 adults (Dovel *et al.* 1992), to the late 1990s (56,708 adults (95% CI 50,862 to 64,072; Bain *et al.* 1998). This increase is thought to be the result of high recruitment (31,000 – 52,000 yearlings) from 1986-1992 (Woodland and Secor 2007). Woodland and Secor (2007) examined environmental conditions throughout this 20-year period and determined that years in which water temperatures drop quickly in the fall and flow increases rapidly in the fall (particularly October), are followed by high levels of recruitment in the spring. This suggests that these environmental factors may index a suite of environmental cues that initiate the final stages of gonadal development in spawning adults. The population in the Hudson River exhibits substantial recruitment and is considered to be stable at high levels.

Delaware River-Chesapeake Bay Metapopulation

Shortnose sturgeon range from Delaware Bay up to at least Scudders Falls (river kilometer 223); there are no dams within the species' range on this river. The population is considered stable (comparing 1981-1984 to 1999-2003) at around 12,000 adults (Hastings et al., 1987 and ERC, 2006b). Spawning occurs primarily between Scudders Falls and the Trenton rapids.

Overwintering and foraging also occur in the river. Shortnose sturgeon have been documented to use the Chesapeake-Delaware Canal to move from the Chesapeake Bay to the Delaware River. In Chesapeake Bay, shortnose sturgeon have most often been found in Maryland waters of the mainstem bay and tidal tributaries such as the Susquehanna, Potomac, and Rappahannock Rivers (Kynard et al., 2016; SSSRT, 2010). Spells (1998), Skjeveland et al. (2000), and Welsh et al. (2002) all reported one capture each of adult shortnose sturgeon in the Rappahannock River.

Recent documented use of Virginia waters of Chesapeake Bay is currently limited to two individual shortnose sturgeon: one captured in 2016 (Balazik, 2017) and a second sturgeon (a confirmed gravid female) caught in 2018 in the James River (Balazik, pers. comm. 2018).

Spawning has not been documented in any tributary to the Bay although suitable spawning habitat and two prespawn females with late-stage eggs have been documented in the Potomac River. Current information indicates that shortnose sturgeon are present year-round in the Potomac River with foraging and overwintering taking place there. Shortnose sturgeon captured in the Chesapeake Bay are not genetically distinct from the Delaware River population.

5.1.3.2.2 Potential Occurrence Within the Action Area

Within the Action Area, shortnose sturgeon occur in Chesapeake Bay, Delaware Bay, the Delaware River, and the C&D Canal (Welsh et al. 2002; Shortnose Sturgeon Status Review Team 2010). Vessels transiting between the Lease Area and the proposed staging facility at Baltimore (Sparrows Point), Maryland may utilize routes through Chesapeake Bay or Delaware Bay via the C&D Canal may encounter shortnose sturgeon (Figure 3-8). Additionally, there is the potential for the Paulsboro Marine Terminal (and other ports New York [Hudson River] and New Jersey; Sections 3.1.1.6 and 3.1.4.6) to be utilized during the Proposed Action. The use of the Paulsboro Marine Terminal would constitute more exposure of the species to vessel interactions. Most of the other ports used during construction and O&M would be nearer to the mouth of Chesapeake and Delaware Bays (Sections 3.1.1.6 and 3.1.4.6) and would therefore be unlikely to encounter shortnose sturgeon due to the large expanse of water compared to a river channel. Vessels using the port at Sparrows Point are anticipated to travel to the Lease Area using the Chesapeake Bay route and return to port using the C&D Canal route (Figure 3-8) while vessels transiting the Delaware River from Paulsboro Marine Terminal may result in greater interaction with the species.

5.1.3.3 Giant Manta Ray (Threatened)

As the largest ray species, the giant manta ray occurs globally in tropical, subtropical, and temperate waters in offshore and coastal regions (NMFS 2022a). They are slow growing, highly migratory animals with sparsely distributed and fragmented populations throughout the world. Regional population sizes are small, between 100 to 1,500 individuals (Marshall et al. 2020; NMFS 2022a). They occur off the U.S. East Coast from Florida to the Carolinas, though they can also occur off the Mid-Atlantic and Northeast (Farmer et al. 2022). Giant manta rays undergo seasonal migrations, which are thought to coincide with the movement of zooplankton, ocean current circulation and tidal patterns, seasonal upwelling, sea surface temperature, and possibly mating behavior (NMFS 2022a). The giant manta ray is a seasonal visitor to coastlines, oceanic island groups, and offshore pinnacles and seamounts that feature high levels of primary and secondary productivity. They primarily feed on planktonic organisms, including euphausiids and copepods (NMFS 2022a). Giant manta rays occur in a wide variety of depths during feeding, including aggregations in waters less than 33 feet (10 meters) deep and dives 656 to 1,476 feet (200 to 450 meters) deep, which are likely driven by vertical shifts in prey location (NMFS 2022a).

A compilation of giant manta ray detections from Farmer et al. (2022) showed regular sightings within the Mid-Atlantic during standardized surveys. Records north of Cape Hatteras were concentrated during the summer months (mainly June through September) and showed use of OCS, slope, and nearshore waters; most abundant sightings for the region occurred on the shelf and in proximity to the slope edge (Farmer et al. 2022). Giant manta rays were reported in bays and estuaries in the southern U.S. and Gulf of Mexico (Farmer et al. 2022). The detection information was used to model potential distribution, which showed preference for sea surface temperatures from 63°F to 90°F (17°C to 32°C), with a strong affinity for thermal fronts (Farmer et al. 2022). As expected from the sighting records, the model predicted the highest probability of occurrence north of Cape Hatteras during warmer months when water temperatures are highest (May to October). Forward predictions by the model show a northward shift for this species distribution through 2024 (Farmer et al. 2022).

Giant manta rays belong to the subclass Elasmobranchii, which, like all fish, have an inner ear capable of detecting sound and a lateral line capable of detecting water motion caused by sound (Hastings and Popper 2005; Popper and Schilt 2008). The hearing range for the giant manta ray specifically is not known, and there are no known studies that have tested their hearing sensitivity. Known hearing sensitivity of several elasmobranchs species is discussed in Mickle and Higgs (2022), which range from 10 hertz (lemon sharks) to 1.5 kilohertz (bull sharks). A benthic skate (*Leucoraja erinacea*) has a hearing sensitivity range of 100 to 800 hertz (Casper et al. 2003), which may represent the mid-range of hearing sensitivities for the pelagic giant manta ray.

5.1.3.3.1 Current Status

The giant manta ray was listed as threatened throughout its range under the ESA in 2018 (83 *Federal Register* 2916). Commercial fishing is the primary threat to the giant manta ray as it is targeted and caught as bycatch in several global fisheries throughout its range (NMFS 2022a). Based on a comprehensive review of the best scientific data available, there are no identifiable PBFs essential to conservation of the giant manta ray within U.S. jurisdiction (84 *Federal Register* 66652). Therefore, no areas within U.S. jurisdiction meet the definition of critical habitat for the giant manta ray (84 *Federal Register* 66652). As a result, NMFS determined a designation of critical habitat for the giant manta ray was not prudent.

5.1.3.3.2 Potential Occurrence Within the Action Area

The giant manta ray has a distributional range that includes offshore Delaware and Maryland; thus, the species may be present in the Project area (Farmer et al. 2022). There are substantial records of giant manta rays from systematic surveys in the waters offshore Delaware and Maryland (Farmer et al. 2022) as well as ancillary reports made by fishermen and recreational boaters in the mid-Atlantic region (e.g., Eichmann 2016). Sightings data from the SEFSC and the North Atlantic Right Whale Consortium indicate they are likely to be present in the Project Lease Area, particularly in the summer and fall when they are more abundant in the Mid-Atlantic (Farmer et al. 2022).

The species feeds in productive nearshore waters and shelf edge upwelling zones at surface thermal frontal boundaries within a temperature range of 63°F to 90°F (17°C to 32°C) (Farmer et al. 2022). Giant manta rays mainly occur in the Mid-Atlantic on a seasonal basis, with the highest likelihood for occurrence within the Project area during May through October in shelf habitats (Farmer et al. 2022). Although the giant manta ray is often observed in shallow coastal waters and estuaries in warmer climates, their preference is for deeper waters and thermal fronts associated with the shelf break north of Cape Hatteras (Farmer et al. 2022). However, giant manta rays have been reported close to shore along the U.S. East Coast and, therefore, may be found in nearshore regions of the Project area, particularly from New Jersey southward.

Given their habitat preferences, giant manta rays may also overlap with vessel transit routes from the Gulf of Mexico in the broader Action Area, especially in nearshore regions, though they are not expected to occur with any regularity along transit routes from Europe.

6 Effects of the Action on ESA-listed Species

Effects of the action are all consequences to ESA-listed species or critical habitat caused by the Proposed Action, including the consequences of other activities caused by the Proposed Action. A consequence is caused by the Proposed Action if the effect would not occur but for the Proposed Action and the effect is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02).

This section of the BA assesses the effects of the action on ESA-listed species and critical habitat that are likely to be adversely affected. The quantitative and qualitative analyses in this section are based on the best available commercial and scientific data on species biology and the effects of the action. Data are limited, and assumptions must be made to overcome these limits. Sometimes, the best available information may include a range of values for a particular aspect under consideration, or different analytical approaches may be applied to the same data set. In those cases, the uncertainty is resolved in favor of the species. This approach provides the "benefit of the doubt" to threatened and endangered species.

Effects of the Proposed Action are evaluated for the potential to result in harm to ESA-listed species. If a Project-related activity may affect an ESA-listed species, the exposure level and duration of effects are further evaluated for the potential to harass or injure ESA-listed species. The following sections present the potential Project-related effects on listed species of marine mammals, sea turtles, and fish from the construction, O&M, and decommissioning stages over the lifetime of the Project, with the application monitoring and mitigation measures as described in Section 3.3.

This effects discussion is organized by stressor responsible for impacts to each ESA-listed animal group (i.e., marine mammals, sea turtles, and marine fish). An overview of the stressors applicable to the Proposed Action is provided in Table 6-1. 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 title in parentheses.

6.1 Description of Stressors

Table 6-1. Stressors that could affect ESA-listed species

Stressor[a]	Description	Sources/Activities	ESA-listed Species[b] Exposed to the Stressor
Air emissions	Release of gaseous or particulate pollutants into the atmosphere. Can occur onshore and offshore.	• Internal combustion engines (e.g., generators) on board stationary sources or structures • Internal combustion engines within mobile sources such as vessels, vehicles, or aircraft	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle
Anchoring	An activity or action that attaches objects to the seafloor.	• Vessel anchoring • Attachment of a structure to the seafloor by use of an anchor, mooring, or gravity-based weighted structure (i.e., bottom-founded structure)	Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon
Cable emplacement and maintenance	An activity or action associated with installing new offshore submarine cables on the seafloor, commonly associated with offshore wind energy.	• Dredging or trenching (Inshore Export Cable) • Cable placement • Seafloor profile alterations • Sediment deposition and burial • Mattress and rock placement	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray
Discharges/ intakes	Generally, refers to routine permitted operational effluent discharges to receiving waters. There can be numerous types of vessel and structure discharges, such as bilge water, ballast water, deck drainage, gray water, fire suppression system test water, chain locker water, exhaust gas scrubber effluent, condensate, among others. These discharges are generally restricted to uncontaminated or properly treated effluents that may have best management practices or numeric pollutant concentration limitations imposed through USEPA National Pollutant Discharge Elimination System (NPDES) permits or USCG regulations. The discharge of dredged material refers to the deposition of sediment at approved offshore disposal sites.	• Vessels • Onshore point and non-point sources • Ocean disposal of dredged material (inshore export cables) • Installation, operation, and maintenance of submarine transmission lines, cables, and infrastructure	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray

Stressor[a]	Description	Sources/Activities	ESA-listed Species[b] Exposed to the Stressor
EMF	Power generation facilities and cables produce electric fields (proportional to the voltage) and magnetic fields (proportional to flow of electric current) in the air/water around the power line. For undersea power cables, the voltage on the wire conductors within the cable does not produce an electric field in the seafloor or ocean because it is locked (shielded) by the outer grounded metallic sheath encircling the conductors. However, the metallic sheath around the undersea power cable does not shield the environment from the magnetic field; therefore, a 60 hertz magnetic field surrounds each cable. This oscillating AC magnetic field induces a weak electric field in the surrounding ocean that is unrelated to the voltage of the cable. This means when the current flow on the undersea power cable increases or decreases, both the magnetic field and the induced electric field increase or decrease. Three major factors determine levels of the magnetic and induced electric fields from offshore wind energy projects: 1) the amount of electrical current being generated or carried by the cable, 2) the design of the generator or cable, and 3) the distance of organisms from the generator or cable.	• Substations • Power transmission cables • Inter-array cables • Electricity generation	Fin whale NARW Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon
Lighting	The presence of light above the water onshore and offshore as well as underwater.	• Vessels or offshore structures above or under the water • Onshore infrastructure	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle
Noise	Noise from various sources commonly associated with construction activities, geophysical and geotechnical surveys, and vessel traffic. May be impulsive (e.g., pile driving) or broad spectrum and continuous (e.g., from Project-associated marine transportation vessels). May also be noise generated from the turbines or interactions of the turbines with wind and waves.	• HRG surveys • Vessels • Cable installation and HDD noise • Dredging during installation of the inshore export cable • WTG operations during O&M • Pile driving • Foundation relief drilling • Seabed preparation	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray

Stressor[a]	Description	Sources/Activities	ESA-listed Species[b] Exposed to the Stressor
Presence of structures	An activity or action associated with onshore or offshore structures other than construction-related impacts, including the following: • Fish aggregation or dispersion • Marine mammal attraction or displacement • Sea turtle attraction or displacement • Scour protection • Allisions • Entanglement and gear ingestion • Gear loss or damage • Fishing effort displacement • Habitat alteration (creation or destruction) • Behavioral disruption (migration or breeding) • Seafloor alterations • Microclimate and circulation effects (above and below water)	• Offshore structures, including foundations, towers, and transmission cable infrastructure	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray
Monitoring surveys and gear utilization	Monitoring surveys refer to effects from biological surveys conducted pre-, during, and post-construction, including the following: • Bottom habitat disturbance • Removal of biological samples • Entanglement/entrapment from lost fishing gear Gear utilization refers to entanglement and bycatch from gear utilization during fisheries monitoring surveys.	• Fishery surveys • Geophysical surveys	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray
Traffic	Marine vessel traffic, including vessel strikes of marine mammals, sea turtles, and marine fish; collisions; and allisions.	• Vessels	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray

Stressor[a]	Description	Sources/Activities	ESA-listed Species[b] Exposed to the Stressor
Turbidity	Effects from turbidity associated with construction activities, vessel traffic, and presence of structures during operations.	• Installation of offshore and inshore infrastructure • Vessel activity • Presence of structures during operations	Fin whale NARW Sei whale Sperm whale Blue whale Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray
Unexpected and accidental events	Effects associated with unexpected and unanticipated events, such as vessel collision with a foundation, turbine failure due to weather events, accidental spills, pollution, and marine debris.	• Vessel traffic • Offshore structures	Fin whale NARW Sei whale Sperm whale Blue whale Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray

AC = alternating current; EMF = electromagnetic field; ESA = Endangered Species Act; NARW = North Atlantic right whale; USCG = U.S. Coast Guard; USEPA = U.S. Environmental Protection Agency

[a] The following stressors have been discounted from the assessment in the BA for the ESA-listed resources analyzed because they are not expected to have any discernable effects on these species: land disturbance and in-air noise.

[b] All critical habitat within the Action Area has been excluded from further analysis (Section 4.3) and, therefore, is not analyzed in Section 6.

6.2 Determination of Effects

In 2019, the term “consequences,” was introduced to the ESA to replace “direct” and “indirect” effects. Consequences are a result or effect of an action on ESA-listed 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 co-occurrence, of one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If NMFS concludes an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, the agency must also conclude 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 proposed activities 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 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, a determination is provided 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 could be affected by the Project: (1) no effect; (2) may affect, not likely to adversely affect; or (3) 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).

A **no effect** determination indicates the Project would have no impacts, positive or negative, on ESA-listed species or designated critical habitat. Generally, this means the species or critical habitat would not be exposed to the 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 effects that are undetectable, not measurable, or so minor 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*[6] 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 would be an adverse effect if it did impact an ESA-listed species), but it is extremely unlikely to occur (NMFS and USFWS 1998).

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

Table 6-2 depicts the effects determinations for each ESA-listed analyzed in this assessment by stressor that were not already discounted in Section 4.2. Following is a description of the existing conditions for each species of ESA-listed marine mammal, sea turtle, and marine fish in the Action Area, accompanied by the detailed effects assessment for each stressor on those ESA-listed species in Sections 6.3 through 6.10.

[6] 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 6-2. Effects determinations by stressor and species for effects of the Proposed Action

	Stressor	Marine Mammals				Sea Turtles				Marine Fish		
		Fin Whale	**North Atlantic Right Whale**	**Sei Whale**	**Sperm Whale**	**Green Sea Turtle (North Atlantic DPS)**	**Leatherback Sea Turtle**	**Loggerhead Sea Turtle (Northwest Atlantic Ocean DPS)**	**Kemp's Ridley Sea Turtle**	**Atlantic Sturgeon**	**Shortnose Sturgeon**	**Giant Manta Ray**
Underwater Noise	HRG surveys	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Vessel noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Cable installation noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Dredging during installation of the inshore export cable e	NE	NE	NE	NE	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NE
	WTG operations	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Effects on prey	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Decommissioning	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Offshore Impact Pile Driving	LAA	LAA	LAA	NLAA	LAA	LAA	LAA	LAA	NLAA	NLAA	NLAA
	Inshore Impact Pile Driving	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Foundation Relief Drilling	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Seabed Preparation	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Vessel Strike Risk	NLAA	NLAA	NLAA	NLAA	LAA	LAA	LAA	LAA	LAA	LAA	NLAA
Habitat Disturbance	Temporary Seafloor Disturbances	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE
	Turbidity	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Dredging during Installation of the Inshore Export Cable	NE	NE	NE	NE	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NE
	Permanent Seafloor Habitat Loss	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Behavioral Changes Due to the Presence of Structures	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA

Stressor		Marine Mammals				Sea Turtles				Marine Fish		
		Fin Whale	North Atlantic Right Whale	Sei Whale	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic Ocean DPS)	Kemp's Ridley Sea Turtle	Atlantic Sturgeon	Shortnose Sturgeon	Giant Manta Ray
	Changes in Oceanographic and Hydrologic Conditions Due to the Presence of Structures	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Reef Effect	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	EMF and Cable Heat	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Entrainment during Installation of the Inshore Export Cable	NE	NE	NE	NE	LAA	NE	NLAA	LAA	LAA	NLAA	NE
Entanglement and Entrainment	Secondary entanglement from derelict fishing gear	NLAA	NLAA	NLAA	NLAA	NLAA	LAA	LAA	NLAA	NLAA	NE	NLAA
Entanglement and Entrainment	Entanglement from fisheries monitoring surveys: stationary gear	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
Entanglement and Entrainment	Entanglement from altered and displaced fishing activities	NLAA	NLAA	NLAA	NLAA	NLAA	LAA	LAA	LAA	NLAA	NE	NLAA
	Air Emissions	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE
	Lighting	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NLAA
	Vessel Collisions/Allisions	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Unexpected and Accidental Events	WTG Failure	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Unexpected and Accidental Events	Accidental Spills, Pollution, and Marine Debris	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Overall Effects Determination	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**

-- = not applicable for resource; DPS = distinct population segment; EMF = electromagnetic field; HRG = high-resolution geophysical; NE = no effect; NLAA = not likely to adversely affect; OSS = Offshore substation; WTG = Wind Turbine Generator

6.3 Underwater Noise (pre-C, C, O&M, D)

BOEM recognizes stressors such as impact pile driving, HRG survey noise, vessel noise, cable installation noise, and WTG operations can result in the exposure of ESA-listed species to underwater noise sufficient to illicit auditory or behavioral effects. The extent and severity of auditory and non-auditory effects from Project generated underwater noise depends 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, US Wind conducted Project -specific underwater noise modeling for impact pile driving during installation of the WTG, OSS, and Met Tower foundations and HRG surveys on marine mammals, sea turtles, and marine fish under NMFS jurisdiction.

6.3.1 Overview

Underwater sounds in the marine environment originate from a variety of sources, including non-biological sources such as wind and waves, and biological sources such as the movements or vocalizations of marine life (Hildebrand 2009). Human activities can also introduce sound into the marine environment through activities like oil and gas exploration, construction, military sonars, and vessel traffic (Hildebrand 2009). The soundscape, or acoustic habitat, of a given ecosystem comprises all such sounds—biological, non-biological, and anthropogenic (Pijanowski et al. 2011). Soundscapes are highly variable across space, time, and water depth, among other factors, due to the properties of sound transmission and the types of sound sources present. A soundscape is sometimes called the acoustic habitat, as it is a vital attribute of a given area where an animal may live (i.e., habitat) (Hatch et al. 2016).

Sounds are created by the vibration of an object within its medium, in this case water. When coupled to the medium, the object's vibration travels as a propagating wave away from the sound source. As this wave moves through the water, particles undergo tiny back-and-forth movements (i.e., particle motion). When the motion results in more particles in one location, that location has relatively higher pressure and particles experience a higher force. Through force, particles are then accelerated out of the higher-pressure region to a lower-pressure region causing particle motion. Particles do not travel with the wave; instead they oscillate in roughly the same location, transferring their energy to surrounding particles. Acoustic pressure is a non-directional (scalar) quantity, whereas particle motion is an inherently directional quantity (a vector). The total energy of the sound wave includes the potential energy associated with the sound pressure as well as the kinetic energy from particle motion.

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

The efficiency of sound propagation in the ocean allows marine animals to use underwater sound as a method of communication, navigation, prey detection, and predator avoidance (Richardson et al. 1995; Southall et al. 2007; Dow Piniak et al. 2012; Popper and Hawkins 2018, 2019). Anthropogenic noise has gained recognition as a potential stressor for marine life because of their reliance on underwater hearing for maintenance of these critical biological functions (Richardson et al. 1995; Ketten 1998; Dow Piniak et al. 2012; Popper and Hawkins 2018, 2019). 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 could induce stress on marine animals in their receiving environment (OSPAR Commission 2009; Erbe 2013).

Anthropogenic noise sources are classified as either impulsive or non-impulsive and continuous or intermittent based on their acoustic characteristics (NMFS 2018, 2023j). Specifically, when it comes to potential damage to marine animal hearing, sounds are classified as either impulsive or non-impulsive, and when considering the potential to affect behavior or acoustic masking, sounds are classified as either continuous or intermittent.

Impulsive noises are characterized as having (Finneran 2016):

- broadband frequency content;
- fast rise times and decay times;
- short durations (i.e., less than 1 second); and
- high peak sound pressures.

Whereas the characteristics of non-impulsive sound sources are less clear but may be:

- variable in spectral composition (i.e., broadband, narrowband, or tonal);
- longer rise times, decay times, and total durations compared to impulsive sound; and
- continuous (e.g., vessel engine-radiated noise), or intermittent (e.g., echosounder pulses).

Underwater sound sources such as explosions, sparkers, boomers, and impact pile driving are impulsive and more likely to cause hearing damage than non-impulsive sources. Underwater explosions are further considered for non-auditory injury due to their source characteristics, as described below. Impulsive sounds are more likely to induce physiological effects, including temporary threshold shift (TTS) and permanent threshold shift (PTS), than non-impulsive sounds with the same energy. This binary, at-the-source classification of sound types, therefore, provides a conservative framework upon which to predict potential adverse hearing impacts to marine life.

For behavioral effects of anthropogenic sound on marine mammals, NMFS classifies sound sources as either intermittent or continuous (NMFS 2023j). Continuous sounds, such as drilling or vibratory pile driving continuously produce noise above ambient sound levels, for a given period of time, though this is often not well defined. An intermittent sound typically consists of bursts or pulses of sound on a regular on-off pattern, also called the duty cycle. Examples of intermittent sounds are those from scientific echosounders, sub-bottom profilers, and even pile driving. These delineations are not always practical in application, as a continuous yet moving sound source (such as a vessel passing over a fixed receiver) could be considered intermittent from the perspective of the receiver.

For auditory effects (i.e., PTS, TTS), underwater noise is less likely to affect an animal's hearing if the received noise occurs at frequencies outside an animal's primary hearing sensitivity. The importance of underwater noise at particular frequencies for a given animal can be scaled by frequency weighting relative to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998; Nedwell et al. 2007). Acoustic thresholds used to predict the extent of potential noise impacts on marine mammal and sea turtle hearing (PTS, 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 2023j).

Auditory thresholds from underwater noise are expressed using three common metrics: root-mean-square sound pressure level (SPL) and peak sound pressure level (L_{pk}), both measured in decibels (dB) referenced to (re) 1 micropascal (μPa), and sound exposure level (SEL), a measure of energy in dB re 1 μPa^2 s. L_{pk} is an instantaneous value, whereas SEL is the total noise energy over a given time period or event. As such, the SEL accumulated over 24 hours, (SEL_{24h}) is appropriate when assessing effects to marine mammals from cumulative exposure to multiple pulses or durations of exposure. SPL is a root mean square 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 SPL are equal.

The auditory and non-auditory thresholds used in this BA are given for each species group in the following subsections. The extent and severity of auditory and non-auditory effects from Project-generated underwater noise depends on the timing of activities relative to species occurrence, type of noise impact, and species -specific sensitivity.

6.3.2 Underwater Noise and Marine Mammals

Marine mammals rely heavily on acoustic cues for extracting information from their environment. Sound travels faster and farther in water (approximately 4,921 ft/s [1,500 m/s]) than it does in air (approximately 1,148 ft/s [350 m/s]), making this a reliable mode of information transfer across large distances and in dark environments where visual cues are limited. Acoustic communication is used in a variety of contexts, such as attracting mates, communicating to young, or conveying other relevant information (Bradbury and Vehrencamp 1998). Marine mammals can also glean information about their environment by listening to acoustic cues, like ambient sounds from a reef, the sound of an approaching storm, or the call from a nearby predator. Additionally, toothed whales produce and listen to echolocation clicks to locate food and navigate (Madsen and Surlykke 2013).

Like terrestrial mammals, the auditory anatomy of marine mammals generally includes the inner, middle, and outer ear (Ketten 1994). Not all marine mammals have an outer ear, but if it is present, it funnels sound into the auditory pathway, capturing the sound. The middle ear acts as a transformer, filtering and amplifying the sound. The inner ear is where auditory reception takes place. The key structure in the inner ear responsible for auditory perception is the cochlea, a spiral-shaped structure containing the basilar membrane, which is lined with auditory hair cells. Specific areas of the basilar membrane vibrate in response to the frequency content of the acoustic stimulus, causing hair cells mapped to specific frequencies to be differentially stimulated and send signals to the brain (Ketten 1994). While the cochlea and basiliar membrane are well conserved structures across all mammalian taxa, there are some key differences in the auditory anatomy of terrestrial versus marine mammals. Marine mammals have the unique need to hear in aqueous environments. Amphibious marine mammals (seals, sea otters, and sea lions) have evolved to hear in both air and under water, and all except phocid pinnipeds have external ear appendages. Cetaceans do not have external ears or air-filled external canals, and the bony portions of the ear are much denser than those of terrestrial mammals (Ketten 1994).

All marine mammals have binaural hearing and can extract directional information from sound. But the pathway that sound takes into the inner ear is not well understood for all cetaceans and may not be the same for all species. For example, in baleen whales (i.e., mysticetes), bone conduction through the lower jaw may play a role in hearing (Cranford and Krysl 2015), while odontocetes have a fat-filled portion of the lower jaw, which is thought to funnel sound towards the ear (Mooney et al. 2012). Hearing tests have been conducted on several species of odontocetes (i.e., toothed whales), but there has yet to be a hearing test on a baleen whale, so most information comes from examining the ears of deceased whales (Erbe et al. 2016; Houser et al. 2017).

Many marine mammal species produce sounds through vibrations in their larynx (Frankel 2009). In baleen whales, for example, air in the lungs and laryngeal sac expands and contracts, producing vibrations and sounds within the larynx (Frankel 2009). Baleen whales produce low-frequency sounds that can be used to communicate with other animals over great distances (Clark and Gagnon 2004). Differences in sound production among marine mammal species vary, in part, with their use of the marine acoustic environment. Toothed whales hunt for their prey using high-frequency echolocation signals. To produce these signals, they have a specialized structure called the melon in the top of their head. When air passes through the phonic lips, a vibration is produced, and the melon helps transmit the vibration from the phonic lips to the environment as a directed beam of sound (Frankel 2009). It is generally believed that if an animal produces and uses a sound at a certain frequency, its hearing sensitivity will at least overlap with those particular frequencies. An animal's hearing range is likely much broader than this, as they rely heavily on acoustic information beyond the signals they produce themselves to understand their environment.

The following subsections provide an overview of the available information on marine mammal hearing, the thresholds applied, source levels for sound sources assessed in this BA, and the impact consequences for each potential underwater noise-generating activity for the Proposed Action.

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

6.3.2.1 Auditory Criteria for Injury and Behavioral Disturbance to Marine Mammals

Assessment of the potential effects of underwater noise on marine mammals requires acoustic thresholds against which received sound levels can be compared. For marine mammals, established acoustic criteria for hearing injury and behavioral disturbance recognized by NMFS were recently updated, specifically auditory injury thresholds (NMFS 2023j). The revised auditory injury thresholds apply dual criteria—Lpk and SEL_{24h}—and are based on updated frequency weighting functions for five marine mammal hearing groups described by NMFS (2023j), Southall et al. (2007) and Finneran and Jenkins (2012). However, the species considered in this BA only belong to two hearing groups (Table 6-3.).

Table 6-3. Hearing groups for ESA-listed marine mammal species

Hearing Group	Taxonomic Group	Generalized Hearing Range[1]
Low-frequency cetaceans (LFC)	Baleen whales (e.g., NARW, fin whale)	7 Hz to 35 kHz
Mid-frequency cetaceans (MFC)	Sperm whale	150 Hz to 160 kHz

Source: Southall et al. (2007); Finneran and Jenkins (2012); NMFS (2023j)
Hz = hertz; kHz = kilohertz; NARW = North Atlantic right whale
[1] 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).

Behavioral disturbance thresholds for marine mammals are based on an SPL of 160 dB re 1 µPa for non-explosive impulsive or non-impulsive, intermittent sounds and 120 dB re 1 µPa for non-impulsive, continuous sounds for all marine mammal species (NMFS 2023j). Although these behavioral 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 exposure to result in adverse impacts on a marine mammal 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.

Sound reaching the receiver at sufficient loudness and for ample duration can result in a loss of hearing sensitivity in marine animals, termed a noise-induced threshold shift (i.e., TTS or PTS). TTS is a relatively short-term, reversible loss of hearing following exposure (Southall et al. 2007, 2019), 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. Data indicate that TTS onset in marine mammals is more closely correlated with the received SEL_{24h} than with the L_{pk} and that received sound energy over time, not just the single strongest pulse, should be considered a primary measure of potential impact (Southall et al. 2007; Finnern et al. 2017; NMFS 2018). 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 (Southall et al. 2007; Finneran et al. 2017). Prolonged or repeated exposure to sound levels sufficient to induce TTS without recovery time can lead to PTS (Southall et al. 2007). TTS is also considered part of Level B harassment under the MMPA meaning it is an indication of potential behavioral disturbances in response to underwater noise.

Table 6-4 outlines the acoustic thresholds for onset of acoustic impacts for marine mammals for impulsive and non-impulsive noise sources. Impulsive noise sources for the Project include impact pile driving and some HRG equipment. Non-impulsive noise sources associated with the Project include some HRG equipment, vessel activities, cable installation, and WTG operations.

Table 6-4. Acoustic marine mammal thresholds (TTS and PTS) for ESA-listed cetaceans

Marine Mammal Hearing Group	Effect	Impulsive Source		Non-Impulsive Source
		Unweighted L_{pk} (dB re 1 µPa)	Weighted SEL_{24h} (dB re 1 µPa² s)	Weighted SEL_{24h} (dB re 1 µPa² s)
LFC	PTS	219	183	199
	TTS	213	168	179
MFC	PTS	230	185	198
	TTS	224	170	178

Source: NMFS 2023j
dB re 1 µPa = decibels relative to 1 micropascal; dB re 1 $\mu Pa^2 s$ = decibels relative to 1 micropascal squared second; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; PTS = permanent threshold shift; TTS = temporary threshold shift

Marine mammals show varying levels of behavioral 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; Finneran et al. 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.

Not all responses within a given category need to be observed; a score is assigned for a severity category if any of the responses in that category are displayed (Southall et al. 2021). To be conservative, the highest (most severe) score is assigned when several responses are observed from different categories. In addition, Southall et al. (2021) acknowledged 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 scale also moves away from distinguishing noise impacts from impulsive versus non-impulsive sound types into considering the specific type of noise (e.g., pile driving, seismic, vessels).

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 6-3).

6.3.3 Underwater Noise and Sea Turtles

Potential adverse auditory effects to sea turtles from Project-generated underwater noise includes PTS, TTS, and behavioral disruption. An overview of the underwater noise modeling conducted for marine mammals for impact pile driving also considered sea turtles and is provided in Section 6.3.5. The following subsection 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.

6.3.3.1 Auditory Criteria for Injury and Disturbance to Sea Turtles

The outermost part of the sea turtle ear, or tympanum, is covered by a thick layer of skin over a fatty layer that conducts sound in water to the middle and inner ear. This is a distinguishing feature from terrestrial and semi-aquatic turtles. This thick outer layer makes it difficult for sea turtles to hear well in air, but it facilitates the transfer of sound from the aqueous environment into the ear (Ketten et al. 1999). The middle ear has two components that are encased by bone, the columella and extracolumella, which provide the pathway for sound from the tympanum on the surface of the sea turtle’s head to the inner ear. The middle ear is also connected to the throat by the Eustachian tube. The inner ear consists of the cochlea and basilar membrane. Because there is air in the middle ear, it is generally believed that sea turtles detect sound pressure rather than particle motion. Sea turtle ears are similar to terrestrial reptilian ears, but due to the historically limited data in sea turtles and terrestrial reptiles, fish hearing has often been used as an analog when considering potential impacts of underwater sound.

Hearing in sea turtles has been measured through electrophysiological and behavioral studies in air and in water on a limited number of life stages for each of the four sea turtle species considered in this BA. In general, sea turtles hear best (in water) between 200 to 750 hertz and do not hear well above 1 kilohertz. There are, however, species- and life stage-specific differences in sea turtle hearing (Table 6-5). Sea turtles are also generally less sensitive to sound than marine mammals, with the most sensitive underwater hearing thresholds measured at or above 75 dB re 1 μPa (Papale et al. 2020; Reese et al. 2023). Loggerhead sea turtles have been studied most thoroughly compared to other species, including post-hatchlings (Lavender et al. 2012, 2014), juveniles (Bartol et al. 1999; Lavender et al. 2012, 2014), and adults (Martin et al. 2012).

Table 6-5. Hearing capabilities of sea turtles

Species	Life Stage(s) Tested	Hearing Frequency Range (Hz)	Maximum Sensitivity (Hz)	Reference(s)
Loggerhead sea turtle (*Caretta caretta*)	Post-hatchling, juvenile	100–900 (in air)	500–700	Bartol and Ketten 2006; Ketten and Bartol 2005
	Post-hatchling, juvenile, adult	50–1,100 (under water)	100–400	Bartol et al. 1999; Lenhardt 2002; Bartol and Bartol 2012; Martin et al. 2012; Lavender et al. 2014

Species	Life Stage(s) Tested	Hearing Frequency Range (Hz)	Maximum Sensitivity (Hz)	Reference(s)
Green sea turtle (*Chelonia mydas*)	Juvenile, sub-adult	50–2,000 (in air)	200–700	Ridgway et al. 1969; Bartol and Ketten 2006; Ketten and Bartol 2005; Piniak et al. 2016
	Juvenile	50–1,600 (under water)	200–400	Piniak et al. 2016
Leatherback sea turtle (*Dermochelys coriacea*)	Hatchling	50–1,600 (in air)	300	Piniak 2012; Piniak et al. 2012
	Hatchling	50–1,200 (under water)	300	Piniak 2012; Piniak et al. 2012
Kemps ridley sea turtle (*Lepidochelys kempii*)	Juvenile	100–500 (in air)	100–200	Bartol and Ketten 2006; Ketten and Bartol 2005

As with marine mammals, the potential for underwater noise to adversely impact a sea turtle depends on the received sound level and the frequency content of the sound relative to the hearing ability of the animal. Potential effects range from subtle changes in behavior at low received levels to strong disturbance effects or potential injury or mortality at high received levels.

Also known as auditory fatigue, TTS is the milder form of hearing impairment that is non-permanent and reversible, and results from exposure to high intensity sounds for short durations or lower intensity sounds for longer durations. In most cases, it is assumed that TTS would occur before PTS; and ranges to TTS thresholds are expected to be greater than PTS threshold ranges. Both PTS and TTS are species-specific, and lead to an elevation in the hearing threshold, meaning it is more difficult for an animal to hear sounds. TTS can last for minutes, hours, or days; the magnitude of the TTS depends on the level (frequency and intensity), energy distribution, and duration of the noise exposure among other considerations. While there is no direct evidence of PTS or TTS occurring in sea turtles, TTS has been demonstrated in other marine species in response to exposure to impulsive and non-impulsive noise sources in laboratory studies (Southall et al. 2007). Prolonged or repeated exposure to sound levels sufficient to induce TTS without recovery time can lead to PTS (Southall et al. 2007). TTS is typically applied when assessing regulatory impacts of specific activities (e.g., military operations, explosions). Preliminary analyses from a Woods Hole Oceanographic Institute (WHOI) (2022) freshwater turtle study showed TTS onset occurring lower than the 200 dB re 1 μPa^2 s criteria currently used to predict TTS in sea turtles, which could be a function of species and other conditions. The WHOI (2022) study indicated that TTS up to 40 dB re 1 µPa may be experienced in freshwater turtles; however, hearing returned to initial sensitivities following a recovery period of 20 minutes to several days (WHOI 2022). It is reasonable to assume that the thresholds for TTS onset are lower than those for PTS onset, but higher than behavioral disturbance onset. Until more studies improve the understanding of TTS in sea turtles, ranges to TTS thresholds and TTS exposures should be considered qualitative; and mitigation measures designed to reduce PTS and behavioral exposures should also contribute to reducing the risk of the TTS exposures.

Tables 6-6 and 6-7 outline the acoustic thresholds used to assess the onset of PTS, TTS, and behavioral disruptions for sea turtles. Behavioral criteria for impact pile driving were developed by the U.S. Navy in consultation with NMFS based on exposure to airgun noise presented by McCauley et al. (2000a) and Finneran et al. (2017). Impact pile driving produces repetitive, impulsive sounds. In addition, the working group that prepared the American National Standards Institute (ANSI) Sound Exposure Guidelines (Popper et al. 2014) provided parametric descriptors of sea turtle behavioral responses to pile driving (Table 6-8).

The received sound level at which sea turtles are expected to actively avoid impulsive sounds like airgun exposures, an SPL of 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 activities (Finneran et al. 2017). For sea turtles, no distinction is made in the behavioral threshold between impulsive and non-impulsive sources.

Table 6-6. Acoustic impact thresholds[1] for sea turtles – impulsive sources

PTS		TTS		Behavioral[2]
L_{pk} Unweighted	SEL_{24h} Weighted	L_{pk} Unweighted	SEL_{24h} Weighted	SPL Unweighted
232	204	226	189	175

Source: Finneran et al. (2017)
[1] 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 to exceed the L_{pk} thresholds associated with impulsive sounds, these thresholds are recommended for consideration.
[2] The behavioral disturbance threshold is for all sources; currently, there are not enough data to derive separate thresholds for different source types.
L_{pk} = peak sound pressure level in units of decibels referenced to 1 micropascal; SEL_{24h} = sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; PTS = permanent threshold shift; SPL = sound pressure level; TTS = temporary threshold shift

Table 6-7. Acoustic impact thresholds[1] for sea turtles – non-impulsive sources

PTS	TTS	Behavioral[2]
SEL_{24h} Weighted	SEL_{24h} Weighted	SPL Unweighted
220	200	175

Source: Finneran et al. (2017)
[1] 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.
[2] Behavioral disturbance threshold applies to all sources – currently, there are not enough data to derive separate thresholds for different source types.
SEL_{24h} = sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; PTS permanent threshold shift; SPL = sound pressure level; TTS = temporary threshold shift

Table 6-8. Qualitative acoustic impact guidelines for sea turtles

Impairment			
Recoverable Injury	**TTS**	**Masking**	**Behavior**
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
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

Source: Popper et al. (2014)
Notes: Relative risk (high, moderate, or 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 because the animals are not exposed to more than one or a few explosive events, and masking would not last beyond the period of exposure. For continuous sounds, data are 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 refers to injuries, including hair cell damage, minor internal or external hematoma, etc. These injuries are not likely to result in mortality.

6.3.4 Underwater Noise and Marine Fish

Many fishes produce sounds for basic biological functions like attracting a mate and defending territory. A recent study revealed sound production in fishes has evolved at least 33 times throughout evolutionary time, and that most ray-finned fishes are likely capable of producing sounds (Rice et al. 2022). Fish may produce sounds through a variety of mechanisms, such as vibrating muscles near the swim bladder, rubbing parts of their skeleton together, or snapping their pectoral fin tendons (Ladich and Bass 2011; Rice et al. 2022).

There are some species that are not known to produce sounds but still have acute hearing (e.g., goldfish), suggesting fish glean information about their environment through acoustic cues, a process called auditory scene analysis (Fay 2009). All sound in a given environment, both natural and anthropogenic, compose the soundscape, or acoustic habitat, for that species (Pijanowski et al. 2011). Acoustic habitats naturally vary over space and time, and there is increasing evidence that some fish and invertebrate species can distinguish between soundscapes of different habitats (Kaplan et al. 2015; McWilliam and Hawkins 2013; Radford et al. 2008). In fact, some pelagic larvae may use soundscapes as a cue to orient towards suitable settlement habitat (Lillis et al. 2013, 2015; Montgomery 2006; Radford et al. 2007; Simpson et al. 2005; Vermeij et al. 2010) or to induce molting into their juvenile forms (Stanley et al. 2015).

All fish are capable of sensing the particle motion component of underwater sound (for additional information about particle motion, see draft EIS Appendix B, BOEM 2023b). The inner ear of fishes is similar to that of all vertebrates. Each ear has three otolithic end organs, which contain a sensory epithelium lined with hair cells as well as a dense structure called an otolith (Popper and Hawkins 2021). Particle motion is the displacement, or back and forth motion, of water molecules and as it moves through the body of the fish (which has a density similar to seawater), the denser otoliths lag behind, creating a shearing force on the hair cells, which sends a signal to the brain via the auditory nerve (Fay and Popper 2000). Available research shows the primary hearing range of most particle-motion sensitive organisms is below 1 kilohertz (Popper and Hawkins 2021).

In addition to particle motion detection shared across all fish, some species are capable of detecting the pressure component of underwater sound (Fay and Popper 2000). Special adaptations of the swim bladder in these species (e.g., anterior projections, additional gas bubbles, bony parts) bring it in close proximity to the ear, and as the swim bladder expands and contracts, pressure signals are radiated to the ear in the form of particle motion (Popper and Hawkins 2021). These species typically can detect a broader range of acoustic frequencies (up to 3 to 4 kilohertz; Wiernicki et al. 2020) and are therefore considered more sensitive to underwater sound than species that can only detect particle motion. Hearing sensitivity in fishes is generally considered to fall along a spectrum: the least -sensitive (hearing generalists) are those that do not possess a swim bladder and only detect sound through particle motion, limiting their range to sounds below 1 kilohertz; the most sensitive (hearing specialists) possess specialized structures enabling pressure detection, which expands their detection frequency range (Popper and Hawkins 2021). A few species in the herring family can detect ultrasonic (greater than 20 kilohertz) sounds (Mann et al. 2001), but this is considered very rare among bony fishes. Another important distinction for species that possess swim bladders is whether it is open or closed; species with open swim bladders can release pressure through a connection to the gut, while those with closed swim bladders can only release pressure very slowly, making them more prone to injury when experiencing rapid changes in pressure (Popper and Hawkins 2019). Also, hearing sensitivity can change with age. In some species (e.g., black sea bass), the closer proximity between the ear and the swim bladder in smaller fish can mean younger individuals are more sensitive to sound than older fish (Stanley et al. 2020). In other species, hearing sensitivity seems to improve with age (Kenyon 1996).

Compared to other fauna such as marine mammals, research has only scratched the surface in understanding the importance of sound to fish species, but there are sufficient data to conclude that underwater sound is vitally important to basic life functions of marine fishes, such as finding a mate, deterring a predator, or defending territory (Popper and Hawkins 2018, 2019). Therefore, these species must be able to detect components of marine soundscapes, and this ability could be adversely affected by the addition of noise from anthropogenic activity.

As with marine mammals and sea turtles, fishes may experience a range of impacts from underwater sound, depending on physical qualities of the sound source and the environment as well as the physiological characteristics and behavioral context of the species of interest. Unlike marine mammals, whose hair cells do not regenerate, fishes are able to regrow hair cells that die or become damaged (Corwin 1981), and therefore do not experience PTS. However, fishes do experience TTS; when very close to impulsive sound sources or explosions, they could experience barotrauma, a class of injuries ranging from recoverable bruises to organ damage, which could lead to death (Stephenson et al. 2010; Popper et al. 2014). When the air-filled swim bladder inside the body of the fish quickly expands and contracts due to a rapid change in pressure, it can cause internal injuries to nearby tissues (Halvorsen et al. 2011). The greater the difference between the static pressure at the site of the fish and the positive/ negative pressures associated with the sound source, the greater the risk of barotrauma. This means that impulsive sounds like those generated by impact pile driving may present a risk of injury due to the rapid changes in acoustic pressure (Hamernik and Hsueh 1991). As with marine mammals, continuous, lower-level sources (e.g., vessel noise) are unlikely to result in auditory injury but could induce changes in behavior or acoustic masking.

The three ESA-listed fish species under NMFS jurisdiction considered in this BA are the Atlantic sturgeon, shortnose sturgeon and giant manta ray (Section 5.1.3). The Atlantic sturgeon and shortnose sturgeon have a swim bladder and can detect the sound pressure component of noise, but the swim bladder is not directly connected to hearing like species of carp or herring and therefore are less sensitive to underwater sound pressure. Giant manta rays do not have a swim bladder and detect noise predominantly through particle motion.

6.3.4.1 Auditory Criteria for Injury and Disturbance to Marine Fish

The currently available underwater noise exposure thresholds for fish are based on the sound pressure component. However, as discussed previously, all fish can detect water-borne particle motion. Anthropogenic sounds that interfere with the ability to detect both sound pressure and particle motion could interfere with an animal's ability to detect acoustic cues in its environment (Hawkins et al. 2021). While these potential effects are acknowledged, exposure thresholds for the particle motion component of sound have yet to be developed for fishes (Hawkins et al. 2021). As such, the potential effects on these species from the particle motion component of cannot be fully assessed at this time.

Acoustic criteria to assess potential effects to fish were developed by the Fisheries Hydroacoustic Working Group (FHWG 2008) and recommended by NMFS (2023j) and are presented in Table 6-9. These criteria include thresholds for impulsive sources (e.g., impact pile driving). Impulsive criteria include dual metrics that are used to assess the effects to fish exposed to high levels of accumulated energy (SEL_{24h}) for repeated impulsive sounds and a single strike at high L_{pk}. The criteria include a maximum accumulated SEL_{12h} for lower-level signals and a maximum L_{pk} for a single pile driving strike or explosive event (NMFS 2023j). NMFS has not established a formal threshold for behavioral disturbance; however, the SPL threshold of 150 dB re 1 μPa 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; NMFS 2023j).

The FHWG was formed in 2004 and consists of biologists from NMFS, the USFWS, the Federal Highway Administration, the 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 criteria 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 weighing ≥2 grams for the onset of physiological effects (Stadler and Woodbury 2009), not necessarily levels at which fish are mortally damaged. These criteria, provided in Table 6-9, were developed to apply to all fish species. However, as the only two fish species considered in this BA are the Atlantic sturgeon and giant manta ray, both of which are considered ≥2 grams, only thresholds for this type are provided in this assessment.

Table 6-9. Thresholds for onset of physiological effects, mortality, and behavioral disturbance for fish from impulsive sources

Marine Fish Type	Physiological Effects[a]		Behavioral Disturbance[b]
	L_{pk} (dB re 1 μPa)	SEL_{12h} (dB re 1 μPa^{2}s)	SPL (dB re 1 μPa)
	Impulsive	Impulsive	Impulsive/Non-Impulsive
Fish (≥2 grams)	206	187	150

[a] From NMFS (2023j)
[b] From Andersson et al. (2007); Mueller-Blenke et al. (2010); Purser and Radford (2011); Wysocki et al. (2007)
≥ = greater than or equal to; dB re 1 μPa = decibels referenced to 1 micropascal; dB re 1 μPa^{2}s = decibels referenced to 1 micropascal squared second

6.3.5 Assumptions/Acoustic Model

Marine Acoustics, Inc. (MAI) was contracted to model and assess the underwater sound produced by impact pile driving used during installation of the WTG, OSS, and Met Tower foundations. The objective was to predict the ranges of acoustic thresholds and resulting injury and behavioral changes in marine mammals, sea turtles, and fish species during construction of the Project. The modeled activities included impact pile driving of 36.1-feet (11-meters) monopile foundations for the WTGs, impact pile driving of 9.8-feet (3-meters) post-piled skirt piles for the OSS jacket foundations, and impact pile driving of 5.9-feet (1.8-meters) pin piles for the Met Tower. US Wind is not proposing vibratory pile driving of any foundations.

The impact pile driving activities were modeled to produce unweighted and frequency-weighted broadband underwater acoustic fields. The acoustic ranges of various physiological and behavioral auditory thresholds for marine mammals, sea turtles, and fishes were determined from these broadband sound fields using the acoustic thresholds described in Sections 6.3.2 through 6.3.4.

HRG surveys were not modeled by MAI; instead the ranges to the behavioral disturbance threshold for marine mammals resulting from HRG survey activities were calculated by TRC (2023) using the NMFS Recommendation for Sound Source Level and Propagation Analysis for HRG Sources and the Associated Level B Harassment Isopleth Calculator (NMFS 2020a) (Section 6.3.5.2). Because the LOA application is an MMPA requirement, sea turtles and fish were not included in this report, and ranges were obtained from the Biological Assessment for Data Collection and Site Survey Activities for Renewable Energy on the Atlantic Outer Continental Shelf (Baker and Howsen 2021) for these species. For all other noise sources, modeling was not conducted by MAI, and ranges were not calculated in the LOA application; therefore, for the purposes of this BA estimated source levels obtained from published literature were used with a spherical spreading loss equation (20log[range]) to provide an estimate of the range over which the thresholds for ESA-listed species may be met or exceeded.

The ranges to modeled and/or calculated acoustic thresholds are presented in the individual effects section for each species group and summarized for three of the primary noise sources in Table 6-10.

Table 6-10. Maximum estimated range in meters to auditory thresholds for individual species groups for sound-producing activities under the Proposed Action.

Auditory Threshold	**Species Group**	**Impact Pile Driving[1]**			**HRG Surveys[2]**	**O&M Facility Piling**			**Other continuous noise sources (vessels, cable laying, HDD, dredging, WTG operations, and relief drilling)[3]**
		WTG Monopile	**OSS Skirt Piles**	**Met Tower Pin Piles**		**12- to 18-inch Steel Piles**	**12- to 18-inch Timber Piles**	**Sheet Piles**	
PTS in marine mammals and sea turtles, recoverable injury for fish	LFC	2,900	1,400	50	N/A	2	0.9	70	N/A
	MFC	<50	0	0	N/A	0.1	0	3	N/A
	Sea Turtles	250	50	0	N/A	0.1	0	3	N/A
	Fish (≥2 g)	4,000	1,500	50	9	3	0.5	38	N/A
TTS	LFC	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M
	MFC	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M
	Sea Turtles	2,750	1,000	50	N/M	N/M	N/M	N/M	N/M
	Fish (≥2 g)	4,500	1,750	50	N/M	N/M	N/M	N/M	N/M
Behavior	LFC	5,250	500	100	50.1	5	3	46	<10,000
	MFC	5,250	500	100	50.1	5	3	46	<10,000
	Sea Turtles	850	0	0	40	0.5	0.3	5	<20
	Fish (≥2 g)	13,650	2,650	750	1,996	25	14	215	<320

HRG = high-resolution geophysical; HDD = highly directional drilling; N/A = Not applicable because no PTS effects are anticipated to be reasonably likely to occur given small ranges to thresholds; N/M = ranges not modeled or not calculated because of limited applicability in regulatory framework or effects determination; OSS = offshore substation; WTG = wind turbine generator.

[1] Ranges for impact pile driving are based on the acoustic modeling conducted by MAI (2023) with 10 decibels noise mitigation as included in US Wind's Letter of Authorization (LOA) LOA application (TRC 2023).

[2] Ranges to the acoustic thresholds for marine mammals for HRG surveys are based on the modeling conducted for the take assessment in US Wind's LOA application (TRC 2023). Ranges to the acoustic thresholds for sea turtles and fish were not available in the LOA application (TRC 2023) so instead were obtained from the Biological Assessment for Data Collection and Site Survey Activities for Renewable Energy on the Atlantic Outer Continental Shelf (Baker and Howsen 2021).

[3] All other continuous noise sources considered in this BA include vessel noise, cable installation noise, HDD noise, dredging noise, WTG operational noise, and foundation relief drilling noise. These sources were not included in the modeling conducted by MAI (2023) nor the LOA application (TRC 2023), so instead ranges were estimated using a spherical spreading loss equation (20log[range]) with available source level estimates from published literature. The ranges provided in this table comprise the maximum estimated ranges for all other continuous noise sources considered in this BA. Additional details and specific literature cited for each noise sources are provided in the subsequent stressor sections of this BA (Sections 6.3.7 through Section 6.3.12; Section 6.3.14 and Section 6.3.15).

Animat, or animal movement and exposure, modeling was also conducted to determine acoustic exposures of marine mammals and sea turtles from impact pile driving activities. The potential acoustic exposures of protected marine mammals and sea turtles were estimated using the Acoustic Integration Model© (AIM). AIM is a Monte Carlo-based statistical model (Frankel et al. 2002) in which many repeated simulations provide the probability of an outcome. AIM simulations create realistic animal movement tracks that, collectively, provide a reasonable representation of movements of the animals in a population. Animats are programmed with a range of values for movement parameters, such as minimum and maximum speed or dive depth (Table B- 1, MAI 2023). The underlying statistical distribution for these parameters is uniform, with the exception of speed. Speed can be specified with a truncated normal (eight standard deviations between the minimum and maximum speed) or a gamma distribution as best fits the data for that animat (MAI 2023). Multiple behavioral states can be included for each species or species group to best represent real animal movement. These simulated movements are integrated with the modeled acoustic fields produced by impact pile driving to estimate the animals' exposure to the acoustic field.

The AIM simulated the four-dimensional movements (range, depth, bearing, and time) of marine mammals and sea turtles during impact pile driving at the modeling location. Animats were distributed in a 104.4- by 95.7-mile (168- by 154-kilometer) box centered on the modeling site (MAI 2023). Animats were limited within this modeling box by the coastline and the minimum occurrence depth for each species (MAI 2023) based on the available scientific literature. Animat movements were convolved with acoustic propagation modeling outputs to predict exposure histories for each simulated animal over a 24-hour period. Movements of marine mammal and sea turtle species potentially occurring in the US Wind Project area were modeled to predict their exposure to the sounds resulting from impact pile driving. The estimated piling schedule for each phase of construction is provided in Table 6-11. However, throughout the effects analysis in Section 6, construction and O&M activities are assessed by year, not by construction campaign (or phase as termed by NMFS), because all the exposure modeling was conducted on an annual basis rather than by construction campaign. Modeling was conducted for each activity (e.g., piling, HRG surveys) and results are provided in the modeling report (MAI 2023); however, final takes were not requested for each activity in the LOA application (TRC 2023). Instead, all Project activities included in the LOA application over an annual period were combined into a single take assessment for all activities. Therefore, the modeling for individual activities such as impact pile driving may have resulted in less than 1 take of a given species or stock (MAI 2023); but combined with other activities, those takes may increase to one or more individuals as shown in the LOA application (TRC 2023). However, for the purposes of this BA, subsequent effects analysis was conducted for each stressor based on the exposure modeling results of individual activities from MAI (2023), not the combined activities.

Table 6-11. Estimated piling schedule for each construction year by foundation type

Month	Year 1 (2025)[a]		Year 2 (2026)			Year 3 (2027)	
	Monopiles[b]	Skirt Piles[c]	Monopiles[b]	Skirt Piles[c]	Pin Piles[d]	Monopiles[b]	Skirt Piles[c]
May	0	0	16	0	0	15	0
June	8	0	16	0	3	10	0
July	0	4	16	8	0	13	4
August	0	0	7	0	0	0	0
September	13	0	0	0	0	0	0
October	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0
Total piles	21	4	55	8	3	38	4
Total piling days	21	1	55	2	1	38	1

Source: TRC 2023
[a] The anticipated 2-month gap during phase 1 construction is based on the expected vessel and contractor availability
[b] Monopiles are the foundations proposed for the wind turbine generators
[c] Skirt piles are the foundations proposed for the offshore substations
[d] Pin piles are the foundations proposed for the Met Tower

Marine mammal density estimates were obtained from the most recent available habitat density models from Roberts et al. (2022) available at the time of the modeling. For sea turtles, the modeling report used two sources of sea turtle densities available: U.S. Department of the Navy [USDON 2007]) and Barco et al. (2018). The USDON (2007) density estimates were prepared for the Navy's U.S. Atlantic operating areas, which include the immediate Project area. More recent, and higher, loggerhead sea turtle density estimates for the immediate Project area are available from Barco et al. (2018), which also included a seasonal availability correction factor. Both the USDON (2007) and Barco et al. (2018) density estimates for the loggerhead sea turtle were included in the exposure modeling (Appendix A, TRC 2023), but only the exposure estimated with Barco et al. (2018) densities were used for this effects analysis because they represented the highest potential number of exposures. Although these numbers are likely overestimates of the actual expected exposures, upward shifts in sea turtle densities within the Mid-Atlantic Bight (Patel et al. 2021) indicated using higher densities projected forward for the Proposed Action represents the best available data and approach.

Though green sea turtles may occur seasonally in the Project area, no at-sea density estimates are available for this less commonly occurring species. Green turtles were included in the USDON (2007) "hard-shelled guild" density data set; therefore, seasonal density estimates from the guild as a whole were used as surrogate densities for the green sea turtle. The resulting higher-than-expected numbers of green sea turtle exposures compared to other more common species is likely the result of a combination of using the hard-shelled guild for densities and the more inshore distribution of Kemp's ridley sea turtles, which may not be fully captured in the USDON (2007) density layers. Acknowledging that the results from using the hard-shelled guild will likely be overestimated, it represents the best available data for green sea turtles in this area. Furthermore, the U.S. Navy set the precedent for using the hard-shelled guild's density estimates to represent the green sea turtle (USDON 2018), as it represents the only available data provided in the modeling report.

The modeled sound exposures were normalized using the density estimates provided in Table 6-12 and Table 6-13, which provide the total number of marine mammals and sea turtles potentially exposed to PTS or behavioral-level noise effects from impact pile driving during installation of the WTG, OSS, and Met Tower foundations and HRG survey noise. Additional details about the modeling for each of these Project activities are provided in the following subsections.

Table 6-12. Monthly mean densities (animals per square kilometer [km^2]) of ESA-listed marine mammals in the Lease Area used in the exposure modeling

Species	January	February	March	April	May	June	July	August	September	October	November	December
NARW	0.00075	0.00076	0.00063	0.00045	0.00008	0.00003	0.00001	0.00001	0.00002	0.00004	0.00011	0.00036
Fin whale	0.00214	0.00184	0.00154	0.00135	0.00094	0.00111	0.00041	0.00028	0.00040	0.00037	0.00045	0.00151
Sei whale	0.00029	0.00021	0.00034	0.00061	0.00020	0.00005	0.00001	0.00000	0.00001	0.00006	0.00017	0.00046
Sperm whale	0.00004	0.00001	0.00001	0.00004	0.00006	0.00002	0.00002	0.00000	0.00000	0.00000	0.00001	0.00003

Source: TRC 2023

Table 6-13. Seasonal mean densities (animals per square kilometer [km^2]) of ESA-listed sea turtles in the Lease Area used in the exposure modeling

Species	Spring (March–May)	Summer (June–August)	Fall (September–November)	Winter (December–February)
Green sea turtle[a]	0.03802	0.05041	0.03802	0.03802
Kemp's ridley sea turtle	0.00220	0.00226	0.00220	0.00220
Leatherback sea turtle	0.02040	0.0.02706	0.02040	0.02040
Loggerhead sea turtle[b]	3.319	1.385	1.488	-

Source: Appendix A, TRC 2023

[a] Population data were insufficient to determine an individual species density estimate for the green sea turtle in the USDON (2007) data set. However, data for the green sea turtle were included in the hard-shelled guild density estimate. Thus, the hard-shelled guild density estimate was used as a surrogate density for the green sea turtle.

[b] Densities for loggerhead sea turtles used data from Barco et al. (2018) rather than USDON (2007), which was used for all other species.

6.3.5.1 Impact Pile Driving

A single representative location (38.3°N, 74.7°W) was selected for the underwater acoustic modeling analysis. The model site has a water depth of 88.6 feet (27 meters), which is an intermediate water depth in the Project area, where water depths range from 42.7 to 137.8 feet (13 to 42 meters). Parameters of the physical environment at this model location, including water column (e.g., bathymetry, surface roughness, seasonal sound velocity profiles), atmosphere (e.g., wind speed), and seafloor (e.g., sediment type and size) properties, were input into an acoustic propagation model. The predicted noise generated during three impact pile driving scenarios was assessed for a 36.1-foot (11-meter) monopile, 9.8-foot (3-meter) skirt pile (post-piled), and 5.9-foot (1.8-meter) pin pile sources. A first step in the acoustic modeling of these sound sources is compiling the source spectra and associated hammer energies for each model scenario, which are used to derive broadband source levels for each source. However, no source spectra were available for the combination of pile diameter and hammer strike energy planned for use in the Project. Surrogate spectra had to be developed from available literature and information. These surrogate spectral values for each pile driving scenario were then scaled by the US Wind pile diameters and hammer energies to predict the associated broadband source levels for each pile driving scenario, as described in the following subsections.

6.3.5.1.1 WTG Foundations

Marine Acoustics, Inc. used the predicted spectrum of a 36.1-foot (11-meter) diameter monopile developed for the South Fork Wind Farm (Denes et al. 2021) as a surrogate source signature in the modeling for the 36.1-foot (11-meter) monopile in the US Wind Project (Appendix A; TRC 2023). This spectrum was predicted for impact pile driving a 36.1-foot (11-meter) monopile using an IHC S-4000 hammer at a strike energy of 4,000 kJ and used to represent the impact pile driving of the 36.1-foot (11-meter) monopile in the Project area with a strike energy of 4,400 kJ. The expected difference in sound level between 4,000 and 4,400 kJ was determined to be minimal at 0.4 decibels; therefore, the Denes et al. (2021) spectrum was used as a surrogate spectrum. The spectral levels shown in Denes et al. (2021) did not include levels for frequencies above 16 kilohertz. The levels were linear in log-frequency for 200 hertz and greater, so a least-squares linear fit on the levels from 200 hertz to 16 kilohertz was used to extrapolate to the 20 and 25 kilohertz band centers. The expected difference of 0.4 decibels was estimated using the scaling relationship presented in von Pein et al. (2022), which states that, during impact pile driving, the measured SEL of an impact hammer strike increases with increasing hammer strike energy. To account for the lower strike energies proposed for the Project's pile installation, the spectrum was scaled using this relationship (Appendix A; TRC 2023).

The broadband source level was calculated by converting each band level to intensity and converting their sum back to a decibel value. The resulting broadband SEL source level at 4,400 kJ was 224 dB re 1 μPa^2 m^2 s. The broadband source levels for the hammer energies US Wind proposes to use to install the 36.1-foot (11-meter) monopile were scaled relative to level associated with the maximum energy of 4,400 kJ. These sound level offsets were used when calculating the SEL_{24h} sound field to assess against the acoustic guidance (Appendix A; TRC 2023). Additionally, as discussed in Section 3.1.1.5.1, US Wind has committed to using noise attenuation systems to achieve a minimum of 10 decibels noise mitigation.

6.3.5.1.2 OSS Foundations

The 9.8-foot (3-meter) skirt pile source spectrum used in the modeling was based on the measured spectra of a 19.7-foot (6-meter) pile reported by Bruns et al. (2014) and a 11.5-foot (3.5-meter) FINO2 pile reported by Matuschek and Betke (2009). The spectrum for the 19.7-foot (6-meter) pile reported by Bruns et al. (2014) was recorded at 49.2 feet (15 meters), and a hybrid spherical/cylindrical spreading model (i.e., 15 x $\log_{10}$ [range]) was used to adjust the received level. The levels were reduced by 5 decibels (16.7 x $\log_{10}$[3m/6m]) to scale for differences in pile diameter (von Pein et al. 2022). The piling of a 11.5-foot (3.5-meter) FINO2 pile was recorded at a distance of 1,640 feet (500 meters), and the same hybrid propagation loss model was used to adjust the received levels to source levels. For consistency, the FINO2 levels were also reduced by 1 decibel to scale for diameter (16.7 x $\log_{10}$[3m/3.5m] = 1 decibel). The mean of the two pile spectra from these sources was taken as the representative spectrum of the 9.8-foot (3-meter) pin pile for the Project. The broadband SEL source level is 208 dB re 1μPa^2 m^2 s (Appendix A; TRC 2023). This value is comparable to the estimated values of approximately 209 dB re 1 μPa^2 m^2 s for an 8-foot (2.4-meter) steel pile driven by a 1,700 kJ Menck Hammer (Molnar et al. 2020), which was estimated by back-calculating the source level assuming transmission loss of 15 x $\log_{10}$ (range) from a measured SEL of 188 decibels at a range of 82 feet (25 meters) from the pile during unmitigated impact pile driving. The steel pile (Molnar et al. 2020) was driven at an angle through a steel frame for the San Francisco Oakland Bay Bridge and is considered to have been post-piled. The good agreement between the source level of the representative spectrum proposed to represent the 9.8-foot (3-meter) skirt piles and the measured post-piled levels of Molnar et al. (2020) suggests the modeling described in Appendix A (TRC 2023) can be considered representative of post-piled pin piles included in the Proposed Action.

6.3.5.1.3 Met Tower Foundations

The spectrum derived for the 9.8-foot (3-meter) post-piled pin pile was scaled to represent the 5.9-feet (1.8-meter) post-piled pin pile for the Met Tower foundation. The spectrum was scaled based on maximum hammer energy and pile diameter using the relationships presented in von Pein et al. (2022). This resulted in the source levels being scaled down by 8 decibels. The resulting broadband SEL source level is 199 dB re 1μPa^2 m^2 s (Appendix A; TRC 2023).

6.3.5.2 HRG Surveys

The equipment types and schedule of proposed HRG survey activities are described in Section 3.1.6.1. Operating frequencies of side-scan sonar and multibeam echosounders are above relevant marine mammal hearing thresholds (180 kilohertz). Ultra-short baseline systems were not carried forward in the effects analysis based on NMFS guidance, dated July 22, 2020. Due to the characteristics and use of sound sources, shallow- and medium-penetration SBPs are the primary acoustic sources for micro-siting HRG surveys. Representative sound sources to be used during micro-siting HRG surveys, which could result in harassment of marine mammals for which authorization is being requested under the MMPA, are presented in Table 6-14.

Table 6-14. Operating parameters[a] of HRG survey equipment included under the Proposed Action

HRG System	Survey Equipment	Operating Frequencies (kHz)	Source Level (L_{pk})	Source Level (SPL)	Pulse Duration (ms)	Repetition Rate (Hz)	Beamwidth (degrees)
Shallow-penetration SBP	Innomar SES 2000 Std	High-frequency operation: 85–115 Low-frequency operation: 2–22	-	240	0.7–1.5	60	2
Medium-penetration SBP	Applied Acoustics S Boomer	0.1–5	211	205	0.6	3	80
	Geo-spark 2000 (2 × 400 tip)	0.3–4	222	219	4	2	100

Source: TRC 2023

[a] Information obtained from manufacturer specifications, except for the Applied Acoustics S Boomer information, which was obtained from Crocker and Fratantonio (2016). Frequency and repetition rate of the AA S Boomer were verified by the survey contractor. The equipment in this table was used during US Wind's previous HRG surveys within the Project area, and the information has been verified by multiple contractors.

L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal; ms = millisecond; SBP = sub-bottom profiler; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal

The ranges to the behavioral disturbance threshold for marine mammals resulting from HRG survey activities were modeled using the NMFS Recommendation for Sound Source Level and Propagation Analysis for HRG Sources and the Associated Level B Harassment Isopleth Calculator (NMFS 2020a). The number of potential exposures of marine mammals resulting from HRG survey activities was then estimated using the following formula:

$$\text{Take Estimation} = n \times \text{Harassment Zone} \times d$$

Where n = species density values; the Harassment Zone is the total area (in square kilometers) within which the behavioral disturbance threshold may be met or exceeded in a day given the speed of the HRG survey vessel, the distance traveled, and the total survey hours per day; and d = total number of days during which the activity is expected to occur (TRC 2023).

6.3.5.3 O&M Facility Pile Driving

A high-level overview of the number and types of pile, pile installation methods, and estimated timeline for in-water pile driving associated with construction of the proposed O&M Facility is provided in Section 3.1.2.2. No acoustic modeling for this activity is currently available from the applicant, so the ranges to the acoustic thresholds for ESA-listed marine mammals, sea turtles, and fish were calculated using the NMFS Multi-Species Pile Driving Calculator tool version 1.2 (NMFS 2023k). Source levels for this activity were obtained from the "impact proxy sound levels" tab of this calculator tool based on the data that used the most comparable pile size, material, and water depth to use as a proxy for the Proposed Action. The estimated strike rates and expected number of piles installed per day were identified based on available incidental take authorization applications on NMFS website (Naval Facilities Engineering Command Mid-Atlantic 2020; Weston Solutions, Inc. 2023). A summary of the parameters used in the Multi-Species Pile Driving Calculator tool are summarized for each proposed pile type below and PDFs of the calculator tool tabs used for this assessment are provided in Appendix D. All calculations assumed use of a noise mitigation system which would achieve at least 5 dB noise attenuation.

- The proxy source levels for impact piling of the proposed 12- to 18-inch steel piles were based on measurements of 20-inch steel piles installed in 10 feet (3 meters) water depth conducted by

Caltrans (2015). It was assumed that up to five piles would be installed per day each requiring up to 100 strikes per pile based on the information provided in Weston Solutions, Inc. (2023).

- The proxy source levels for impact piling of the proposed 12- to 18-inch timber piles were based on measurements of 14-inch steel piles installed in 16 feet (5 meters) water depth conducted by Caltrans (2020). It was assumed that up to five piles would be installed per day each requiring up to 100 strikes per pile based on the information provided in Weston Solutions, Inc. (2023).
- The proxy source levels for impact piling of the proposed sheet piles were based on measurements of 24-inch sheet piles in 7 to 20 feet (2 to 6 meters) water depth conducted by Caltrans (2020). It was assumed that up to three piles would be installed per day based on the information provided by Naval Facilities Engineering Command Mid-Atlantic (2020). A strike rate for impact piling of the sheet piles was not provided in this report, just the duration of the installation for each sheet pile. Therefore, using information available in Caltrans (2020) which indicates sheet piles could be installed using an APE 7.5, and the maximum blow rate of 75 blows per minute for this hammer based on manufacturer specifications (American Pile Driving Equipment, Inc. 2023), it was assumed for the purposes of this assessment that 975 blows would be required for each sheet pile installation assuming a total installation duration of 13 minutes (Naval Facilities Engineering Command Mid-Atlantic 2020).

6.3.6 HRG Surveys

As described in Section 3.1.6.1, HRG surveys will be conducted during construction phase 2 and phase 3 as detailed in the anticipated construction time frames in Table 3-2 to refine the locations of project elements such as construction footprints, WTG and OSS foundations, and cables, or to meet BOEM or other agency requirements for additional survey. Surveys would include equipment operating at less than 180 kilohertz as listed in Table 6-14. US Wind assumes HRG surveys would be conducted only during daylight hours, for an average daily distance of 69 miles (111.1 kilometers), and at a transit speed of 4 knots (2.1 m/s). The total HRG survey days for both phase 2 and phase 3 construction would be a total of 28 days (14 survey days per year).

6.3.6.1 Marine Mammals

Based on the assessment conducted for the Project's LOA application, no PTS is expected to occur for any ESA-listed marine mammals, and no Level A takes for marine mammals were requested for any species due to HRG survey activities in the LOA application (TRC 2023). Previous assessments of these equipment indicate the PTS range for all marine mammal species are small, and even without mitigation exposures are unlikely (87 FR 61575; 87 FR 52913; 87 FR 51359; 87 FR 50293; 87 FR 44087; Ruppel et al. 2022). However, US Wind will implement a 1,640-foot (500-meter) clearance zone for NARWs and a 328-foot (100-meter) clearance zone for all other ESA-listed marine mammals (Table 3-20), which would fully cover the area over which PTS thresholds may be exceeded. Therefore, potential for PTS exposures during HRG surveys are **discountable**.

As noted in the modeling assumptions (Section 6.3.5), acoustic exposure modeling was conducted for each activity (e.g., piling, HRG surveys) and results are provided in the modeling report (MAI 2023); however, final takes were not requested for each individual activity in the LOA application (TRC 2023). Instead, the LOA application final take request differs from the modeling report results in that all Project activities included in the LOA over an annual period were assessed and a single take assessment for those combined activities were provided. Therefore, modeled activities such as impact pile driving may have resulted in less than 1 take of a given species or stock (MAI 2023); but combined with other activities, those takes may increase to one or more individuals (TRC 2023). For the purposes of this BA, subsequent effects analysis was conducted for each activity based the results of the exposure modeling report (MAI 2023) for individual activities, not the take requested from combined activities in the LOA application.

The non-zero modeling results for each activity were rounded up to the nearest whole integer (i.e., animal) that are used for effects analysis in this BA for each stressor but are not considered additive for the combined activities due to the format of the LOA application. Although less than 1, non-zero modeled results imply that there is a risk of exposure. This method was applied to the BA as the best way to assess potential effects of individual stressors for species having less than one modeled exposure (TRC 2023). The rounded-up exposures for the individual activities assessed in this BA are therefore assumed to be the maximum exposure assessments for any single underwater noise stressor as they represent the maximum potential contribution from that activity to the combined LOA take analysis.

Ranges to the behavioral disturbance threshold for marine mammals (Section 6.3.2.1) were estimated using the method described in Section 6.3.5.2 and are provided for each type of equipment in Table 6-15. The exposures for marine mammals were estimated using the highest monthly density for each species from Table 6-12 and the equation provided in Section 6.3.5.2. Exposures were estimated assuming all HRG surveys will be conducted using equipment that produces the greatest distance to the behavioral disturbance threshold (i.e., the Geo-spark 2000; Table 6-14), a maximum survey period of 14 days per year during phases 2 and 3 (which coincides with Year 2 and Year 3 from the modeling results [TRC 2023]), and a maximum of 15 active survey hours per day (TRC 2023). Behavioral exposures calculated for marine mammals are provided in Table 6-16.

Table 6-15. Distance to the behavioral disturbance threshold for ESA-listed marine mammals

HRG System	Survey Equipment	Distance to Threshold (m)
Shallow-penetration SBP	Innomar SES 2000 Std	0.7
Medium-penetration SBP	Applied Acoustics S Boomer	35.2
	Geo-spark 2000 (2 × 400 tip)	50.1

Source: TRC 2023
[a] Information obtained from the manufacturer specifications, except for the Applied Acoustics S Boomer information, which was obtained from Crocker and Fratantonio (2016). Frequency and repetition rate of the AA S Boomer were verified by the survey contractor. The equipment in this table was used during US Wind's previous HRG surveys within the Project area, and the information has been verified by multiple contractors.
L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal; ms = millisecond; SBP = sub-bottom profiler; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal

Table 6-16. Maximum modeled annual behavioral exposures of ESA-listed marine mammals during HRG survey activities during the construction planned for the Proposed Action

Species	Construction Year	Behavior
NARW[a]	Year 2	0.1
	Year 3	0.1
	Total	**0.2**
Fin whale[b]	Year 2	0.3
	Year 3	0.3
	Total	**0.6**

Species	Construction Year	Behavior
Sei whale[c]	Year 2	0.1
	Year 3	0.1
	Total	**0.2**
Sperm whale	Year 2	0
	Year 3	0
	Total	**0**

Source: TRC 2023

[a] Less than one exposure was estimated for NARWs for behavioral disturbance, however, TRC (2023) adjusted their final take numbers based on species group sizes so a total of 6 behavioral disturbance (Level B) takes are requested for NARW by the Applicant over the 3 years of construction. However, this number includes takes associated with all Project activities, not just HRG surveys so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

[b] TRC (2023) adjusted their final take request based on fin whale group size to include an extra 2 fin whales in construction year 3 for a total of 8 behavioral disturbance (Level B) takes for this species in that year. However, this number includes takes associated with all Project activities, not just HRG surveys so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

[c] Less than on exposure was estimated for sei whales for behavioral disturbances for all 3 years of construction, but TRC (2023) adjusted their final take request based on sei whale group size to include 1 sei whale take per year for a total of 3 behavioral disturbance (Level B) takes over the 3 years of construction. However, this number includes takes associated with all Project activities, not just HRG surveys so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

Though HRG surveys would occur intermittently over an approximate 2-year period during construction phases 2 and 3, the sources would only be operational for up to 14 days per year, and the maximum range to behavioral thresholds was estimated to be 105.6 feet (35.2 meters) during operations of the Geo-spark source (Table 6-15). US Wind may use a range of equipment during any of the surveys; however, the exact amount of time each equipment type may be used during the proposed HRG surveys is unknown. The exposures in Table 6-16 assumed the equipment with the largest behavioral threshold range (i.e., the sparker) was used during all survey days. Using this assumption, the modeling predicted no exposures for sperm whales, and less than one annual exposure for NARWs, fin whales, and sei whales for the HRG surveys (Table 6-16). However, exposures leading to behavioral disturbances are still considered possible for NARW, fin and sei whales because the modeled estimates resulted in greater than zero exposures; thus, rounding up the non-zero annual modeled exposures to a whole integer results in 2 behavioral exposures for fin whales, 2 behavioral exposures for NARWs, 2 behavioral exposures for sei whales, and no behavioral exposures for sperm whales for construction years 2 and 3 during which HRG surveys will be conducted.

Recently, BOEM and the USGS characterized underwater sounds produced by HRG sources and their potential to affect marine mammals (Ruppel et al. 2022). Although some geophysical sources can be detected by marine mammals, given several key physical characteristics of the sound sources, including source level, frequency range, duty cycle, and beamwidth, most HRG sources are unlikely to result in behavioral disturbance of marine mammals, even without mitigation (Ruppel et al. 2022). This finding is supported empirically: Kates Varghese et al. (2020) found no change in three of four beaked whale foraging behavior metrics (i.e., number of foraging clicks, foraging event duration, and click rate) during two deepwater mapping surveys using a 12 kilohertz multibeam echosounder. There was an increase in the number of foraging events during one of the mapping surveys, but this trend continued after the survey ended, suggesting the change was more likely in response to another factor, such as the prey field of the beaked whales, than to the mapping survey. During both multibeam mapping surveys, foraging continued in the survey area and the animals did not leave the area (Kates Varghese et al. 2020, 2021). Vires (2011) found no change in Blainville's beaked whale click durations before, during, and after a scientific survey with a 38 kilohertz EK-60 echosounder, while Cholewiak et al. (2017) found a decrease in beaked whale echolocation click detections during use of an EK-60 echosounder. Quick et al. (2017)

found short-finned pilot whales did not change foraging behavior but did increase their heading variance during use of an EK-60 echosounder.

The areas where HRG surveys will occur overlap with a BIA for migrating NARWs. A northward migration occurs during March and April and a southward migration occurs during October and November between summer feeding and winter calving grounds. This partially overlaps with the expected period of HRG survey activities between April and June (Table 3-2; TRC 2023). During migration, adults may be accompanied by calves and periodically feed and rest along the migration route. Fin whales are present in the area year-round; however, fin whales and 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. 2022). The area over which HRG surveys would occur would not extend to the OCS where sperm whales are more commonly observed, as evidenced by the low densities and lack of behavioral exposures estimated (Table 6-16).

For some of the higher-amplitude sources such as sparkers, behavioral disturbance is possible but unlikely given the small distance to the threshold (up to 105.6 feet [35.2 meters] from the source; Table 6-15) and the mitigation measures included in the Proposed Action. Under the Proposed Action, a 1,640-ft (500-m) clearance and shutdown zone for NARWs and a 328-ft (100-m) shutdown zone for all other marine mammals will be implemented (Table 3-20) for the selected HRG surveys which covers the entire behavioral zone for all species (Table 6-15), and would limit the potential for behavioral effects. Given the small distance and mitigation, above-threshold noise would not be expected impede the migration of NARWs to critical habitats north and south of the Project area because animals would still be able to move outside of the behavioral disturbance zone easily or wait until the vessel passes. Additionally, though the range of frequencies emitted from the equipment assessed in this BA overlaps with marine mammal hearing, masking of all hearing groups is considered unlikely given the short duration (up to 28 days) of the proposed surveys. Furthermore, as the effects of masking would be transient in nature (moving with the vessel), the potential for communications to be masked is reduced.

As discussed previously, no PTS is expected to occur for any ESA-listed marine mammal species Given the small distances to the behavioral disturbance threshold, the mitigation included in the Proposed Action discussed previously in this section, and the limited (28-days over 2 years) duration of these surveys, exposures, if they were to occur, would have **insignificant** effects because any effects would be so small that they could not be meaningfully detected, measured, or evaluated Therefore, effects of noise exposure from Project HRG surveys **may affect, but are not likely to adversely affect** ESA-listed marine mammals.

6.3.6.2 Sea Turtles

Ranges to the acoustic thresholds for sea turtles were not modeled for HRG survey activities; however, the modeled ranges and assessment from the Biological Assessment for Data Collection and Site Survey Activities for Renewable Energy on the Atlantic Outer Continental Shelf (Baker and Howsen 2021) were used to assess the potential for impacts on sea turtles from the Proposed Action. Calculated ranges to the PTS thresholds for sea turtles were 0 feet (0 meters) for all HRG equipment (Baker and Howsen 2021); therefore the potential for ESA-listed sea turtles to be exposed to HRG survey noise above PTS thresholds is considered extremely unlikely to occur and effects are **discountable**.

Results of the modeling conducted for HRG surveys by Baker and Howsen (2021) indicates the SPL 175 dB re 1 µPa behavioral threshold for sea turtles would extend out to 131 feet (40 meters) for boomers and 295 feet (90 meters) for sparkers. Ranges to the TTS thresholds were not calculated by Baker and Howsen (2021). As discussed in Section 6.3.3, TTS is the milder form of hearing impairment that is non-permanent and reversible, and results from exposure to high intensity sounds for short durations or lower intensity sounds for longer durations. Generally, it appears animals would reach TTS thresholds prior to reaching behavioral thresholds; however, the time consideration in the TTS SEL_{24h} metric (NMFS

2023j) renders these ranges not fully comparable to the SPL ranges since the approach used assumes any given animal would be stationary within the ensonified area during the entire HRG survey period which is not representative of how an animal would be expected to behave in the wild. A shorter modeled time exposure, a single pulse exposure for TTS, or modeled TTS exposure ranges which account for animal movement and behavior may provide more comparable results; however, these are not available in Baker and Howsen (2021) and would not be expected to change the effects determinations. As discussed previously, TTS is a form of auditory fatigue that, unlike PTS, is non-permanent and reversible, so onset of TTS does not equate to an individual being removed from a population or facing any long-term restrictions on critical behaviors.

The 1,640-foot (500-meter) clearance zone and 328-foot (100-meter) shutdown zone included in the Proposed Action (Table 3-20) would be expected to fully cover the area exceeding the behavioral disturbance threshold and would be expected to encompass a portion of the are exceeding the TTS threshold, reducing the likelihood of sea turtles experiencing any changes in behavior. Additionally, the effects are transient and would dissipate as the vessel moves away from the sea turtle, and the limited (28-days over two years) duration of these surveys would reduce the likelihood of prolonged exposure for any individuals. Due the small ranges to behavioral thresholds, sea turtle exposure above behavioral thresholds is unlikely, and any responses to potentially brief exposures to HRG survey noise would have **insignificant** effects because any effects would be undetectable, not measurable, or so minor they could not be meaningfully evaluated. Therefore, the effects of noise exposures during HRG surveys **may affect, but are not likely to adversely affect** ESA-listed sea turtles.

6.3.6.3 Marine Fish

Of the sources that may be used during HRG surveys under the Proposed Action, only the boomers and sparkers emit sounds at frequencies within the hearing range of Atlantic sturgeon, shortnose sturgeon, and giant manta ray (Crocker and Fratantonio 2016; Ruppel et al. 2022). HRG equipment types are considered intermittent sources which have a temporal pattern that emits sound in bursts or pulses separated by intervals of silence or lower intensity sound (Crocker and Fratantonio 2016; NMFS 2023j). For the HRG sources that are audible to fishes, other factors such as source level, beamwidth, and duty cycle should be considered when assessing the potential risk of adverse effects (Ruppel et al. 2022). The estimated ranges to the physical injury threshold for fish ≥2 g based on the maximum value for either the SEL over 12 hours and an L_{pk} metrics from NMFS (2023j) were 10.5 feet (3.2 meters) for boomers and 30 feet (9 meters) for sparkers (Baker and Howsen 2021). This small acoustic range combined with the short duration (up to 28 days over a 2-year period) of the HRG surveys would significantly reduce the risk of ESA-listed fish species being exposed to injurious sound levels. Additionally, HRG sources would be moving throughout the survey activities, so individuals present near the vessel would only be exposed for a short duration before the survey vessel moves away. Soft-start procedures are possible for some HRG equipment types and included in the Proposed Action; therefore, will be implemented for appliable equipment and would further reduce the risk of injury to fish when applied. Given the small threshold ranges, short survey duration, and transient nature of the survey equipment, physiological injury in Atlantic sturgeon, shortnose sturgeon, and giant manta rays resulting from HRG surveys is extremely unlikely to occur.

Behavioral impacts could occur over larger spatial scales given the SPL threshold of 150 dB re 1 μPa recommended for behavioral disturbance in marine fish (NMFS 2023j). Unlike the SEL_{12h} metric for onset of physical injury, the SPL behavioral thresholds do not require a minimum amount of time of exposure for the threshold to be met. Therefore, not only is the behavioral threshold lower than the injury threshold, a single instance of exposure to noise above 150 dB re 1 μPa can exceed the behavioral threshold. However, the behavioral thresholds for fish are all reported in terms of acoustic pressure as there currently are no behavioral disturbance thresholds for particle motion (Section 6.3.4). As discussed in Section 6.3.4, all fish are capable of sensing the particle motion component of underwater sound predominantly at frequencies below 1 kilohertz (Popper and Hawkins 2021), whereas fish with swim bladders are also capable of detecting the pressure component of underwater noise (Fay and Popper 2000; Popper and Hawkins 2021).

The Atlantic sturgeon and shortnose sturgeon have a swim bladder and can detect both the sound pressure component of noise, but the swim bladder is not directly connected to hearing like species of carp or herring and therefore are less sensitive to underwater sound pressure than these hearing specialists (Section 6.3.4). Conversely, giant manta rays do not have a swim bladder and detect noise predominantly through particle motion. The assessment from Baker and Howsen (2021) estimated ranges to the behavioral disturbance threshold of 2,323 feet (708 meters) for boomers and 6,549 feet (1,996 meters) for sparkers; however, these ranges only account for the sound pressure component of noise produced by some HRG sources. Available information indicates particle motion would only be dominant within a subset of these modeled ranges (i.e., within 33 feet [10 meters]) around the source (Mickle and Higgs 2022; Harding and Cousins 2022). Beyond that range, the sound pressure component of noise would dominate which is more important for species with a swim bladders that include Atlantic and shortnose sturgeon.

The HRG surveys under the Proposed Action would only occur over a 28-day period over two years which would help lower the overall duration that survey noise is present within the Project area. As discussed in Section 3.1.6.1, HRG surveys will only be conducted during phase 2 and phase 3 of construction to refine the locations of project elements such as construction footprints, WTG and OSS foundations, and cables, or to meet BOEM or other agency requirements for additional survey. All HRG survey activities under the Proposed Action would occur in marine waters along the offshore export cable route and within the Project Lease Area (Figure 3-1).

Giant manta rays are the predominant ESA-listed fish species likely to occur within the footprint of the proposed HRG surveys given their potential occurrence within the Project area (Section 5.1.3.3.2). However, giant manta rays do not have a swim bladder and primarily detect underwater sound via particle motion, and exposure to particle motion levels sufficient to result in biologically relevant behavioral disturbances would only be expected to occur within short ranges (i.e., within 33 feet [10 meters]) around the source. This limits the risk of behavioral disturbance occurring, and any effects to this species that do occur would be brief and would not be expected to affect migratory or foraging behaviors for giant manta rays; therefore, behavioral effects on giant manta rays from HRG survey noise are extremely unlikely to occur and therefore **discountable**.

Atlantic sturgeon are known to move to marine waters starting at the beginning of their subadult stage, but are expected to occur within the 164-feet (50-meter) depth contour when in the marine environment (Section 5.1.3.1.2). They predominantly occur in waters offshore Delaware in spring and fall, which overlaps with the seasons in which HRG surveys will occur (Table 3-2), but they are expected to occur nearer to the coast rather than offshore in the Lease Area based on available tagging and survey data (Section 5.1.3.1.2). Therefore, Atlantic sturgeon may be encountered during a portion of the HRG surveys conducted within the offshore export cable corridor. While the assessment from Baker and Howsen (2021) showed that the range to the behavioral disturbance threshold for fish may extend out to 6,549 feet (1,996 meters) for sparkers and 2,323 feet (708 meters) for boomers, this equipment is not anticipated to be used throughout the entire 28-day survey duration for the HRG surveys. A shallow-penetration parametric Innomar SBP is also proposed for the HRG surveys which operate primarily at frequencies that are outside the main sensitivity range for Atlantic surgeon (Table 6-14) and are therefore not expected to result in any behavioral disturbances. This helps limit the risk of exposure to above-threshold noise by reducing the overall ensonified area if the highest power sources are not used throughout the entire survey duration. Additionally, because HRG surveys would only occur over a 14-day survey duration in phases 1 and 2, long-term, substantial effects on behavior for Atlantic sturgeon in the project area are extremely unlike to occur; therefore effects on Atlantic sturgeon from HRG survey noise are **discountable.**

Shortnose sturgeon are only expected to occur in rivers and bays within the Project area, predominantly Chesapeake Bay, Delaware Bay, the Delaware River, and the C&D Canal (Section 5.1.3.2.2). No HRG survey activities are expected to occur in these inshore areas as they will be focused on the offshore export cable corridor and Lease Area (Section 3.1.6.1). Therefore, shortnose sturgeon are not expected to encounter noise produced by the proposed HRG surveys, and the Proposed Action would therefore have **no effect** on this species.

Overall, because physiological injuries are extremely unlikely to occur for any ESA-listed fish species, and behavioral disturbances would be limited to brief, relatively minor effects that would not impact foraging or reproductive behavior, the effects of noise exposures during HRG surveys **may affect, but are not likely to adversely affect** ESA-listed fish species.

6.3.7 Vessel Noise

Vessel sound is characterized as low frequency (typically below 1,000 hertz with peak frequencies between 10 and 50 hertz), non-impulsive (rather than impulsive like impact pile driving), and continuous (i.e., there are no substantial pauses in the sounds that vessels produce). The acoustic signature produced by a vessel varies based on the vessel type (e.g., tanker, bulk carrier, tug, container ship) and characteristics (e.g., engine specifications, propeller dimensions and number, length, draft, hull shape, gross tonnage, speed). Larger barges and commissioning vessels would produce lower-frequency noise with a primary energy near 40 hertz and underwater source levels that can range from 177 to 200 dB re 1 μPa m (McKenna et al. 2012; Erbe et al. 2019). Smaller CTVs would typically produce higher-frequency noise (1,000 to 5,000 hertz) at source levels between 150 and 180 dB re 1 μPa m (Kipple and Gabriele 2003, 2004). Vessels using dynamic positioning thrusters (e.g., platform or cable-laying vessels) are known to generate substantial underwater noise, with source levels ranging from 150 to 180 dB re 1 μPa m depending on operations and thruster use (BOEM 2013; McPherson et al. 2016). While vessel noise was not modeled for the Project, qualitative information about vessel noise produced during Project activities and how it may affect marine mammals was obtained from available literature. Parsons et al. (2021) reviewed literature for the source levels and spectral content of vessels less than 82 feet (25 meters) in length, a category often not addressed in vessel noise assessment measurements. Parsons et al. (2021) found reported source levels in smaller vessels were highly variable (up to 20 decibels difference); however, an increase in speed was consistently shown to increase source levels, while vessels at slower speeds were shown to emit low-frequency acoustic energy (less than 100 hertz) that is often not characterized in broadband analyses of small vessel sources. A description of the types, sizes, and potential transit activities of vessels assessed under the Proposed Action is provided in Section 3.1.1.6 for construction and Section 3.1.4.6 for O&M. Vessel activity under the Proposed Action would be present throughout all three years of construction, and there would likely be an overlap in the construction and O&M vessel traffic for adjacent construction phases (e.g., phase 1 O&M traffic would partially overlap with phase 2 construction traffic). However, during these periods of overlap, the construction traffic would be expected to dominate the sound field as it would produce higher noise levels because it comprises a higher volume of vessels as well as larger sized vessels (Table 3-11) which have higher estimated source levels than the smaller support vessels used during O&M (Table 3-17). Therefore, during these periods of overlap, it is anticipated that any responses to vessel noise would be driven by the construction vessel traffic, and O&M vessel traffic during these periods of overlap would be expected to contribute a nominal amount to the overall increase in the noise in the Project area caused by Project vessel traffic. Only after construction is completed in 2028 (Table 3-2) would all vessels in the Action Area be associated with O&M.

6.3.7.1 Marine Mammals

PTS is extremely unlikely to occur for ESA-listed marine mammals as a result of vessel noise due to the non-impulsive nature of the sources and relatively low source levels produced (BOEM 2013; McPherson et al. 2016). Ranges to the 120 dB re 1 μPa behavioral disturbance threshold for continuous sources (Section 6.3.2.1) may extend out to a maximum range of 6 miles (10 kilometers) assuming a spherical spreading loss equation (20log[range]) and a source level of 200 dB re 1 μPa m (which is most applicable for larger barges and commissioning vessels), so behavioral disturbances may occur for ESA-listed marine mammal species in the Action Area.

A comprehensive review of the literature (Richardson et al. 1995; Erbe et al. 2019) revealed most of the reported adverse effects of vessel noise and presence are changes in behavior, though the specific behavioral changes vary widely across species. Physical behavioral responses include changes to dive patterns (e.g., longer dives in beluga whales [Finley et al. 1990]), disruption to resting behavior (harbor seals [Mikkelsen et al. 2019]), increases in swim velocities (beluga whales [Finley et al. 1990]; humpback whales [Sprogis et al. 2020]; narwhals [*Monodon monoceros*; Williams et al. 2022]), and changes in respiration patterns (longer inter-breath intervals in bottlenose dolphins [Nowacek et al. 2006]; increased breathing synchrony in bottlenose dolphin pods [Hastie 2006]; increased respiration rates in humpback whales [Sprogis et al. 2020]). A playback study of humpback whale mother-calf pairs exposed to varying levels of vessel noise revealed the mother's respiration rates doubled and swim speeds increased by 37 percent in the high-noise conditions (low-frequency weighted received SPL at 328 feet [100 meters] was 133 dB re 1 μPa) compared to control and low-noise conditions (SPL of 104 dB re 1 μPa and 112 dB re 1μPa respectively [Sprogis et al. 2020]). Changes to foraging behavior, which can have a direct effect on an animal's fitness, have been observed in porpoises (Wisniewska et al. 2018) and killer whales (Holt et al. 2021) in response to vessel noise. Thus far, one study has demonstrated a potential correlation between low-frequency anthropogenic noise and physiological stress in baleen whales. Rolland et al. (2012) showed fecal cortisol levels in NARWs decreased following the 9/11 terrorist attacks, when vessel activity was significantly reduced. Interestingly, NARWs do not seem to avoid vessel noise nor vessel presence (Nowacek et al. 2004), yet they may incur physiological effects as demonstrated by Rolland et al. (2012). This lack of observable response, despite a physiological response, makes it challenging to assess the biological consequences of exposure. In addition, there is evidence that individuals of the same species may have differing responses if the animal has been previously exposed to the sound or if it is a completely novel interaction (Finley et al. 1990). Reactions may also be correlated with other contextual features, such as the number of vessels present; their proximity, speed, direction, or pattern of transit; or vessel type. Erbe et al. (2019) provides a more detailed and comprehensive review of the effects of vessel noise on specific marine mammal groups.

Some marine mammals may change their acoustic behaviors in response to vessel noise, either due to a sense of alarm or in an attempt to avoid masking. For example, fin whales (Castellote et al. 2012) and beluga whales (Lesage et al. 1999) have altered frequency characteristics of their calls in the presence of vessel noise. When vessels are present, bottlenose dolphins have increased the number of whistles (Buckstaff 2006; Guerra et al. 2014), while sperm whales decrease the number of clicks (Azzara et al. 2013), and humpback and beluga whales have been seen to completely stop vocal activity (Tsujii et al. 2018; Finley et al. 1990). Some species may change the duration of vocalizations (e.g., fin whales shortened their calls [Castellote et al. 2012]) or increase call amplitude (killer whales [Holt et al. 2009]) to avoid acoustic masking from vessel noise.

Understanding the scope of acoustic masking is difficult to observe directly, but several studies have modeled the potential decrease in "communication space" when vessels are present (Clark et al. 2009, Erbe et al. 2016; Putland et al. 2017). For example, Putland et al. (2017) showed that during the closest point of approach (less than 6.2 miles [10 kilometers]) of a large commercial vessel, the potential communication space of Bryde's whales (*Balaenoptera edeni*) was reduced by 99 percent compared to ambient conditions.

Although there have been many documented behavioral changes in response to vessel noise (Erbe et al. 2019), it is necessary to consider what the biological consequences of those changes may be. One of the first attempts to understand the energetic cost of a change in vocal behavior found that metabolic rates in bottlenose dolphins increased 20 to 50 percent compared to resting metabolic rates (Holt et al. 2015). Although this study was not tied directly to exposure to vessel noise, it provides insight about the potential energetic cost of this type of behavioral change documented in other works (i.e., increases in vocal effort such as louder, longer, or increased number of calls). In another study, the energetic cost of high-speed escape responses in dolphins was modeled, and the researchers found that the cost per swimming stroke was doubled during such a flight response (Williams et al. 2017). When this sort of behavioral response was coupled with reduced glide time for beaked whales, the researchers estimated metabolic rates would increase by 30.5 percent (Williams et al. 2017). Differences in response have been reported within and among species groups (Finley et al. 1990; Tsujii et al. 2018). Despite demonstrable examples of biological consequences to individuals, there is still a lack of understanding about the strength of the relationship between many of these acute responses and the potential for long-term or population-level effects.

Additionally, as discussed in Section 3.2.1.1.4 and 3.2.1.1.7, commercial shipping traffic is prevalent in the Project area and the existing acoustic habitat in this region. Median SPL measured by Bailey et al. (2018) using hydrophones deployed within and adjacent to the Maryland WEA ranged from 107.2 dB re 1 µPa for a site nearest to shore to 116.1 dB re 1 µPa for a site located in the southeastern portion of the Maryland WEA.

Overall, ESA-listed marine mammals may be exposed to noise above the behavioral thresholds and may experience masking effects depending on the vessel type and speed. However, the likelihood of prolonged exposures that would affect biologically important behaviors such as foraging or reproduction is low with the proposed mitigation and monitoring measures (Section 3.3). The contribution of noise from project vessels during construction would increase ambient noise conditions; however, the increase would be temporary with vessel noise conditions returning to ambient conditions once construction is completed. Increased vessel noise during construction is not expected to produce any measurable behavioral effects or disturb critical behaviors. Vessel noise during O&M would be localized and highly transient and not expected to produce any measurable effects beyond a limited distance from each vessel. The Proposed Action includes mitigation for vessel strike avoidance (Table 3-20; Section 6.4) such as minimum separation distances, which would reduce the risk of an animal being close enough to receive sound energy above the behavioral threshold, and vessel speed restrictions. This, in turn would help reduce the level of noise exposure from Project vessels because vessels would remain farther from ESA-listed marine mammals and would slow (thus reducing noise output) in the presence of ESA-listed marine mammals (ZoBell et al. 2021). With these combined mitigation measures, exposure of ESA-listed LFCs and MFCs to vessel noise that results in behavioral disturbances is **insignificant**.

Overall, marine mammals are not likely to experience PTS due to Project vessel noise given the anticipated source levels and noise characteristics, as discussed previously in this section, and the effects of behavioral disturbances from vessel noise on ESA-listed marine mammals is insignificant as no long-term changes in biologically important behaviors such as foraging or reproduction would occur. Therefore, vessel noise as a result of the Proposed Action, **may affect, but it is not likely to adversely affect** ESA-listed marine mammals.

6.3.7.2 Sea Turtles

Construction and O&M vessel noises are the most broadly distributed source of non-impulsive noise associated with offshore wind projects. Sea turtles are less sensitive to sound compared to marine mammals, and no PTS from vessel noise is anticipated under the Proposed Action. Received levels of underwater noise from vessel activities are unlikely to exceed PTS thresholds for sea turtles, as the PTS threshold for non-impulsive sources is an SEL_{24h} of 220 dB re 1 μPa^2 s (NMFS 2023j), comparable to the maximum source level reported for large shipping vessels described previously (approximately 200 dB re 1 μPa m). This means beyond 3.3 feet (1 meter), the sound level produced by the loudest Project vessel would likely be below the sea turtle PTS threshold. Exposures of ESA-listed sea turtles to noise above the PTS threshold resulting from Project vessel noise is therefore not expected to occur.

The most likely effects of vessel noise on sea turtles would include behavioral disturbances. Ranges to the 175 dB re 1 μPa behavioral disturbance threshold for continuous sources for sea turtles (Section 6.3.3.1) may extend out to a maximum range of 59 feet (18 meters) assuming a spherical spreading loss equation (20log[range]) and a source level of 200 dB re 1 μPa m (which is most applicable for larger barges and commissioning vessels). A recent study suggests sea turtles may exhibit TTS effects even before they show any behavioral response (Woods Hole Oceanographic Institution [WHOI] 2022). Hazel et al. (2007) demonstrated that sea turtles appear to respond behaviorally to vessels at approximately 33 feet (10 meters) or closer. Based on the source levels outlined previously, the SPL 175 dB re 1 μPa behavioral threshold for sea turtles is likely to be exceeded out to approximately 59 feet (18 meters) for large barges and out to 7 feet (2 meters) for smaller support vessels assuming a spherical spreading loss equation (20 log [range]). Behavioral disturbance for sea turtles is likely to be highly contextual and site specific; therefore, generalized effects categories may be more applicable for this group. Popper et al. (2014) suggested that in response to continuous shipping sounds, sea turtles have a high risk for behavioral disturbance closer to the source (e.g., tens of meters), moderate risk at hundreds of meters from the source, and low risk at thousands of meters from the source.

Behavioral effects are considered possible but unlikely and any effects would be temporary, dissipating once the vessel or individual has left the area. The contribution of noise from project vessels during construction would increase ambient noise conditions; however, the increase would be temporary with vessel noise contributing less to ambient conditions once construction is completed. Increased vessel noise during construction is not expected to produce any measurable behavioral effects or disturb critical behaviors. Vessel noise during O&M would be localized and highly transient and not expected to produce any measurable effects beyond a limited distance from each vessel. The Proposed Action includes implementation of a minimum vessel separation distance of 164 feet (50 meters) for sea turtles, which, though geared towards vessel strike avoidance, would help reduce the level of noise a sea turtle is exposed to and the likelihood of sea turtles receiving sound energy above the behavioral threshold. The additional BOEM proposed measures to reduce vessel strikes on sea turtles, which includes slowing to 4 knots (2.1 m/s) when a sea turtle is sighted within 328 feet (100 meters) of the forward path of the vessel and avoiding transiting through areas of visible jellyfish aggregations or floating *Sargassum*, will reduce the potential for behavioral disturbance effects by reducing the sound level received by sea turtles in the Action Area during vessel activities. Though these mitigation measures will not eliminate the potential for sea turtles to be exposed to above-threshold noise, the potential effects if exposure were to occur would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects of this brief exposure would be so small that they could not be measured, detected, or evaluated and are, therefore, **insignificant**. Because the risk of PTS is discountable, as discussed previously in this section, and the risk of behavioral disturbances is insignificant, vessel noise as a result of the Proposed Action, therefore, **may affect, but it is not likely to adversely affect** ESA-listed sea turtles.

6.3.7.3 Marine Fish

Research indicates the effects of vessel noise, including dynamic positioning vessel noise, will not cause mortality or injuries in adult fish (Hawkins et al. 2014) given the low source levels and non-impulsive nature of the source. The potential for exposures above physiological injury thresholds is extremely unlikely and **discountable**. Ranges to the 150 dB re 1 μPa behavioral disturbance threshold for continuous sources for fish (Section 6.3.4.1) may extend out to a maximum range of 1,037 feet (316 meters) assuming a spherical spreading loss equation (20log[range]) and a source level of 200 dB re 1 μPa m (which is most applicable for larger barges and commissioning vessels).

Several studies have shown an increase in cortisol, a stress hormone, in fish after playbacks of vessel noise (Wysocki et al. 2006; Nichols et al. 2015; Celi et al. 2016), but other work has shown that the stress of being handled during the experiment itself may induce a greater stress response than an acoustic stimulus (Harding et al. 2020; Staaterman et al. 2020). The overlap in the frequency of vessel noise and fish auditory capabilities could lead to masking of important auditory cues, including conspecific communication (Haver et al. 2021; Parsons et al. 2021). Stanley et al. (2017) demonstrated the communication range of haddock and cod (species with swim bladders not involved in hearing) would be significantly reduced in the presence of vessel noise, which is frequent in their habitat in Cape Cod Bay. Generally speaking, species sensitive to acoustic pressure would experience masking at greater distances than those that are only sensitive to particle motion (Section 6.3.4.1). Rogers et al. (2021) and Stanley et al. (2017) theorized fish may be able to use the directional nature of particle motion to extract meaning from short range cues (e.g., other fish vocalizations) even in the presence of distant noise from vessels.

Avoidance of vessels and vessel noise has been observed in several pelagic, schooling fishes, including Atlantic herring (Vabø et al. 2002), Atlantic cod (Handegard 2003) and others (reviewed in De Robertis and Handegard [2013]). Fish may dive toward the seafloor, move horizontally out of the vessel's path, or disperse from their school (De Robertis and Handegard 2013). These types of changes in schooling behavior could render individual fish more vulnerable to predation but these behavioral responses are unlikely to have population-level effects. A more recent body of work has documented other, more subtle behaviors in response to vessel noise, but has focused solely on tropical reef-dwelling fish, which are not likely to occur in the Action Area. For example, damselfish antipredator responses (Simpson et al. 2016; Ferrari et al. 2018) and boldness (Holmes et al. 2017) seem to decrease in the presence of vessel noise, while nest-guarding behaviors seem to increase (Nedelec et al. 2017). There is some evidence of habituation, though; Nedelec et al. (2016) found that domino damselfish (*Dascyllus trimaculatus*) increased hiding and ventilation rates (i.e., rate of oxygen absorption) after 2 days of vessel sound playbacks, but responses diminished after 1 to 2 weeks, indicating habituation over longer durations.

The planktonic larvae of fishes and invertebrates may experience acoustic masking from continuous sound sources like vessels. Several studies have shown that larvae are sensitive to acoustic cues and may use sound signals to navigate toward suitable settlement habitat (Simpson et al. 2005; Montgomery 2006), metamorphosize into their juvenile forms (Stanley et al. 2012), or maintain group cohesion during their pelagic journey (Staaterman et al. 2014). However, given the short range of such biologically relevant signals for particle motion-sensitive animals like giant manta rays (Kaplan and Mooney 2016), the spatial scale at which these cues are relevant is rather small. If vessel transit areas overlap with settlement habitat, vessel noise could mask some biologically relevant sounds (Holles et al. 2013), but these effects are expected to be short term and would occur over a limited area around the operating vessel.

Overall, evidence suggests fish will return to normal baseline behavior faster following exposure to continuous sources such as vessel noise versus intermittent noise such as pile driving (Neo et al. 2014). Therefore, while the contribution of noise from project vessels during construction would increase ambient noise conditions in the Project area, the increase would be temporary with vessel noise contributing less to ambient conditions once construction is completed. Increased vessel noise during construction is not expected to produce any measurable behavioral effects or disturb critical behaviors. Vessel noise during O&M would be localized and highly transient and not expected to produce any measurable effects beyond a limited distance from each vessel. In addition, though Atlantic sturgeon and shortnose sturgeon have swim bladders that are not involved in hearing, they are likely to be more sensitive to vessel noise than giant manta rays, who do not have a swim bladder (Popper et al. 2014); these species are all thought to be more sensitive to particle motion than sound pressure (Popper and

Hawkins 2018; Mickle and Higgs 202). Given the nature of non-impulsive sources such as vessels noise, particle motion levels sufficient to result in behavioral disturbances would not occur more than a few meters from the source, and any effects to this brief exposure would be so small that they could not be measured, detected, or meaningfully evaluated and are, therefore, **insignificant**. Because the risk of physiological injury is discountable, as discussed previously in this section, and the risk of behavioral disturbances is insignificant, vessel noise as a result of the Proposed Action, therefore, **may affect, but it is not likely to adversely affect** ESA-listed fish species.

6.3.8 Cable Installation Noise

As described in Section 3.1.1.4*,* the inter-array and export cables will be installed from a dynamically positioned cable-installation vessel equipped with the required industry standard cable-handling equipment. Cable installation activities will occur intermittently over the 3 construction phases and will therefore occur intermittently across all three years of construction. Cable installation is anticipated between the first and fourth quarter of 2025 for phase 1, the first and fourth quarter of 2026 for phase 2, and the first and fourth quarter of 2027 for phase 3 (Table 3-2).

US Wind assumes cables will be installed using a towed or self-driving jet plow, which allows for direct installation and burial of the cable. A jet plow uses high-pressure water to temporarily fluidize the sediment and the cable subsequently settles into the area opened by the jets through a combination of its own weight and a depressor arm. The displaced sediment settles back over the cable, effectively burying the cable. If soil conditions do not permit the use of a jet plow, a mechanical trenching tool or conventional cable plow may be employed. US Wind plans to bury inter-array cables between 3.3 and 6.6 feet (1 and 2 meters), but no more than 13.1 feet (4 meters).

During construction for all 3 phases, vessels used for array cable installation would include cable-laying vessels and burial vessels in addition to support vessels (Table 3-11). The action of laying cables on the seafloor is unlikely to generate high levels of underwater noise. Most of the noise energy would originate from the vessels, including propellor cavitation noise and noise generated by onboard thruster/stabilization systems and machinery (e.g., generators) such as noise emitted by tugs when moving anchors (see Section 6.3.7 for description of vessel noise). Noise would also be produced during the HDD activities employed for installation of the Project cables at the transition points between water and land. As described in Section 3.1.1.7, the primary HDD equipment will be located on land and will consist of a drilling rig, mud pumps, drilling fluid cleaning systems, pipe-handling equipment, excavators, and support equipment such as generators and trucks. Land-side operations will be in existing parking areas or other already developed areas (e.g., access roads) to avoid impacts to sensitive coastal habitats. Water-side HDD equipment will vary based on the installation location but will generally consist of a work platform (either a barge or small jack-up) and associated support vessels (e.g., tugs, small work boats). The work platform will be equipped with a crane, an excavator, winches, and auxiliary equipment, including generators and lights. The use of cofferdams, which would require vibratory hammers to install sheet piles into the seafloor, were considered but not selected due to increased underwater sound (COP Volume I, Section 3.6.1.2; US Wind 2023), so all infrastructure associated with the HDD, including casing pipes, would be installed using gravity-based installation methods under the Proposed Action.

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 pipe laying and a fleet of nine vessels. Mean noise levels of 130.5 dB re 1 µPa were measured 4,921 feet (1,500 m) from the source. Reported noise levels generated during a jet-trenching operation provided a source level estimate of 178 dB re 1 µPa measured 3.3 feet (1 meter) from the source (Nedwell et al. 2003).

Noise associated with HDD (not including the vibratory installation of a cofferdam which is not included under the Proposed Action) is expected to be similar to other small scale geotechnical drilling activities.

Erbe et al. (2017) measured sounds from a jack-up rig geotechnical drilling in shallow water (23 to 43 feet [7 to 13 meters]). In one location, using a 3.3-inch (8.3-centimeters) drill bit to penetrate 13 to 66 feet (4 to 20 meters) into the seafloor (including sand, mudstone, and limestone), they back-calculated the SPL source level to be 145 dB re 1 µPa m, with most of the energy in the 30 to 400 Hz range.

6.3.8.1 Marine Mammals

Cable-laying and HDD noise sources associated with the Project were below the established PTS injury thresholds for all marine mammal hearing groups (Table 6-4). Therefore, the potential for ESA-listed marine mammals to be exposed to noise above PTS thresholds from cable laying and HDD activities is extremely unlikely to occur and **discountable**.

Based on the source levels previously presented in Section 6.3.8 from the available literature for cable-laying activities comparable to those that will be used for the Project, behavioral disturbance thresholds could be exceeded, and behavioral disturbance could occur if the animals do not avoid the activities. Using a spherical spreading transmission loss equation of 20log(R), the range to the 120 dB re 1 µPa behavioral disturbance threshold for marine mammals was estimated to be 2,605 feet (794 meters) from jet trenching activities with an estimated source level of 178 dB re 1 µPa m; and 59 feet (18 meters) from HDD activities with an estimated source level of 145 dB re 1 µPa m. However, all the ESA-listed marine mammals are highly mobile and expected to move away from any noise effects that may result in prolonged behavioral disturbance. Of the few studies that have examined behavioral responses from cable-installation and HDD noise, most have involved other industrial activities, making it difficult to attribute responses specifically to cable-installation noise. Some found no observable response (Hoffman 2012), while others showed avoidance behavior (Richardson et al. 1990; Pirotta et al. 2013).

Any behavioral effects would be expected to dissipate once the activity has ceased or the individual has left the area and, therefore, would be considered temporary. Behavioral disturbances from cable-laying operations are not expected to impede the migration of NARWs to the designated critical habitats north and south of the Project area as animals would still be able to move outside of the behavioral disturbance zone. Other LFCs would also 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 (Table 3-20), potential behavioral effects are further reduced. Masking of LFC communications is possible; however, the effects of masking would be transient in nature, moving with the cable-laying vessel, and would occur intermittently in several separate areas, as discussed previously. The potential for communications to be masked from cable-laying operations is considered temporary and transient.

The area in which cable-laying operations would occur does not extend beyond the continental slope where sperm whales are more commonly observed. Sperm whales are not expected to be exposed to underwater noise above behavioral thresholds and effects from any potential exposures are highly unlikely due to the ranges to behavioral disturbance thresholds and the expected distribution of sperm whales. Additionally, only the Atlantic Ocean HDD location connecting the offshore export cable to the 3R's Beach landfall location (Table 3-12) would have the potential to occur where ESA-listed marine mammals may be located. However, the HDD transition vault at this location is estimated to be 550 feet (167 meters) in approximately 30 feet (9 meters) water depth (Table 3-12), so the large whale species are not likely to occur where HDD activities would take place.

Based on the mitigation measures presented and discussed (Table 3-20), the location of the proposed HDD activities, and the relatively small ranges to the behavioral disturbance threshold, the potential for exposure of these ESA-listed cetaceans to noise produced by cable-laying and HDD activities at levels leading to behavioral disruption would be reduced to the level of the individual animal and would not be expected to have population-level effects. NARWs, fin whales, and sei whales, may be exposed to noise above the behavioral thresholds depending on the type of vessel and equipment used for cable-laying operations. Given the interim definition for ESA harassment (Section 6.2), an animal's ability to avoid harmful noises, and the established mitigation and monitoring measures in Table 3-20, the potential for low-frequency ESA-listed marine mammals to be exposed to underwater noise exceeding behavioral disruption thresholds from cable-laying operations would be so minor that they cannot be meaningfully evaluated and, therefore, considered **insignificant**. Sperm whales are not expected to be exposed to above-threshold noise levels from cable laying activities and effects for sperm whales are extremely unlikely to occur such that effects would be **discountable**. Because the behavioral disturbance threshold for all ESA-listed marine mammals may only be exceeded by HDD activities out to approximately 59 feet (18 meters) and the nearshore location of this activity limits large whale occurrence in the ensonified area, effects from HDD activities are extremely unlikely to occur for any ESA-listed marine mammal species and are therefore **discountable**.

Because the risk of PTS is discountable, as discussed previously in this section, and the effects of behavioral disturbances is insignificant, the effects of noise exposure from Project cable-laying and HDD operations leading to behavioral disturbance and masking **may affect, but are not likely to adversely affect** ESA-listed marine mammals.

6.3.8.2 Sea Turtles

Given the low source levels and transitory nature of noise associated with cable-laying and HDD activities, exceedance of PTS levels is not likely for sea turtles, according to measurements and subsequent modeling by Heinis et al. (2013). Therefore, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds from cable laying is extremely unlikely to occur and **discountable**.

Cable-laying operations could exceed the behavioral disturbance threshold for sea turtles (SPL of 175 dB re 1 μPa), whereas HDD activities are not expected to exceed this threshold based on the estimated source levels. As outlined earlier, there is very little information regarding behavioral responses of sea turtles to underwater noise. Of the few studies that have examined behavioral responses from cable-installation or HDD noise, most have involved other industrial activities, making it difficult to attribute responses specifically to cable installation. Some found no observable response (Hoffman 2012), while others showed avoidance behavior (Richardson et al. 1990; Pirotta et al. 2013). 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) suggested 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).

Behavioral effects are considered possible but would be temporary, with effects dissipating once the activity has ceased or the 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 from this brief exposure would be so small that they could not be measured, detected, or evaluated and are, therefore, **insignificant**. Because the risk of PTS is discountable, as discussed previously in this section, and the effects of behavioral disturbances is insignificant, the effects of noise exposure from Project cable-laying and HDD operations leading to behavioral disturbance **may affect, but are not likely to adversely affect** ESA-listed sea turtles.

6.3.8.3 Marine Fish

Received levels of underwater noise from cable-laying and HDD operations are unlikely to exceed physiological injury thresholds for Atlantic sturgeon, shortnose sturgeon, or giant manta rays because the animals would move away from any noise that could result in injury. Thus, the potential for ESA-listed fish to be exposed to noise above physiological injury thresholds is considered extremely unlikely to occur and **discountable**.

Behavioral effects are considered possible but would be temporary, with effects dissipating once the activity or individual has left the area. Only potential cable installation activities have the potential to exceed the behavioral disturbance threshold of 150 dB re 1 µPa out to an estimated range of 82 feet (25 meters); the estimated source level for HDD activities is below this threshold and is therefore extremely unlikely to affect ESA-listed fish species. Should an exposure occur, the potential effects would be brief (e.g., an individual 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 are, therefore, **insignificant**. Because the risk of physiological injury is discountable, as discussed previously in this section, and the effects of behavioral disturbances is insignificant, the effects of noise exposure from Project cable-laying operations leading to behavioral disturbance **may affect, but are not likely to adversely affect** ESA-listed fish species.

6.3.9 Dredging during Installation of the Inshore Export Cable

As described in Section 3.1.3, US Wind has determined that dredging will be required to allow barge access needed for cable installation of the inshore export cables to precede cable installation along portions of the cable route. The proposed Inshore Export Cable Route would cut through Indian River Bay, as depicted in Figure 3-8. Dredging would be conducted using mechanical, or most likely, hydraulic means. The specific type of hydraulic method to be used is not known yet. The maximum volume of dredging, assuming all four cables were installed within both the northern and southern Inshore Export Cable Routes is estimated to approximately 390,648 cubic yards (298,6712 cubic meters). Installation of the four inshore export cables associated with all project development phases would occur within and along the same Inshore Export Cable Route

Inshore export cable installation in Indian River Bay is anticipated to occur over two construction seasons (Campaign 1 – one cable, associated with MarWin and Campaign 2 – up to three cables, associated with Momentum and future development). Installation of the inshore export cable is anticipated to occur over an approximate 21-month period between the third quarter of 2024 and the second quarter of 2026 (Table 3-14). US Wind assumes all construction within Indian River Bay, including any dredging, would occur in October-March window, observing the general time of year restrictions for summer flounder and other species. Time of year restrictions would be determined through consultations with DNREC.

Under the Proposed Action it is anticipated that the dredged material would be deposited within the construction corridor of approximately 633 feet (193 meters) on either side of the centerline of the Inshore Export Cable Route using a floating pipeline system, barge, or scow. Dredge material disposal would occur within the surveyed Inshore Export Cable Route in areas with compatible physical and chemical characteristics. The sediment habitat within the Indian River Bay consists of a 100% soft bottom (Section 3.2.1.1.2). Furthermore, the sediments will have to meet State standards prior to placement.

Dredging produces distinct sounds during each specific phase of operation: excavation, transport, and placement of dredged material (Central Dredging Association 2011; Jiminez-Arranz et al. 2020). Engines, pumps, and support vessels used throughout all phases may introduce low-level, continuous noise into the marine environment. The sounds produced during excavation vary depending on the sediment type; the denser and more consolidated the sediment is, the more force the dredger needs to impart, and the higher sound levels that are produced (Robinson et al. 2011). Sounds from mechanical dredges occur in intervals as the dredge lowers a bucket, digs, and raises the bucket with a winch. During the sediment transport phase, many factors (including the load capacity, draft, and speed of the vessel) influence the sound levels that are produced (Reine et al. 2014). SPL source levels during backhoe dredge operations range from 163 to 179 dB re 1 µPa m (Nedwell et al. 2008; Reine et al. 2012), and source levels during TSHD operations range from 172 to 190 dB re 1 µPa m (Nedwell et al. 2008; de Jong et al. 2010). As a whole, dredging activities generally produce low-frequency sounds; with most energy below 1,000 Hz and frequency peaks typically occurring between 150–300 Hz (McQueen et al. 2018). Additional detail and measurements of dredging sounds can be found in (Jiminez-Arranz et al. 2020; McQueen et al. 2018; Robinson et al. 2011).

6.3.9.1 Marine Mammals

The inshore location of this activity in Indian River Bay (Figure 3-8) would minimize the risk of ESA-listed marine mammals being exposed to above-threshold noise during any dredging activities required for the installation of the Inshore Export Cable. The ESA-listed species analyzed in this BA are all considered large whale species, which, while they may travel closer to shore to forage, would predominantly remain offshore and not be expected to occur within Indian River Bay. Because ESA-listed marine mammal species are not likely to occur in Indian River Bay where dredging for installation of the Inshore Export Cable will occur, **no effect** from dredging noise during installation of the inshore export cable under the Proposed Action is expected for ESA-listed marine mammal species.

6.3.9.2 Sea Turtles

The inshore location of this activity in Indian River Bay (Figure 3-8) does not occur near any known sea turtle nesting sites (Section 5.1.2), but adult and juvenile green, Kemp's ridley, and loggerhead sea turtles are expected to be present within Indian River Bay from May through the end of November and may be foraging. This timing overlaps with the proposed timing of dredging activities between October and March; however, sound exposure levels from dredging are not expected to exceed the recommended sea turtle acoustic threshold for TTS or PTS (Table 6-7) (Finneran et al. 2017; Popper et al. 2014). Behavioral responses are possible close to the source, as TSHD may produce source levels up to an SPL of 190 dB re 1 μPa (Nedweall et al. 2008; de Jong et al. 2010), which would exceed the behavioral response threshold of 175 dB re 1 μPa out to approximately 20 feet (6 meters) from the source.

There is currently no information on the effects of dredging noise on sea turtles (Popper et al. 2014). There is evidence, however, of potentially positive impacts of dredging to breeding flatback turtles, which increased their use of a dredging area and made longer and deeper resting dives during dredging operations (Whittock et al. 2017). The most likely driver for the observed behavioral response was speculated to be the absence of predators which were displaced by the noise from dredging operations. Despite the presence of active dredge vessels (which can often pose a risk to turtles), no events of injury or mortality were recorded, and given the relatively low noise levels produced by this activity, behavioral effects are extremely unlikely to occur for green, Kemp's ridley, and loggerhead sea turtles. As such, effects on these species would be **discountable**. Overall, exposure to noise above behavioral thresholds during dredging for installation of the inshore export cables under the Proposed Action **may affect, but it is not likely to adversely affect** green, Kemp's ridley, and loggerhead sea turtles. Leatherback sea turtles are a pelagic species that are not expected to occur in the inshore areas where dredging during installation of the inshore export cables would occur (Section 5.1.2.3), so there would be **no effect** to this species.

6.3.9.3 Marine Fish

Atlantic sturgeon would have the potential to be present withing Indian River Bay from October to December prior to migrating further offshore to deeper waters. Given the likelihood of Atlantic sturgeon presence in Indian River Bay during October through December, Atlantic sturgeon may be present during the proposed dredging activities. For shortnose sturgeon, they are primarily expected to be migrating upstream in rivers around Indian River Bay during the October to March window for dredging, so they are less likely to be present than Atlantic sturgeon. Giant manta ray are a predominantly pelagic species who are not expected to occur inshore (Section 5.1.3.3).

Given the sound source characteristics and estimated source levels for dredging activities described previously in this section, injury and auditory impairment are unlikely, but Atlantic and shortnose sturgeon could experience behavioral disturbance or masking close to these activities. No research has specifically looked at responses to these noise sources, but impacts are likely to be similar, though less intense, than those observed with vessel noise (Section 6.3.7), since these activities are not as widespread or frequent as vessel transits and would be limited to Indian River Bay. Behavioral responses may occur, as TSHD may produce source levels up to an SPL of 190 dB re 1 µPa (Nedweall et al. 2008; de Jong et al. 2010), which would exceed the behavioral response threshold of 150 dB re 1 µPa out to approximately 328 feet (100 meters) from the source.

Given the relatively low noise levels produced by this activity and the limited overlap in shortnose sturgeon presence in Indian River Bay with the proposed dredging activities, behavioral effects are extremely unlikely to occur for this species, and would therefore be **discountable**. Atlantic sturgeon are likely to be present in Indian River Bay during the proposed dredging activities and may therefore be exposed to above threshold noise; however, behavioral disturbances are only estimated to occur out to 328 feet (100 meters) from the source, and responses would be similar to those described for vessel noise in Section 6.3.7. Any behavioral effects that occur would be so minor they cannot be meaningfully evaluated and would be considered **insignificant**. Overall, exposure to noise above behavioral thresholds during dredging for installation of the inshore export cables under the Proposed Action **may affect, but it is not likely to adversely affect** Atlantic sturgeon and shortnose sturgeon. Giant manta rays are not expected to occur in Indian River Bay, so there would be **no effect** to this species from dredging noise during installation of the inshore export cable under the Proposed Action.

6.3.10 WTG Operation

The PDE includes up to 121 WTGs, however as shown in Figure 3-1, not all of these WTG will be associated with the same Project phase and all phases of WTG operations will not come online at the same time. It is anticipated that a total of 21 WTGs will be installed during phase 1 for MarWin, targeted to be operational in December 2025; up to 55 WTGs will be installed during phase 2 for Momentum Wind which will likely be operational sometime in 2026 though no date is specified in the COP; and up to 38 WTGs will be installed during phase 3 for future development which will likely be operational sometime in 2027 though no date is specified in the COP (US Wind 2023). Though these WTGs will all be operational at different times, the noise during operations is expected to contribute only negligible amounts of noise when paired with adjacent construction noise. Therefore, effects from the incremental WTG operations during construction of subsequent phases are expected to be extremely unlikely with no measurable effects anticipated and discountable for ESA-listed species. The effects analysis therefore pertains only to the potential effects of WTG noise from all the proposed WTG operations after all three phases of construction have been completed.

Reported sound levels of operational WTGs is generally low (Madsen et al. 2006; Tougaard et al. 2020; Stöber and Thomsen 2021), with a source SPL of approximately 151 dB re 1 µPa m and a frequency range of 60 to 300 hertz (Wahlberg and Westerberg 2005; Tougaard et al. 2020). At the Block Island Wind Farm, low -frequency noise generated by turbines reaches ambient levels at 164 feet (50 meters) (Miller and Potty 2017). Tougaard et al. (2020) summarized available monitoring data on wind farm operational noise, including older -generation, geared turbine designs and quieter, modern, direct drive systems like those proposed for the Project. They determined that operating WTGs produce underwater noise on the order of 110 to 125 dB re 1 µPa SPL at a reference distance of 164 feet (50 meters), occasionally reaching as high as 128 dB re 1 µPa SPL, in the 10 hertz to 8 kilohertz range.

SPL measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 µPa at 46 and 66 feet (14 to 20 meters) from the WTGs (Tougaard et al. 2009). Thomsen et al. (2016) indicated SPL ranging from 122 to 137 dB re 1 µPa at 492 and 131 feet (150 and 40 meters), respectively, with peak frequencies at 50 hertz and secondary peaks at 150 , 400, 500, and 1,200 hertz from a jacket foundation turbine and from 133 to 135 dB re 1 µPa at 492 and 131 feet (150 and 40 meters), respectively, with peak frequencies at 50 and 140 hertz from a steel monopile foundation turbine.

Measurements within 131 feet (40 meters) of the monopile were similar to those observed at the jacket foundation WTG, though at the greater distance of 492 feet (150 meters), the jacketed turbine was quieter. However, the measurements and reported noise levels available from these studies are all for WTG that are 6.15 megawatts or smaller, which are less than half the size of the 18-megawatt WTG included under the Proposed Action.

In an attempt to predict noise levels with increasing turbine size, Tougaard et al. (2020) reviewed the literature sources previously cited, along with others, to attempt some standardization in reporting and assessment. The complied data showed an approximate 13.6 dB increase in noise levels with every 10-fold increase in the WTG power rating. This means that operational noise could be expected to increase by 13.6 dB when increasing in size from a 0.5-megawatt turbine to a 5-megawatt one, or from 1-megawatt to 10-megawatt. The least squares fit of the dataset from Tougaard et al. (2020) would predict that the SPL measured 328 feet (100 meters) from a hypothetical 15-megawatt turbine in operation in 19 knot (10 meters per second) wind would be 125 dB re 1 µPa. Tougaard et al. (2020) also noted the noise produced from a WTG is stationary and persistent, and the cumulative contribution of multiple WTGs within a region must be critically assessed; however, the results of their modeling for an array of 81, 1-megawatt WTG showed the noise levels dropped below ambient conditions, based on European waters, within a few miles (a few kilometers).

Stöber and Thomsen (2021) also reviewed published literature and identified an increase in underwater source levels (up to 177 dB re 1 µPa) with increasing power size of a nominal 10-megawatt, current-generation, direct-drive WTG, which is smaller than the proposed 18-megawatt WTG included in the Proposed Action. However, all the measurement data from Tougaard et al. (2020) except one were from WTG operating with gear boxes, and Stöber and Thomsen (2021) estimated a sound decrease of roughly 10 dB from WTGs using gear boxes to WTGs using direct drive technology which is expected to be used for the US Wind Project.

More recently, Betke and Bellmann (2023) conducted standardized underwater sound measurements from 25 German offshore wind farms that included turbines up to 8.3 megawatts. The trend analysis in the Betke and Bellmann (2023) study showed that there was no statistical increase in radiated noise with increasing turbine power size. Results from field measurements showed primary frequency ranges between 50 and 200 Hz consistently across all wind farms regardless of turbine type. The average noise levels for monopile foundations measured 121.5 dB re 1 µPa at 328 feet (100 meters) from the foundation. This measurement was 0.5 dB higher for other foundation types. Average noise levels for foundations with gear box drives was 122.3 dB re 1 µPa at 328 feet (100 meters) from the foundation; foundations with gearless (direct) drive were 2.3 dB lower (Betke and Belmann 2023). Holmes et al. (2023) also found that the modeled results from Tougaard et al. (2020) tended to overestimate the sound noise by approximately 8 dB when compared to measurements taken 230 feet (70 meters) from the turbine. The underwater noise predictive model developed by Holmes et al. (2023) using their measurements estimated that WTG operational noise would be approximately 115 dB re 1 µPa at 230 feet (70 meters) from the turbine and approximately 117 dB re 1 µPa at 492 feet (150 meters) from the turbine. These predictions were based on the assumption of 6.3 megawatt turbines and a wind speed of 13 m/s (Holmes et al. 2023). Furthermore, Holmes et al. (2023) revealed no significant difference in noise levels between a 6.2- and 8.3-megawatt WTG, and did not demonstrate any daily variation in their underwater sound measurements, indicating that neither power production nor wind speed had a discernible impact on the noise level produce.

Overall, given the more recent results from Betke and Bellmann (2023) and Holmes et al. (2023), and the predictions from Stöber and Thomsen (2021) that the direct drive technology anticipated for the WTG under the Proposed Action would produce lower noise levels than WTG using gear boxes, a linear increase in the sound levels produced due to increased WTG size is not expected and the noise levels from the Proposed Action WTG are not expected to be significantly louder than those reported from European wind farms.

In addition to the size of the WTG, when evaluating WTG noise it's crucial to factor in the presence of vessels relating to the operation of WTG (Betke and Bellmann 2023). Results of the analyses from Tougaard et al. (2020) showed sound levels produced by individual WTGs were low and comparable to or lower than sound levels within 0.6 mile (1 kilometer) of commercial ships. Holme et al. (2023) conducted measurements of broadband underwater noise levels from windfarms consisting of 6.3- to 8.3-megawatt WTG using hydrophones positioned 230 feet (70 meters) to 3.1 miles (5 kilometers) away from the WTG. The results showed no relationship between the recorded underwater sound levels and the turbine activity, which was assessed using the WTG blades revolutions per minute (Holmes et al. 2023). Variation was still observed in the ambient recorded sound levels when the WTG were at a standstill (i.e., not moving), indicating that other processes, either natural or anthropogenic, are the main drivers for underwater noise levels (Holmes et al. 2023). Given the level of baseline vessel traffic in the Project area (Section 3.2.1.1.7) and the key characteristics of ambient noise in the Project area being attributed to shipping noise and natural wave energy noise (Section 3.2.1.1.4), it is expected have vessel noise would be more prevalent than Project WTG noise.

6.3.10.1 Marine Mammals

Based on currently available sound field data for turbines smaller than 8.3 megawatts (Betke and Bellmann 2023) summarized in the previous section and comparisons to acoustic impact thresholds (Section 6.3.2), underwater sound from offshore WTG operations is not likely to cause PTS for any ESA-listed marine mammal assessed in this BA. Though the 18-megawatt WTG included under the Proposed Action is bigger than the largest WTG measured in the field to date (8.3 megawatts; Holmes et al. 2023), the available data also show that the noise levels are not expected to significantly increase due to increasing turbine size. Given that WTG noise is a non-impulsive source which poses a lower risk of auditory injury than impulsive sources such as impact pile driving (Section 6.3.1), and the relatively low noise levels expected from WTG operations, especially in comparison to ambient conditions (Section 3.2.1.1.4 and 3.2.1.1.7), PTS effects on marine mammals are not considered likely and are **discountable**.

Based on the available source level and modeling information previously presented, underwater noise from WTG operations could exceed behavioral thresholds and cause masking of communications. Estimated ranges to behavioral thresholds for marine mammals using the SPL estimates at 230 feet (70 meters) from Holmes et al. (2023) extend out to 131 feet (40 meters) using a spherical spreading loss equation (20 log [range]). Given this small threshold range and the relatively low sound levels that would be produced during WTG operations, only temporary changes in marine mammal behavior would be expected at close distances to the Project WTGs.

Some studies have shown an increase in acoustic occurrences of harbor porpoises within a wind farm during the operational phase (Scheidat et al. 2011; Russell et al. 2016), while another study showed a decrease in the abundance of harbor porpoises 1 year after operations began compared with the pre-construction period (Tougaard et al. 2005). However, no change in acoustic behavior was detected in the animals that were present (Tougaard et al. 2005). In these field monitoring studies, it is not always clear if the behavioral responses have anything to do with operational noise or merely the presence of turbine structures. Regardless, these findings suggest turbine operational noise did not have any severe adverse effect on the acoustic behavior of the animals.

Very few empirical studies have looked at the effect of operational WTG noise on wild marine mammals, in particular LFCs, mainly because wind farm operations monitoring has largely been conducted in Europe where the LFC species content is not comparable to that expected at U.S. wind farms. Modeling conducted on 6 megawatt WTGs estimated minke whales (*Balaenoptera acutorostrata*) would detect wind farms at distances of 11.2 miles (18 kilometers). Although there were no predictions of behavioral alterations at these distances, the of anticipated minimum 18-megawatt WTG nameplate power planned for US Wind is not anticipated to produce significantly higher sound levels than the 6-megawatt WTG given the likelihood of direct drive technology being used (Stöber and Thomsen 2021; Betke and Bellmann 2023; Holmes et al. 2023); however, data supporting this potential effect are lacking.

For high ambient noise conditions, the distance at which a turbine could be heard above ambient noise is anticipated to be small (Betke and Bellman 2023; Holmes et al. 2023). It is important to note that just because a sound is audible, that does not mean that it would be disturbing or be at a sufficient level to mask important acoustic cues. There are many natural sources of underwater sound that vary over space and time and would affect an animal's ability to hear turbine operational noise over ambient conditions.

WTG operational noise would be considered a chronic effect, such as vessel noise, in which the effect of noise contributes to an overall degradation of the acoustic space and may result in long-term, sub-acute effects on marine mammals. These chronic effects may result in lowered health and behavioral changes over the operational term of the wind farm. Sources of chronic noise typically fall within the low-frequency bands that are problematic for LFCs due to masking risk. Masking of LFC communications is considered likely, but, as with behavioral disturbances, the extent of these effects is unknown. There is no published literature assessing long-term movement or acoustic exposure of LFCs in or around offshore wind farms. Rather than sound levels produced by individual WTGs, cumulative noise from individual wind farms as well as combined regional wind farms are likely to produce more widespread sound fields, which, in the absence of other similar ambient noise (e.g., ships), could produce a pronounced change to the regional soundscape and affect marine mammals (and other species) acoustic acuity (Tougaard et al. 2020).

Similar to LFCs, there are limited data regarding responses of MFC species to WTG operational noise. Some studies indicated no change in the acoustic presence of marine mammals during wind farm operations (Scheidat et al. 2011; Russell et al. 2016), while some indicated temporary avoidance of the wind farm (Tougaard et al. 2005). Masking of high-frequency echolocation clicks used by sperm whales is not anticipated because WTG operational noise is not expected to overlap with the broadband sperm whale click frequencies at sufficient sound levels to propagate into sperm whale habitat. Lucke et al. (2007) explored the potential for acoustic masking from operational noise by conducting hearing tests on trained harbor porpoises while they were exposed to sounds resembling operational WTGs (less than 1 kilohertz). They saw masking effects at 128 dB re 1 μPa at frequencies of 700, 1,000, and 2,000 hertz, but found no masking at SPLs of 115 dB re 1 μPa. Based on propagation loss in a shallow-water environment, the sound would attenuate to 115 dB re 1 μPa within 66 feet (20 meters) of the operating turbine (Lucke et al. 2007), suggesting the masking range for high-frequency cetaceans is very small and would likely be similarly small for mid-frequency cetacean species like the sperm whales given the low overlap between the frequencies of WTG operational noise and the peak hearing sensitivity of sperm whales (Section 6.3.2). Additionally, sperm whales are likely to face a lower risk of exposure to Project WTG noise given the lower densities of this species expected in the Project area compared to the low-frequency cetacean species. If any behavioral or masking effects would occur due to an animal's proximity to the WTG, the effects would be temporary and limited to the few individuals present in the project area, and would therefore not be expected to have any long-term population level effects.

The potential for exposure of ESA-listed LFCs and MFCs to noise levels which meet or exceed the behavioral disturbance threshold during WTG operations would be reduced to the level of the individual animal and would not be expected to have population-level effects. NARWs, fin whales, sei whales, and sperm whales may be exposed to noise above the behavioral thresholds during WTG operations; however, the behavioral disturbance threshold is not likely to be exceeded beyond 131 feet (40 meters) from the WTGs based on recent SPL estimates from Holmes et al. (2023). Additionally, Holmes et al. (2023) emphasized that local increases in ambient noise were not directly attributed to wind turbine activity such as changes in the blade rotation speed, as increases in ambient noise measurements were also reported at hydrophones positioned 3.1 miles (5 kilometers) away from the wind farm (Holmes et al. 2023).

Available studies suggest WTG operational noise would not have any severe adverse effect on the behavior of the animals, and potential behavioral effects of ESA-listed cetaceans from WTG operations is considered **insignificant**. Because the risk of PTS is discountable, as discussed previously in this section, and the risk of behavioral disturbances is insignificant, the effects of exposure to noise from Project WTG operations **may affect, but are not likely to adversely affect** ESA-listed marine mammals.

6.3.10.2 Sea Turtles

Sea turtle hearing (frequencies less than 1,200 hertz) is within the frequency range of operational WTGs (less than 500 hertz; Thomsen et al. 2016; Tougaard et al. 2020; Stöber and Thomsen 2021). Thus, WTG noise could be perceptible to sea turtles and may influence sea turtle behavior. Potential responses to WTG noise generated during normal operations may include avoidance of the noise source, disorientation, and disturbance of normal behaviors such as feeding (Minerals Management Service 2007). In the discussion on reef effects from foundation structures (Section 6.5.5.3), sea turtles may be attracted to prey concentrations at foundation structures. This attraction may override avoidance of low-level noise sources; in these cases, the acclimation of sea turtles to WTG noise may introduce low-level, long-term effects of noise exposures or masking.

Based on the source characteristics of WTGs described in the beginning of Section 6.3.10, received levels of underwater noise from WTG operations are unlikely to exceed the SEL_{24h} of 200 dB re 1 μPa^2 s PTS thresholds for sea turtles for non-impulsive sources. As a result, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely and **discountable**.

Behavioral responses of sea turtles to noise, particularly long-term increases in ambient noise levels due to ocean development activities, are not well studied. Similar to increases in vessel noise, WTG operations could increase sound levels within the hearing range of sea turtles throughout the habitat used in the Project area. While avoidance of WTG structures due to increased noise levels is possible, there is no evidence of habitat abandonment due to an increase in sound levels. Many sea turtle species occupy coastal and heavily industrialized areas such as ports and harbors that have high ambient noise levels. However, the lack of a behavioral reaction may not fully capture potential effects of smaller noise increases that are expected during WTG operations. Samuel et al. (2005) recorded seasonal increases in vessel noise within coastal sea turtle habitat in the Peconic Bay Estuary, New York, and noted that such increases highlight that the spatial overlap between increased sound levels and sea turtles poses a potential acoustic exposure risk even though the “activity” is already part of the acoustic environment within which the sea turtles congregate. While the WTG sound level contributions may be small, the long-term change in acoustic habitat could cause some behavioral changes. Sea turtles are known to be attracted to offshore energy structures (Lohoefener et al. 1990; Viada et al. 2008; Valverde and Holzwart 2017), and sea turtles would likely be attracted to the WTG and OSS foundations due to beneficial foraging and sheltering opportunities (NRC 1996; Barnette 2017). Oil and gas platforms used by sea turtles are expected to produce higher SPLs than WTG operations. Furthermore, satellite-telemetered sea turtles in the Gulf of Mexico showed platforms were part of home range core areas, and home range sizes for sea turtles captured at platforms were comparable to the home range sizes for telemetered sea turtles captured at Flower Garden Banks National Marine Sanctuary (Valverde and Holzwart 2017). In a comprehensive noise control study conducted by Spence et al. (2007), underwater noise sources were ranked based on the approximate overall source level for the source type, the affected or detectable range from the source, and the duration or prominence of sounds. All types of oil and gas platforms ranked in the lowest significance category, which is indicative of a low likelihood of acoustic impacts (e.g., seismic surveys were ranked as highest significance). Recent measurements from Holmes et al. (2023) indicate WTG operational noise would be approximately 115 dB re 1 μPa at 230 feet (70 meters) from the turbine and approximately 117 dB re 1 μPa at 492 feet (150 meters) from the turbine for 6.3-megawatt WTG and a wind speed of 13 m/s. Though these measurements are based on WTG that are smaller than the 18-megawatt WTG proposed for this Project, the anticipated use of direct drive technology in the WTG under the Proposed Action and the results of Betke and Bellmann (2023) and Holmes et al. (2023) indicate that the larger WTG included in the Proposed Action are not expected to produce significantly higher noise levels than the smaller WTG measured using gear box technology. Assuming an SPL of 115 dB re 1 μPa at 230 feet (70 meters) (Holmes et al. 2023), the 175 dB re 1 μPa SPL behavioral disturbance threshold for sea turtles is not expected to be met or exceeded at any distance using a spherical spreading loss equation (20 log [range]). Additionally, as discussed previously in the beginning of Section 6.3.10, WTG are not expected to exceed ambient noise levels driven by commercial vessel traffic more than a few miles (kilometers) from the wind farm (Tougaard et al. 2020; Betke and Bellmann 2023; Holme et al. 2023).

Because WTG operations are expected to produce even lower sound levels, the acoustic impact on sea turtles is expected to be low, even for sea turtles that frequent the foundations or remain at the foundations for long periods. Therefore, the potential effects of operational WTG noise could not be measurable or meaningfully evaluated and would be **insignificant**. Because the risk of PTS is discountable, as discussed previously in this section, and the risk of behavioral disturbances is insignificant, the effects of noise exposures during WTG operations **may affect, but are not likely to adversely affect** ESA-listed sea turtles.

6.3.10.3 Marine Fish

Noise produced by WTG operations is within the hearing range of Atlantic sturgeon and giant manta rays; however, this is a non-impulsive sound source, which produces relatively low noise levels (compared to construction noise), so noise produced at levels sufficient to elicit injury in either species would only occur within a few meters of the WTG foundations. Therefore, the potential for injury resulting from WTG noise is extremely low and would be **discountable** for Atlantic sturgeon and giant manta rays.

Depending on the intensity, noises produced by WTG operations could disturb or displace fish within the surrounding area or cause auditory masking (Minerals Management Service 2007). However, with generally low noise levels, fish would be affected only at close ranges (within 328 feet [100 meters]) to the operating WTG (Tougaard et al. 2020; Holmes et al. 2023). Elliot et al. (2019) compared field measurements during offshore wind operations from the Block Island Wind Farm to the published audiograms of a few fish species. They found that, even 164 feet (50 meters) from an operating WTG, particle acceleration levels were below the hearing thresholds of several fish species, meaning it would not be audible at that distance. Pressure-sensitive species may be able to detect operational noise at greater distances, though this would depend on other characteristics of the acoustic environment such as sea state, which would influence ambient noise levels in the Project area.

In a study conducted by Cresci et al. (2023), Atlantic cod were exposed to low-frequency noise (100 Hz) at a median SPL of 139.5dB re 1 μPa for 15-minute intervals transmitted 12 times over a period of 3 days. The frequency and noise levels were selected to simulate a comparable range of noise produced by WTGs. Results of the experiment showed exposure to noise did not impact the swimming performance of the cod larvae. However, it did influence their orientation, causing the larvae to shift towards the source of the sound. The researchers concluded that WTG noise could potentially alter the dispersal trajectory of larvae by affecting their orientation, potentially impacting their distribution in specific areas (Cresci et al. 2023).

Based on the available source level and modeling information previously presented, underwater noise from WTG operations could exceed the SPL 150 dB re 1 μPa behavioral threshold for fish ≥2 grams (Section 6.3.4). Estimated ranges to behavioral thresholds for fish using the SPL estimates at 230 feet (70 meters) from Holmes et al. (2023) extend out to 1 foot (1 meter) using a spherical spreading loss equation (20 log [range]). Given this and the available data summarized previously in this section, operational WTG noise is unlikely to be audible to fishes beyond those in close proximity to the pile, and even if it is audible, it would not be expected to affect biologically relevant behaviors such as feeding or mating.

Shortnose sturgeon are not expected to occur in the Lease Area (Section 5.1.3.2) so **no effects** to this species are anticipated due to WTG operational noise under the Proposed Action.

As described previously, Atlantic sturgeon would be more likely to be present around the wind farm in non-spawning years as spawning adults typically travel upriver to reproduce (Section 5.1.3.1), and giant manta rays are regularly found offshore Maryland and would likely be present around the wind farm between May and October (Section 5.1.3.3), so both species could be found around the WTG foundations during O&M. While there may be some behavioral modifications, these would be localized and not likely to affect activities such as foraging or reproduction. Effects of behavioral disturbances resulting from WTG noise would be minor enough that they cannot be meaningfully evaluated and are **insignificant**. Because the risk of PTS is discountable, as discussed previously in this section, and the risk of behavioral disturbances is insignificant, the effects of exposure to noise during WTG operations **may affect, but are not likely to adversely affect** Atlantic sturgeons and giant manta rays.

6.3.11 Effects to Prey

Prey species important to ESA-listed marine mammals, sea turtles, and fish species include plankton, squid, small schooling fish, bottom-dwelling fish such as sand lance, crustaceans, and seagrasses. Further details of the primary prey for each species considered in this BA are provided in Section 5.1.

Reduction of prey availability could affect marine animals if rising sound levels alter prey abundance, behavior, or distribution (McCauley et al. 2000a,b; Popper and Hastings 2009; Slabbekoorn et al. 2010). Prey species may show responses to noise; however, there are limited data on hearing mechanisms and potential effects of noise on common prey species (e.g., crustaceans, cephalopods, fish) that would result in loss of availability to marine mammals. These species have been increasingly researched as concern has grown related to noise effects on the food web. Invertebrates appear able to detect sounds and particle motion (André et al. 2016; Budelmann 1992; Solé et al. 2016, 2017) and are most sensitive to low-frequency sounds (Packard et al. 1990; Budelmann and Williamson 1994; Lovell et al. 2005a,b; Mooney et al. 2010).

Squid and other cephalopods are an extremely important food chain component for many higher order marine predators, including fin and sperm whales. Cephalopods (e.g., octopus, squid) and decapods (e.g., lobsters, shrimps, crabs) are capable of sensing low-frequency sound. Packard et al. (1990) showed three species of cephalopod were sensitive to particle motion, not sound pressure, with the lowest particle acceleration thresholds reported as 0.002 to 0.003 m/s^2 at 1 to 2 hertz. Solé et al. (2017) showed SPLs ranging from 139 to 142 dB re 1 μPa at one-third octave bands centered at 315 Hz and 400 hertz may be suitable threshold values for trauma onset in cephalopods. Cephalopods have exhibited behavioral responses to low-frequency sounds (under 1,000 hertz), including inking, locomotor responses, body pattern changes, and respiratory rate changes (Kaifu et al. 2008; Hu et al. 2009). In squid, Mooney et al. (2010) measured acceleration thresholds of -26 dB re 1 m/s^2 between 100 and 300 hertz and an SPL threshold of 110 dB re 1 μPa at 200 hertz. Lovell et al. (2005a) found a similar sensitivity for the common prawn (*Palaemon serratus*), an SPL of 106 dB re 1 μPa at 100 hertz, noting this was the lowest frequency they tested and the prawns might be more sensitive at even lower frequencies. Hearing thresholds at higher frequencies have been reported, such as 134 and 139 dB re 1 μPa at 1,000 hertz for the oval squid (*Sepioteuthis lessoniana*) and common octopus (*Octopus vulgaris*), respectively (Hu et al. 2009). McCauley et al. (2000a) reported caged squid exposed to seismic airguns showed behavioral responses such as inking. Wilson et al. (2007) exposed two groups of longfin inshore squid (*Loligo pealeii*) in a tank to killer whale echolocation clicks at SPLs from 199 to 226 dB re 1 μPa, which resulted in no apparent behavioral effects or any auditory debilitation. However, both the McCauley et al. (2000a) and Wilson et al. (2007) experiments used caged squid, so it is unclear how unconfined animals would react. André et al. (2011) exposed four cephalopod species (European squid [*Loligo vulgaris*], cuttlefish [*Sepia officinalis*], octopus, and southern shortfin squid [*Ilex coindetii*]) to 2 hours of continuous noise from 50 to 400 hertz at a received SPL of 157 dB re 1 μPa ± 5 dB, and reported lesions occurring on the statocyst's sensory hair cells of the exposed animals that increased in severity with time, suggesting cephalopods are particularly sensitive to low-frequency sound. Similar to André et al. (2011), Solé et al. (2013) conducted a low-frequency (50 to 400 hertz) controlled exposure experiment on two deep-diving squid species (southern shortfin squid and European squid), which resulted in lesions on the statocyst epithelia. Sóle et al. (2013) described their findings as "morphological and ultrastructural evidence of a massive acoustic trauma induced by low-frequency sound exposure." In experiments conducted by Samson et al. (2014), cuttlefish exhibited escape responses (i.e., inking, jetting) when exposed to sound frequencies between 80 and 300 hertz with an SPL above 140 dB re 1 μPa and particle acceleration of 0.01 m/s^2; the cuttlefish habituated to repeated 200 hertz sounds. The intensity of the cuttlefish response with the amplitude and frequency of the sound stimulus suggests cuttlefish possess loudness perception with a maximum sensitivity of approximately 150 hertz (Samson et al. 2014).

Several species of aquatic decapod crustaceans are also known to produce sounds. Popper et al. (2001) concluded that many are able to detect substratum vibrations at sensitivities sufficient to tell the proximity of mates, competitors, or predators. Popper et al. (2001) reviewed behavioral, physiological, anatomical, and ecological aspects of sound and vibration detection by decapod crustaceans and noted many also have an array of hair-like receptors within and upon the body surface that potentially respond to water- or substrate-borne displacements, as well as proprioceptive organs that could serve secondarily to perceive vibrations. However, the acoustic sensory system of decapod crustaceans remains poorly studied (Popper et al. 2001). Lovell et al. (2005a, 2005b, 2006) reported potential auditory-evoked responses from prawns showing auditory sensitivity to sounds from 100 to 3,000 hertz, and Filiciotto et al. (2016) reported behavioral responses to vessel noise within this frequency range.

Solé et al. (2021) showed seagrasses may be sensitive to anthropogenic noise. They exposed Neptune grass (*Posidoniaceae oceanica)* to noise sweeping through 50 to 400 hertz frequencies at a received SPL of 157 dB re 1 μPa within a few meters (16 feet [less than 5 meters]) from the source to the grasses. Neptune grass is a slow-growing seagrass, endemic to the Mediterranean Sea; though it is not the same species as the common eelgrass (*Zostera marina*) found in the region (BOEM 2023b), they both come from same order (Alismatales) and have similar physiological traits (Biodiversity of the Central Coast 2022). Results showed deformed starch grain structure in the plants after 48 hours of noise exposure and damage to starch grains after 96 to 120 hours of exposure (Solé et al. 2021). Damage to the starch grains in seagrasses could affect successful growth, and though the sound source used in the study is not the same as many of the noise-producing activities included under the Proposed Action, this shows seagrasses may be affected by low-frequency noise. However, the Proposed Action has been sited to avoid submerged aquatic vegetation (SAV) beds where seagrasses would occur. SAVs were not observed during the surveys within the Lease Area, along the Offshore Export Cable, inter-array cable, or Inshore Export Cable Routes, and seagrasses would therefore not be affected by any Project noise-producing activities.

Minimal data are available for zooplankton responses to anthropogenic sound. A 2022 study (Guihen et al. 2022) found an avoidance of Antarctic krill species to the presence of an autonomous glider carrying a single beam echosounder. However, these disturbances had small ranges (i.e., the observed avoidance response extended approximately 66 to 131 feet [20 to 40 meters] as the glider passed) and may be the result of several factors not limited to acoustic avoidance, including visual cues, wake and bow wave turbulence, and simulated bioluminescence (Guihen et al. 2022). Although reactionary behavior to acoustic disturbance by zooplankton is likely, the localized and temporary nature of the movement is not expected to cause significant loss in the availability of prey species to marine mammals.

The effects on ESA-listed species 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, effects from underwater noise sources due to the Proposed Action **may affect,** but are **not likely to adversely affect** prey organisms of ESA-listed marine mammals, sea turtles, and fish.

6.3.12 Decommissioning

According to 30 CFR Part 285 and other BOEM requirements, US Wind would be required to remove or decommission all installations and clear the seafloor of all obstructions created by the Project. All foundations would need to be removed to a depth of 15 feet (4.6 meters) below the mudline (30 CFR § 285.910(a)). US Wind would be required to complete decommissioning within 2 years of termination of the lease and either reuse, recycle, or responsibly dispose of all removed materials. BOEM requires US 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 commercial activities on the lease; or 90 days after cancellation, relinquishment, or other termination of the lease (30 CFR § 285.905). Upon completion of the technical and environmental reviews, BOEM can approve, approve with conditions, or disapprove US Wind's decommissioning application. This process includes an opportunity for public comment and consultation with municipal, state, and federal management agencies. US Wind would need to obtain separate and subsequent approval from BOEM to leave any portion of the Project in place in compliance with all applicable law.

An overview of the potential decommissioning methods included under the Proposed Action is provided in Section 3.1.5. Noise produced during decommissioning activities is expected to be similar to that described for construction and O&M activities in the previous sections, except the levels of noise and extent of propagation of above-threshold noise would be lower as there would be no impact pile driving during decommissioning and no explosive methods of foundation removal are anticipated to occur during decommissioning.

Potential effects from noise produced during decommissioning of the Project would be limited to short-term behavioral disturbances. Individuals who alter their behavior in response to decommissioning noise would be expected to experience behavioral effects that would jeopardize the continued existence of any populations. Because no pile driving or explosive removal of foundations is included under the Proposed Action, any effects that occur would be limited to behavioral disturbances that are so minor they cannot be meaningfully evaluated and would be considered **insignificant**. Thus, exposure to noise above PTS and behavioral thresholds during decommissioning of the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed marine mammals, sea turtles, and fish species.

6.3.13 Impact Pile Driving

6.3.13.1 Marine Mammals

6.3.13.1.1 Offshore Impact Pile Driving

Impact pile driving is an impulsive noise source (defined in Section 6.3.1) that can cause behavioral effects in marine mammals, including avoidance and displacement (Lindeboom et al. 2011; Scheidat et al. 2011; Dähne et al. 2013; Russell et al. 2016); and physiological auditory effects including TTS or PTS. Avoidance of impulsive noise sources has been observed in odontocetes (Watkins et al. 1993; Hatakeyama et al. 1994) and mysticetes (Richardson et al. 1986, 1999; McCauley et al. 1998; Johnson 2002). Avoidance of pile driving noise has also been documented in harbor porpoises (e.g., Brandt et al. 2011; Scheidat et al. 2011; Dähne et al. 2013; Benhemma-Le Gall et al. 2021) and observed in harbor seals (Russell et al. 2016). However, individual responses to pile driving noise are unpredictable and likely species and context specific, therefore, avoidance of sound levels that meet or exceed TTS or PTS thresholds cannot be presumed. The severity of underwater noise effects associated with impact pile driving depends on the received sound level (i.e., the sound level to which the organism is exposed), which is a function of the sound level generated by the noise source, the distance between the source and the organism, the acoustic properties of the water and seafloor in between, and the duration of sound exposure.

Behavioral effects and temporary physiological effects (i.e., stress responses, TTS) resulting from impact pile driving are expected to be short term and localized. Impact pile driving noise may be detected by marine mammals at a distance greater than 62 miles (100 kilometers); however, the received levels of impact pile driving at these distances not expected to result in behavioral disturbance, TTS, or stress responses; the mere perception of sound is not sufficient to assume behavioral or other effects. No permanent behavioral effects (e.g., abandonment of foraging sites) are expected. Impact pile driving would be intermittent, and the contribution of noise produced by the pile driving would vary and would not occur continuously during construction. Therefore, any disruptions to normal behaviors would be short term, and increased energy expenditures associated with displacement are expected to be small and temporary.

Impact pile driving can produce PTS threshold ranges greater than a kilometer. PTS could permanently limit an individual's ability to locate prey, detect predators, navigate, or find mates and could have long-term effects on individual fitness; and in cases of small populations, could have population-level effects.

The assumptions for underwater acoustic propagation and exposure modeling used to assess the risk of effects during impact pile driving of the WTG, OSS, and Met Tower foundations is described in Section 6.3.5. Results of the modeling for marine mammal species are provided in Tables 6-17 to 6-19 for each group, respectively. As discussed in Section 3.1.1.5.1, US Wind has committed to using noise attenuation systems to achieve a minimum of 10 decibels noise mitigation.

Table 6-17. Summary of acoustic ranges (95th percentile) in meters to PTS (SEL_{24h} and L_{pk}) and behavioral regulatory threshold levels during impact pile driving of the 36.1-foot (11-meter) WTG monopile foundations[a] for ESA-listed marine mammals with 10 decibel noise attenuation

Hearing Group	Range to PTS Threshold (L_{pk}) in meters	Range to PTS Threshold (SEL_{24h}) in meters	Range to Behavioral Threshold (SPL) in meters
LFC	<50	2,900	5,250
MFC	<50	<50	5,250

Source: TRC 2023

[a] The modeling assumed installation of a single monopile foundation requiring up to 2 hours of pile driving per day.

LFC = low-frequency cetacean; L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal;
MFC = mid-frequency cetacean; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL= root-mean-square sound pressure level in units of dB referenced to 1 micropascal

Table 6-18. Summary of acoustic ranges (95th percentile) in meters to PTS (SEL_{24h} and L_{pk}) and behavioral regulatory threshold levels during impact pile driving of the 9.8-foot (3-m) OSS skirt pile foundations[a] for ESA-listed- marine mammals with 10 decibel noise attenuation

Hearing Group	Range to PTS Threshold (L_{pk}) in meters	Range to PTS Threshold (SEL_{24h}) in meters	Range to Behavioral Threshold (SPL) in meters
LFC	<50	1,400	500
MFC	<50	0	500

Source: TRC 2023
[a] The modeling assumed installation of four skirt piles requiring up to 8 hours of pile driving per day.
L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift;
SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL= root-mean-square sound pressure level in units of dB referenced to 1 micropascal

Table 6-19. Summary of acoustic ranges (95th percentile) in meters to PTS (SEL24h and Lpk) and behavioral regulatory threshold levels during impact pile driving of the 5.9-foot (1.8-meter) Met Tower pin pile foundations[a] for ESA-listed marine mammals with 10 decibel noise attenuation

Hearing Group	Range to PTS Threshold (L_{pk}) in meters	Range to PTS Threshold (SEL_{24h}) in meters	Range to Behavioral Threshold (SPL) in meters
LFC	<50	50	100
MFC	<50	0	100

Source: TRC 2023
[a] The modeling assumed installation of three pin piles requiring up to 6 hours of pile driving per day.
LFC = low-frequency cetacean; L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal;
MFC = mid-frequency cetacean; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL= root-mean-square sound pressure level in units of dB referenced to 1 micropascal

Marine mammal densities were estimated for the buffered Lease Area (Table 6-12). The buffer distance applied to the perimeter of the Lease Area was the largest range to a regulatory threshold for the pile driving hammer sources proposed for use in the Project, which was 3.26 miles (5.25 kilometers). As discussed in Section 6.3.5, the modeled sound exposures from TRC (2023) were normalized using the density estimates to provide the total number of marine mammals potentially exposed to PTS or behavioral-level noise effects during impact pile driving of the WTG, OSS, and Met Tower foundations provided in Tables 6-20 through 6-22.

The resulting estimated number of ESA-listed marine mammal species exposed to PTS or behavioral-level noise effects from impact pile driving of the WTG monopiles were modeled using the AIM and the pile driving schedule provided in Table 6-11. As noted in the modeling assumptions (Section 6.3.5) while acoustic exposure modeling was conducted for each activity (e.g., piling, HRG surveys) and results are provided in the modeling report (MAI 2023); final takes were not requested for each activity in the LOA application (TRC 2023). Instead, the LOA application take request differs from the modeling report results in that all Project activities included in the LOA over an annual period were assessed and a single take assessment for those combined activities were provided. Therefore, modeled activities for individual stressors such as impact pile driving may have resulted in less than 1 take of a given species or stock (MAI 2023); but when group size is taken into account and the individual stressor is combined with other noise-producing activities, those takes may increase to one or more individuals (TRC 2023). For the purposes of this BA, subsequent effects analysis was conducted for each activity based the results of the exposure modeling report (MAI 2023) for individual activities, not the take requested from combined activities in the LOA application.

Modeling of the offshore impact pile driving activities for each individual foundation type indicates up to two fin whales, less than one sei whale, and less than one NARW may be exposed to underwater noise levels above PTS thresholds from impact pile driving of the WTG foundations (Table 6-20). No PTS exposures for sperm whales were modeled for pile driving of the WTG foundations (Table 6-20), and no PTS exposures for any species were modeled for impact pile driving of the OSS and Met Tower foundations (Tables 6-21 and 6-22). Results of the modeling for each individual foundation type also indicate less than one NARW, up to 22 fin whales, up to 2 sei whales, and no sperm whales may be exposed to underwater noise levels above the behavioral disturbance thresholds for pile driving of any of the foundation types (Tables 6-20 through 6-22).

Table 6-20. Maximum annual PTS and behavioral exposures of ESA-listed marine mammals during impact pile driving of 36.1-foot (11-meter) monopiles during the 3 years of construction planned for the Proposed Action with 10 decibel noise attenuation

Species	Construction Year	PTS	Behavior
NARW[a]	Year 1	0.01	0.06
	Year 2	0.05	0.24
	Year 3	0.02	0.08
	Total	**0.08**	**0.38**
Fin whale[b]	Year 1	0.39	3.94
	Year 2	1.16	11.57
	Year 3	0.68	6.83
	Total	**2.23**	**22.34**
Sei whale[c]	Year 1	0.01	0.11
	Year 2	0.12	0.83
	Year 3	0.02	0.17
	Total	**0.15**	**1.11**
Sperm whale	Year 1	0	0
	Year 2	0	0
	Year 3	0	0
	Total	**0**	**0**

Source: TRC 2023

[a] Less than one exposure was estimated for NARWs for PTS and behavioral disturbance, and due to mitigation measures proposed by US Wind as described below in Section 6.3.13.1.1 of the BA, no PTS (Level A takes) exposures are expected and no Level A takes have been requested for this species. It is worth nothing that TRC (2023) adjusted their final take numbers based on species group sizes so a total of 6 behavioral disturbance (Level B) takes are requested by the Applicant over the 3 years of construction. However, this number includes takes associated with all Project activities, not just impact pile driving of the WTG monopile foundations so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

[b] A total of 2 PTS (Level A) exposures were calculated for fin whales for all 3 years of construction, but TRC (2023) adjusted their final take request based on fin whale group size to include 2 fin whales per year for a total of 6 PTS (Level A) takes for fin whales over the 3 years of construction. Additionally, an extra 2 fin whales were requested in construction year 3 for a total of 8 behavioral disturbance (Level B) takes for this species in that year. However, this number includes takes associated with all Project activities, not just impact pile driving of the WTG monopile foundations so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

[c] Less than on exposure was estimated for sei whales for PTS for all 3 years of construction, but TRC (2023) adjusted their final take request based on sei whale group size to include 1 sei whale take per year for a total of 3 PTS (Level A) takes over the 3 years of construction. However, this number includes takes associated with all Project activities, not just impact pile driving of the WTG monopile foundations so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

Table 6-21. Maximum annual PTS and behavioral exposures of ESA-listed marine mammals during impact pile driving of 9.8-foot (3-meter) OSS skirt piles during the 3 construction phases planned for the Proposed Action with 10 decibel noise attenuation

Species	Construction Year	PTS	Behavior
NARW[a]	Year 1	0	0
	Year 2	0	0
	Year 3	0	0
	Total	**0**	**0**
Fin whale[b]	Year 1	0	0.03
	Year 2	0	0.06
	Year 3	0	0.03
	Total	**0**	**0.12**
Sei whale[c]	Year 1	0	0
	Year 2	0	0
	Year 3	0	0
	Total	**0**	**0**
Sperm whale	Year 1	0	0
	Year 2	0	0
	Year 3	0	0
	Total	0	0

Source: TRC 2023

[a] Less than one exposure was estimated for NARWs for PTS and behavioral disturbance, and due to mitigation measures proposed by US Wind as described below in Section 6.3.13.1.1 of the BA, no PTS (Level A takes) exposures are expected and no Level A takes have been requested for this species. It is worth nothing that TRC (2023) adjusted their final take numbers based on species group sizes so a total of 6 behavioral disturbance (Level B) takes are requested by the Applicant over the 3 years of construction. However, this number includes takes associated with all Project activities, not just impact pile driving of the OSS skirt pile foundations so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

[b] A total of 2 PTS (Level A) exposures were calculated for fin whales for all 3 years of construction, but TRC (2023) adjusted their final take request based on fin whale group size to include 2 fin whales per year for a total of 6 PTS (Level A) takes for fin whales over the 3 years of construction. Additionally, an extra 2 fin whales were requested in construction year 3 for a total of 8 behavioral disturbance (Level B) takes for this species in that year. However, this number includes takes associated with all Project activities, not just impact pile driving of the OSS skirt pile foundations so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

[c] Less than on exposure was estimated for sei whales for PTS for all 3 years of construction, but TRC (2023) adjusted their final take request based on sei whale group size to include 1 sei whale take per year for a total of 3 PTS (Level A) takes over the 3 years of construction. However, this number includes takes associated with all Project activities, not just impact pile driving of the OSS skirt pile foundations so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

Table 6-22. Maximum annual PTS and behavioral exposures of ESA-listed marine mammals during impact pile driving of 5.9-foot (1.8-meter) Met Tower pin piles during the second year of construction during year two and year three planned under the Proposed Action with 10 decibel noise attenuation

Species	PTS	Behavior
NARW[a]	0	0
Fin whale[b]	0	0.01
Sei whale[c]	0	0
Sperm whale	0	0

Source: TRC 2023

[a] Less than one exposure was estimated for NARWs for PTS and behavioral disturbance, and due to mitigation measures proposed by US Wind as described below in Section 6.3.13.1.1 of the BA, no PTS (Level A takes) exposures are expected and no Level A takes have been requested for this species. It is worth nothing that TRC (2023) adjusted their final take numbers based on species group sizes so a total of 6 behavioral disturbance (Level B) takes are requested by the Applicant over all 3 construction phases. However, this number includes takes associated with all Project activities, not just impact pile driving of the Met Tower pin pile foundations so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

[b] A total of 2 PTS (Level A) exposures were calculated for fin whales for all 3 construction phases, but TRC (2023) adjusted their final take request based on fin whale group size to include 2 fin whales per phase for a total of 6 PTS (Level A) takes for fin whales over the 3 construction phases. Additionally, an extra 2 fin whales were requested in phase 3 for a total of 8 behavioral disturbance (Level B) takes for this species in phase 3. However, this number includes takes associated with all Project activities, not just impact pile driving of the Met Tower pin pile foundations so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

[c] Less than on exposure was estimated for sei whales for PTS for all 3 construction phases, but TRC (2023) adjusted their final take request based on sei whale group size to include 1 sei whale take per phase for a total of 3 PTS (Level A) takes over the 3 construction phases. However, this number includes takes associated with all Project activities, not just impact pile driving of the Met Tower pin pile foundations so for the purposes of this assessment, only the raw takes calculated for this activity are presented in this table.

As noted previously, the LOA application for this Project adjusted the final requested take numbers by rounding up the combined modeled takes for all activities (e.g., HRG surveys, pile driving) then correcting for group size for species where the modeled acoustic exposure was less than the mean group size (TRC 2023) as summarized in Table 6-23. The individual stressor estimates from Tables 6-20 through 6-22 rounded up to the nearest whole integer for each activity are not additive for the combined activities due to the format of the LOA application, and are only used to assess the relative risk of the individual stressors on marine mammals in this BA. This method is the only way to assess potential effects of individual stressors based on take the final requests because no individual activity results in one or more takes; thus, effects analysis would otherwise not comport with the final LOA application which requests both PTS and behavioral takes. However, the assessment of effects for each species account for the requested take numbers present in Table 6-23 in the final effects determinations.

Table 6-23. Total requested MMPA Level A (PTS) and Level B (behavioral disturbance) takes associated with acoustic exposure during construction of the Proposed Action[a]

Species	Requested Level A (PTS) Takes	Requested Level B (Behavioral Disturbance) Takes
NARW	0	6
Fin whale	6	24
Sei whale	3	3
Sperm whale	0	0

Source: TRC 2023

[a] The total requested take numbers presented in this table include all foundation installation activities as well as HRG survey activities, adjusted for group size for species where the modeled acoustic exposure was less than the mean group size as well as enhanced mitigation proposed specifically for NARW.

The potential for behavioral and PTS impacts is minimized by the implementation of mitigation measures before and during pile driving operations which will reduce impact risk for all species. Piling of each foundation will begin using a soft start procedure. Soft-starts decrease the range of ensonification at the start of piling by using a lower hammer energy for a period of time, thus allowing any animals within the area of disturbance to move away before higher hammer energies are employed. Soft-starts could also deter marine mammals from impact pile driving activities prior to exposure resulting in a serious injury. However, few empirical studies have been conducted that test how effective soft-start procedures are for moving marine mammals, particularly baleen whales, out of acoustic injury ranges. Studies on soft-starts of deep-penetration seismic surveys (i.e., airgun arrays) have shown mixed results for efficacy and seem to be highly contextual (Barkaszi et al. 2012; Dunlop et al. 2016; Barkaszi and Kelly 2019). Recent studies by Graham et al. (2023) showed combined use of acoustic deterrent devices and soft-start procedures resulted in a strong directional response by harbor porpoises away from the sound source. Therefore, in the effects analysis of all impact pile driving, soft-start procedures are assumed to be reasonably effective in reducing high-level exposure but are not considered fully effective, particularly at farther distances.

The project will also establish a 17,224-foot (5,250 meter) pre-piling clearance zone for the WTG and OSS foundations and a 328-foot (100 meter) pre-piling clearance zone for the Met Tower foundations. Clearance zones would facilitate a delay of pile driving if marine mammals were observed approaching or within areas that could receive sound levels above behavioral disturbance or auditory injury thresholds after piling begins. The pre-piling clearance zones were designed to cover the maximum ranges to the behavioral disturbance thresholds and will be monitored by PSOs using a combination of visual and acoustic methods such that the entire zone has either visual and/or acoustic coverage for applicable species.

A 9,514-foot (2,900-meter) shutdown zone would be established for LFCs for the WTG foundations; 4,593-foot (1,400-meter) shutdown zone for LFCs for the OSS foundations; and a 164-foot (50-meter) shutdown zone for LFC for the Met Tower foundations (Table 3-20). The shutdown ranges are designed to minimize, and effectively eliminate, the risk of PTS exposures to ESA-listed marine mammals and cover the maximum ranges to the PTS thresholds (Tables 6-17 through 6-19). The size of the shutdown zones are within ranges that vessel based visual PSOs can effectively monitor.

A team of up to eight visual and acoustic PSOs will be on board the construction vessel and secondary support vessel during the foundation installation period, with at least two PSOs on each monitoring platform on active monitoring duty during all clearance periods and impact pile driving. At least two PAM operators will be located on the construction site on the construction vessel with a real-time monitoring station. The final number of PSOs, PAM operators, and their locations will be determined in the final Pile Driving Monitoring Plan (as described in Table 3-20) such that both visual and acoustic PSOs would be able to sufficiently cover these zones, and in the case low visibility, alternative monitoring measures would be implemented (as described in Table 3-20) such that coverage is maintained during all pile driving activities. Finally, pile driving would be halted if the shutdown zones cannot be effectively monitored visually.

The potential for serious injury is largely minimized through using a noise mitigation system during all impact pile driving operations and through implementation of clearance and shutdown zones as described. With these standard mitigation measures in place, no PTS exposures were modeled or requested for sperm whales; PTS exposures for sperm whales are highly unlikely to occur due to smaller PTS ranges for MFCs and low abundance of sperm whales. Therefore, PTS effects from impact pile driving on sperm whales are considered **discountable;** however, exposures leading to PTS are still possible for NARW, fin and sei whales because the modeled estimates were greater than zero exposures; thus, with rounding effects analysis must consider the potential for PTS to occur.

Additional mitigation measures will be implemented for the NARW to ensure that PTS exposures are extremely unlikely to occur and no Level A take is requested in the LOA application (TRC 2023). These measures include:

- Foundation installation would only occur between May and November of any construction phase in order to avoid the winter and spring seasons when NARW presence is greatest (Section 5.1.1.2.2);
- Shutdown of pile driving would occur for NARWs visually detected at any distance or acoustically detected within 5 km of the piling location.

These additional measures optimize the opportunity for visual and acoustic PSOs to detect NARWs around the foundation installation activities and increase preventative mitigation measures. These measures would help reduce the amount of time an animal is receiving acoustic energy above the PTS onset thresholds, which lowers the risk of PTS. With full implementation of these measures and the low number of PTS exposures estimated by the modeling, the potential for PTS exposure to NARWs is considered highly unlikely to occur and **discountable**. However, these mitigation measures are specific to NARW, so fin and sei whales would not benefit from the expanded shutdown zone for NARW; additionally, fin and sei whales are likely to be present in the Project area outside the designated seasonal restriction for NARW (Section 5.1.1.1 and 5.1.1.3) so they would similarly not benefit from the decrease in duration of potential exposures to pile driving noise that NARW receive. Therefore, these mitigation measures would not fully eliminate the risk of PTS for fin and sei whales and this effect cannot be discounted for these species. Based on the results of the modeling and expected group sizes for fin and sei whales in the Project area, 6 PTS exposures for fin whales and 3 PTS exposures for sei whales may still occur over the 3-year construction period (Table 6-23) during impact pile driving of the Project foundations.

Considering all foundation types as well as expected group sizes for marine mammal species in the Project area, the LOA application (TRC 2023) indicates up to 6 NARW, 24 fin whales, and 3 sei whales could be exposed to noise that meets or exceeds the behavioral thresholds during installation of the WTG, OSS, and Met Tower foundations over all three years (Table 6-23). No behavioral exposures were modeled or requested for sperm whales. The most commonly reported behavioral effect of impact pile driving activities on marine mammals has been short-term avoidance or displacement from the pile driving site. This has been well documented for harbor porpoises (a species of high concern in European waters) and seal species, but responses to impact pile driving noise in ESA-listed species are absent from the literature. Because the ESA-listed species considered in this BA include LFC species (fin whales, NARWs, and sei whales) and one MFC species (sperm whales), responses documented for harbor porpoises (a high-frequency cetacean species) and seals are not applicable for this analysis. However, available information for assessing responses to impact pile driving noise for non-ESA listed marine mammal species is provided in Section 3.5.6 of the EIS (BOEM 2023b).

As no studies have directly examined the behavioral responses of baleen whales to pile driving, studies using other impulsive sound sources (e.g., seismic airguns) serve as the best available proxies. With seismic airguns, the distance at which responses occur depends on many factors, including the volume of the airgun (and consequently source level) as well as the hearing sensitivity, behavioral state, and even life stage of the animal (Southall et al. 2021). Malme et al. (1986) observed gray whales (*Eschrichtius robustus*) exposed to received levels of approximately 173 dB re 1 μPa, had a 50 percent 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 gray whale responses were highly variable. Other studies have documented baleen whales initiating avoidance behaviors to full-scale seismic surveys at distances as close as 1.8 miles (3 kilometers) away (Richardson et al. 1986; McCauley et al. 1998; Johnson 2002) and as far as 12 miles (20 kilometers) away (Richardson et al. 1999). Bowhead whales (*Balaena mysticetus*) have exhibited other behavioral changes, including reduced surface intervals and dive durations, at received SPLs between 125 and 133 dB re 1 μPa (Malme et al. 1988). A more recent study by Dunlop et al. (2017) compared the migratory behavior of humpback whales exposed to a 3,130-cubic-inch-airgun array with those that were not exposed. There was no gross change in behavior observed (including respiration rates), although whales exposed to the seismic survey made a slower progression southward along their migratory route compared to the control group. This was largely seen in female-calf groups, suggesting there may be differences in vulnerability to underwater sound based on life stage (Dunlop et al. 2017). The researchers produced a dose-response model that suggested behavioral change was most likely to occur within 2.5 miles (4 kilometers) of the seismic survey vessel at SELs greater than 135 dB re 1 μPa^2 s (Dunlop et al. 2017).

Though no studies specific to effects of impact pile driving noise on sperm whales are available, studies assessing other MFC species show varying levels of sensitivity to mid-frequency impulsive noise sources (i.e., impact 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. 1994), decreased vocal activity, and disruption in foraging patterns (Goldbogen et al. 2013). Würsig et al. (2000) studied the response of Indo-Pacific humpbacked dolphins (*Sousa chinensis*) to impact pile driving in the seafloor 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 ceased, dolphin abundance and behavioral activities returned to pre-pile driving levels. The effect of impact and vibratory pile driving on the vocal presence of bottlenose dolphins and harbor porpoises was compared within and outside the construction area based on a study conducted during wind farm construction in Cromarty Firth, Scotland (Graham et al. 2017). The researchers found a similar level of response of both species to impact and vibratory piling, likely due to the similarly low received SELs from the two approaches, which were measured at 133 dB re 1 μPa^2 s for impact 2,664 feet (812 meters) from the pile. There were no statistically significant responses attributable to either type of pile driving activity in the presence/absence of a species or the duration over which individuals were encountered, except for bottlenose dolphins on days with impact pile driving. The duration of bottlenose dolphin acoustic encounters decreased by an average of approximately 4 minutes at sites within the Cromarty Firth (closest to pile driving activity) in comparison to areas outside the Cromarty Firth (Graham et al. 2017). The authors hypothesized the lack of a strong response was because the received levels were very low in this particularly shallow environment, despite similar size piles and hammer energy to other studies.

Acoustic masking can occur if the frequencies of the activity overlap with the communication frequencies used by marine mammals. Modeling results indicate dominant frequencies of impact pile driving activities for the Proposed Action were concentrated below 1 kilohertz (TRC 2023), which overlaps most closely with the hearing sensitivity of LFC species (Section 6.3.2). Additionally, low-frequency sound can propagate greater distances than higher frequencies, meaning masking may occur over larger distances than masking related to higher-frequency noise. There is evidence that some marine mammals can compensate for the effects of acoustic masking by changing their vocalization rates (Di Iorio and Clark 2010; Blackwell et al. 2013; Cerchio et al. 2014), increasing call amplitude (Scheifele et al. 2004; Holt et al. 2009), or shifting the dominant frequencies of their calls (Lesage et al. 1999; Parks et al. 2007). When effects of masking cannot be compensated for, increasing noise could affect marine mammals' ability to locate and communicate with other individuals. NARWs appear to be particularly sensitive to the effects of masking as a result of underwater noise and have faced significant reductions in their communication space due to anthropogenic noise. For example, vocalizing NARWs in the Stellwagen Bank National Marine Sanctuary were exposed to noise levels greater than 120 decibels for 20 percent of their peak feeding month and were estimated to have lost 63 to 67 percent of their communication space (Hatch et al. 2012). Reduced communication space caused by anthropogenic noise could contribute to population fragmentation and dispersal of the critically endangered NARW (Hatch et al. 2012; Brakes and Dall 2016). However, given that pile driving would only occur intermittently between May and

November for all 3 construction phases under the Proposed Action, it is unlikely that expansive auditory masking would occur.

Overall, it is reasonable to assume there would be greater impacts to LFC species than to the sperm whale (an MFC species), even though direct research of pile driving noise effects on baleen whales is limited. As discussed previously, there is evidence suggesting LFC species may avoid or change their behavior when exposed to impulsive sounds. Also, their primary frequency range for listening to their environment and communicating with others overlaps with the dominant frequency of impact pile driving noise. Finally, because LFCs have specific feeding and breeding grounds (unlike MFC species who perform these life functions over broader spatial scales), disturbance from anthropogenic noise occurring in one of these key geographic areas may come at an increased cost to these species.

Sperm whales may occur year-round but are most likely to occur in deeper slope and canyon environments (Sections 5.1.1.4). It is extremely unlikely that any behavioral reactions to noise exposures above the behavioral thresholds would result in effects to sperm whales and no Level B takes have been requested for these species (Table 6-23); therefore, effects would be **discountable**.

Fin whales and sei whales are expected to utilize the Project area year-round and demonstrate some feeding site fidelity that may include waters offshore Maryland (Section 5.1.1.1 and 5.1.1.3); and NARWs predominantly occur between December and April but may be present year-round in small numbers. Based on the mitigation and monitoring measures included in the Proposed Action (Table 3-20) and temporary, intermittent nature of pile driving noise under the Proposed Action, the potential for exposure of 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 effects could be measurable and may affect small numbers of individuals engaging in critical functions such as feeding.

Given the adjusted take numbers in the LOA application and take analysis conducted for individual activities, the effects of underwater noise leading to PTS or behavioral disturbance **may affect, likely to adversely affect** fin, sei and NARW; but **may affect, not likely adversely affect** sperm whales.

6.3.13.1.2 Inshore Impact Pile Driving

Impact pile driving activities may occur inshore during construction to support the development and retrofitting of the proposed O&M Facility (Section 3.1.2). Construction at the O&M Facility will include pile driving associated with the proposed sheet steel bulkhead and pile supported fixed pier. The bulkhead repairs will be performed by placing sheet piling a maximum of 18 inches (45.7 centimeters) beyond the existing wharf face and filling the void between the two before being capped. The proposed fixed pier will be 625 feet (190.5 meters) long and range from 30 feet (9.1 meters) to 32 feet (9.7 meters) wide. The length of the proposed pier will not extend any further into Ocean City Harbor than the current dock and pier structures. It is anticipated up to 170, 12-to-18-inch (30.5 to 45.7 centimeters) diameter steel pipe piles will be installed using impact pile driving over an approximate 6-month period; up to 240, 12-to-18-inch (30.5 to 45.7 centimeters) diameter timber fender system piles will be installed using impact pile driving over an approximate 6-month period; and up to 120 sheet piles will be installed using impact pile driving for the bulkhead over an approximate 3-month period (Section 3.1.2). While no specific timeline for acquisition and retrofitting of the O&M facility is provided in the COP (US Wind 2023), it is anticipated that any inshore impact pile driving required to develop the O&M facility will be completed before the targeted commercial operations date for phase 1 in December 2025.

Noise produced during these activities would be similar in the characteristics as that described in Section 6.3.13.1.1 for offshore impact pile driving but would produce lower sound levels due to the smaller pile sizes used for the O&M Facility. As described in Section 6.3.5.3, no acoustic modeling is available for this activity from the applicant, so the NMFS Multi-Species Pile Driving Calculator Tool (NMFS 2023k) was used to estimate ranges to the thresholds for marine mammals. Summary pages of both the inputs and results of the calculator tool are provided in Appendix D.

Results from the calculator tool indicate PTS ranges for LFC may be met or exceeded up to 7 feet (2 meters) from the source for the 12- to 18-inch steel piles; 3 feet (1 meter) from the source for the 12- to 18-inch timber piles; and 229 feet (70 meters) from the source for the sheet piles based on the SEL_{24h} metric (Appendix D). PTS ranges for MFC may be met or exceeded within <1 foot (<1 meter) from the source for both the 12- to 18-inch steel piles and timber piles; and 8 feet (3 meters) from the source for the sheet piles based on the SEL_{24h} metric (Appendix D). Noise levels may exceed the SPL 160 dB re 1 µPa behavioral disturbance threshold for all ESA-listed marine mammals within 18 feet (5 meters) from the 12- to 18-inch steel piles; 10 feet (3 meters) from the 12- to 18-inch timber piles; and 152 feet (46 meters) from the sheet piles (Appendix D).

The mitigation measures described in Section 6.3.13.1.1 for offshore impact pile driving would similarly apply to inshore impact pile driving and would be similarly effective at mitigating the risk of noise effects on ESA-listed marine mammals by reducing the overall noise levels produced and establishing PSO monitoring and reporting protocols to minimize the number of individuals present within ranges to the source in which effects could occur. The inshore location of this activity would also reduce the risk of ESA-listed marine mammals being exposed to above-threshold noise. The ESA-listed species analyzed in this BA are all considered large whale species, which, while they may travel closer to shore to forage, would predominantly remain offshore and not be expected to occur at any inshore locations near where the proposed O&M Facility would be developed (Figure 3-11). Additionally, pile driving activities during development of the O&M Facility would only occur over an approximate 6-month period for the steel piles, a 6-month period for the timber piles, and a 4-month period for the sheet piles. Therefore, any behavioral effects that occur would be so minor they cannot be meaningfully evaluated and would be considered **insignificant**. Exposure to noise above both the PTS and behavioral thresholds during inshore impact pile driving for the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals.

6.3.13.2 Sea Turtles

6.3.13.2.1 Offshore Impact Pile Driving

Impact pile driving would occur during construction to install WTG, OSS, and Met Tower foundations (Section 3.1.1.5). Impact pile driving generates impulsive underwater noise that may result in physiological or behavioral effects in sea turtles. Potential behavioral effects include altered dive patterns, short-term disturbance or displacement, and startle responses (Samuel et al. 2005; National Science Foundation and USGS 2011). Potential physiological effects include temporary stress response and, close to the pile driving activity, TTS, or PTS. Behavioral effects and most physiological effects are expected to be of short duration and localized to the ensonified area. Any disruptions to foraging or other normal behaviors would be temporary, and increased energy expenditures associated with displacement are expected to be small. PTS could permanently limit an individual's ability to locate prey, detect predators, or find mates and could, therefore, have long-term effects on individual fitness. The severity of the effect depends on the received sound level (i.e., the sound level to which the organism is exposed), which is a function of the sound level generated by the noise source, the distance between the source and the organism, and the duration of sound exposure.

The assumptions for the underwater acoustic propagation and exposure modeling used to assess the risk of effects during impact pile driving of the WTG, OSS, and Met Tower foundations is described in Section 6.3.5. Results of the modeling for sea turtles are provided in Tables 6-24 to 6-26 for each foundation type, respectively. As discussed in Section 3.1.1.5.1, US Wind proposes to use noise attenuation systems to achieve a minimum of 10 decibels noise mitigation.

Table 6-24. Summary of acoustic ranges (95th percentile) in meters to PTS (SEL_{24h} and L_{pk}), TTS (SEL_{24h} and L_{pk}), and behavioral regulatory threshold levels during impact pile driving of the 36.1-foot (11-meter) WTG monopile foundations[a] for ESA-listed sea turtles with 10 decibel noise attenuation

Range to PTS Threshold (L_{pk}) in meters	Range to PTS Threshold (SEL_{24h}) in meters	Range to TTS Threshold (L_{pk}) in meters	Range to TTS Threshold (SEL_{24h}) in meters	Range to Behavioral Threshold (SPL) in meters
<50	250	<50	2,750	850

Source: Appendix A, TRC 2023
[a] The modeling assumed installation of a single monopile foundation requiring up to 2 hours of pile driving per day.
L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL= root-mean-square sound pressure level in units of dB referenced to 1 micropascal; TTS = temporary threshold shift

Table 6-25. Summary of acoustic ranges (95th percentile) in meters to PTS (SEL_{24h} and L_{pk}), TTS (SEL_{24h} and L_{pk}), and behavioral regulatory threshold levels during impact pile driving of the 9.8-foot (3-meter) OSS skirt pile foundations[a] for ESA-listed sea turtles with 10 decibel noise attenuation

Range to PTS Threshold (L_{pk}) in meters	Range to PTS Threshold (SEL_{24h}) in meters	Range to TTS Threshold (L_{pk}) in meters	Range to TTS Threshold (SEL_{24h}) in meters	Range to Behavioral Threshold (SPL) in meters
<50	50	<50	1,000	0

Source: Appendix A, TRC 2023
[a] The modeling assumed installation of four skirt piles requiring up to 8 hours of pile driving per day.
L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL= root-mean-square sound pressure level in units of dB referenced to 1 micropascal; TTS = temporary threshold shift

Table 6-26. Summary of acoustic ranges (95th percentile) in meters to PTS (SEL_{24h} and L_{pk}), TTS (SEL_{24h} and L_{pk}), and behavioral regulatory threshold levels during impact pile driving of the 5.9-foot (1.8-m) Met Tower pin pile foundations[a] for ESA-listed sea turtles with 10 decibel noise attenuation

Range to PTS Threshold (L_{pk}) in meters	Range to PTS Threshold (SEL_{24h}) in meters	Range to TTS Threshold (L_{pk}) in meters	Range to TTS Threshold (SEL_{24h}) in meters	Range to Behavioral Threshold (SPL) in meters
<50	0	<50	50	0

Source: Appendix A, TRC 2023
[a] The modeling assumed installation of three pin piles requiring up to 6 hours of pile driving per day.
L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL= root-mean-square sound pressure level in units of dB referenced to 1 micropascal; TTS = temporary threshold shift\

The modeled sound exposures were normalized using the density estimates in Table 6-13, which provide the total number of sea turtles potentially exposed to PTS or behavioral-level noise effects from impact pile driving during installation of the WTG monopile foundations, OSS skirt pile foundations, and Met Tower pin pile foundations (Tables 6-27 through 6-29).

Table 6-27. Maximum annual PTS, TTS, and behavioral exposures[a] of ESA-listed sea turtles during impact pile driving of 36.1-ft (11-m) monopiles during the 3 years of construction planned for the Proposed Action with 10 decibel noise attenuation

Species	Construction Year	PTS	TTS	Behavior
Green sea turtle	Year 1	0	25.13	3.59
	Year 2	0	72.08	10.30
	Year 3	0	53.64	7.66
	Total	**0**	**150.85**	**21.55**
Kemp's ridley sea turtle	Year 1	0	1.31	0.19
	Year 2	0	3.45	0.49
	Year 3	0	2.40	0.34
	Total	**0**	**7.16**	**1.02**
Leatherback sea turtle	Year 1	0	13.49	1.93
	Year 2	0	38.69	5.53
	Year 3	0	28.79	4.11
	Total	**0**	**149.28**	**11.57**
Loggerhead sea turtle[a]	Year 1	0	344.65	49.24
	Year 2	0	1,406.33	200.90
	Year 3	0	866.54	123.79
	Total	**0**	**2,617.52**	**373.93**

Source: Appendix A, TRC 2023
[a] Exposures for loggerhead sea turtles use density data from Barco et al. (2018) rather than USDON (2007), which was used for all other species.

Table 6-28. Maximum annual PTS, TTS, and behavioral exposures[a] of ESA-listed sea turtles during impact pile driving of 9.8-foot (3-meter) OSS skirt piles during the 3 years of construction planned for the Proposed Action with 10 decibel noise attenuation

Species	Construction Year	PTS	TTS	Behavior
Green sea turtle	Year 1	0	0.20	0
	Year 2	0	0.40	0
	Year 3	0	0.20	0
	Total	**0**	**0.80**	**0**
Kemp's ridley sea turtle	Year 1	0	0.01	0
	Year 2	0	0.02	0
	Year 3	0	0.01	0
	Total	**0**	**0.03**	**0**
Leatherback sea turtle	Year 1	0	0.11	0
	Year 2	0	0.22	0
	Year 3	0	0.11	0
	Total	**0**	**0.44**	**0**
Loggerhead sea turtle[a]	Year 1	0	2.42	0
	Year 2	0	4.85	0
	Year 3	0	2.42	0
	Total	**0**	**9.69**	**0**

Source: Appendix A, TRC 2023
[a] Exposures for loggerhead sea turtles use density data from Barco et al. (2018) rather than USDON (2007), which was used for all other species.

Table 6-29. Maximum annual PTS, TTS, and behavioral exposures of ESA-listed sea turtles during impact pile driving of 5.9-foot (1.8-meter) Met Tower pin piles during the second year of construction for the second construction campaign planned for the Proposed Action with 10 decibel noise attenuation

Species	PTS	TTS	Behavior
Green sea turtle	0	0	0
Kemp's ridley sea turtle	0	0	0
Leatherback sea turtle	0	0	0
Loggerhead sea turtle[a]	0	0	0

Source: Appendix A, TRC 2023
[a] Exposures for loggerhead sea turtles use density data from Barco et al. (2018) rather than USDON (2007), which was used for all other species.

Modeled sea turtle PTS threshold isopleths range from 820 feet (250 meters) during installation of the WTG foundations to 0 feet (0 meters) during installation of the Met Tower foundations (Tables 6-24 through 6-26). No PTS exposures were calculated for any sea turtle species for any of the foundation types modeled (Tables 6-27 through 6-29). Additionally, BOEM and the USACE would ensure US Wind employs the following mitigation measures:

- A clearance zone which covers the full 820-foot (250-meter) extent of the behavioral disturbance range for the largest foundations will be monitored for the duration of all pile driving activities and for 30 minutes following the cessation of pile driving activities;
- A 1,640-foot (500-meter) shutdown zone will be implemented for the WTG foundations, OSS skirt pile foundations, and Met Tower pin pile foundations to comply with BOEM's minimum shutdown zone requirements for sea turtles.

Given the small threshold ranges, the lack of modeled exposures, and the proposed mitigation measures, PTS is extremely unlikely to occur for any ESA-listed sea turtles and effects of PTS on sea turtles during impact pile driving is therefore **discountable**.

Much of the knowledge of behavioral reactions of sea turtles to underwater sounds has been derived from a few studies, most of which have been conducted in a laboratory or caged setting. Potential behavioral effects may include altered submergence patterns, startle responses (e.g., diving, swimming away), short-term displacement of feeding or migrating activity, and a temporary stress response if present within the ensonified area (Samuel et al. 2005; National Science Foundation and USGS 2011). The accumulated stress and energetic costs of avoiding repeated exposures to pile driving noise over a season or life stage could have long-term effects on survival and fitness (USDON 2018), though the consequences of potential behavioral changes to sea turtle fitness are unknown.

The frequency range of best hearing sensitivity estimated for sea turtles is between approximately 100 and 700 hertz. Acoustic effects on sea turtles would most likely occur from activities producing noise within that bandwidth. Lenhardt (1994) demonstrated 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 their behavior when exposed to seismic activities with source levels ranging from 175 to 179 dB re 1 μPa m. Avoidance was also demonstrated by O'Hara and Wilcox (1990), who found sea turtles in a canal would avoid areas where seismic work was being conducted, although the received levels were not measured. McCauley et al. (2000b) estimated an airgun array operating in 328 to 394 feet (100 to 120 meters) water depth could elicit behavioral changes in sea turtles out to 1.2 miles (2 kilometers), whereas avoidance responses would occur out to approximately 0.6 miles (1 kilometer). A monitoring assessment conducted by DeRuiter and Doukara (2012) estimated 51 percent of loggerhead sea turtles observed dove at or before the closest point of approach to the airgun array. Conversely, Weir (2007) reported no obvious avoidance by sea turtles at the sea surface to seismic sounds, as recorded by ship-based observers, although the observers noted fewer sea turtles were observed at the surface when the airgun array was active versus when it was inactive.

As previously discussed for marine mammals, auditory masking occurs when acoustic cues used by sea turtles (e.g., physical sounds of prey activity, acoustic signature of key habitats such as hard-bottom structures, environmental cues) overlap in time and frequency with another sound source, such as seismic sound. Popper et al. (2014) concluded that continuous noise of any level detectable by sea turtles can mask signal detection. The consequences of potential masking and associated behavioral changes to sea turtle fitness are unknown. Masking is more likely to occur from sound sources with dominant frequencies in the low-frequency spectrum such as vessel activities, vibratory pile driving, and WTG operations. These activities also have high duty cycles (i.e., are continuous) and, therefore, have a higher chance of affecting sea turtles' ability to detect biologically important acoustic cues compared to intermittent sources.

Modeled sea turtle behavior threshold isopleths range from 492 feet (150 meters) for the WTG foundations to 0 feet (0 meters) for the Met Tower foundations (Tables 6-24 through 6-26); modeled TTS threshold isopleths with 10 dB noise mitigation range from 9,022 feet (2,750 meters) for the WTG foundation to 164 feet (50 meters) for the Met Tower foundation (Tables 6-24 through 6-26). The behavioral threshold ranges use the SPL metric which is based on the acoustic energy produced by a single hammer strike on the pile, while the TTS ranges are based on the SEL_{24h} metric which requires accumulation of acoustic energy for the full duration of the pile installation. Therefore, while it appears animals would reach TTS thresholds prior to reaching behavioral thresholds, the time consideration in the TTS metric renders these ranges not fully comparable to the SPL ranges since the approach used assumes any given animal would be stationary for the full pile installation period which is not representative of how an animal would be expected to behave in the wild. A shorter modeled time exposure, a single strike exposure for TTS, or modeled TTS exposure ranges which account for animal movement and behavior may provide more comparable results; however, these are not available in the modeling report and would not be expected to change the effects determinations. As discussed previously, TTS is a form of auditory fatigue that, unlike PTS, is non-permanent and reversible. Onset of TTS does not equate to an individual being removed from a population or facing any long-term restrictions on critical behaviors.

The exposure modeling indicated up to 22 green, 1 Kemp's ridley, 12 leatherback, and 374 loggerhead sea turtles may be exposed to noise exceeding the behavioral thresholds levels over the 3 years of construction, and up to 152 green, 7 Kemp's ridley, 151 leatherback, and 2,628 loggerhead sea turtles may be exposed to noise exceeding the TTS thresholds over the 3 years of construction (Tables 6-27 through 6-29). Exposure probability is high given the foundation installation will occur between May and November, which falls into the migratory timelines and summer residency periods for some species (Section 5.1.2).

As described in Table 3-20, BOEM will require a clearance zone for sea turtles be established that covers the full extent of the behavioral disturbance threshold range for each pile type (i.e., 820 feet [250 meters] for the WTG monopile foundations; Table 6-24). Additionally, a 1,640-foot (500-meter) shutdown zone will be implemented for sea turtles during installation of the WTG monopile foundations; OSS skirt pile foundations; and Met Tower pin pile foundations (Table 3-20). Monitoring activities will be conducted by a team of six to eight PSOs onboard the construction vessel and secondary support vessels, the locations of which will be determined in the final Pile Driving Monitoring Plan. Additionally, if, at any point prior to or during impact pile driving activities, the PSO coverage included in the Proposed Action is determined to be insufficient to reliably detect ESA-listed sea turtles within the designated clearance and shutdown zones, additional PSOs, platforms, or both will be deployed, pending review of the Pile Driving Monitoring Plan with the relevant agencies.

While the mitigation and monitoring measures are expected to decrease the severity of behavioral disturbances that do occur, predominantly by limiting the duration of the exposure through pre-piling clearance and shutdown procedures, the possibility for behavioral disturbances of relatively large numbers of individuals cannot be discounted. Therefore, though the risk of PTS is considered discountable, as discussed previously, given the risk of effects of noise exposures above behavioral thresholds resulting from impact pile driving during foundation installation **may affect, likely to adversely affect** ESA-listed sea turtles.

6.3.13.2.2 Inshore Impact Pile Driving

Under the Proposed Action, impact pile driving activities will occur inshore during construction to support the development of the proposed O&M Facility (Section 3.1.2). As discussed previously in Section 6.3.13.2.1, development of the O&M facility will include installation using impact pile driving of up to 170, 12-to-18-inch (30.5 to 45.7 centimeters) diameter steel pipe piles installed over an approximate 6-month period; up to 240, 12-to-18-inch (30.5 to 45.7 centimeters) diameter timber fender system piles installed over an approximate 6-month period; and up to 120 sheet piles installed for the bulkhead over an approximate 3-month period (Section 3.1.2).

Noise produced during these activities would be similar in the characteristics as that described in Section 6.3.13.1.1 for offshore impact pile driving but would produce lower sound levels due to the smaller pile sizes used for the O&M Facility. As described in Section 6.3.5.3, no acoustic modeling is available for this activity from the applicant, so the NMFS Multi-Species Pile Driving Calculator Tool (NMFS 2023k) was used to estimate ranges to the thresholds for sea turtles. Summary pages of both the inputs and results of the calculator tool are provided in Appendix D.

Results from the calculator tool indicate PTS ranges for sea turtles may be met or exceeded within <1 foot (<1 meter) from the source for both the 12- to 18-inch steel piles and timber piles; and within 9 feet (3 meters) from the source for the sheet piles based on the SEL_{24h} metric (Appendix D). Noise levels may exceed the SPL 175 dB re 1 μPa behavioral disturbance threshold for sea turtles within 1.8 feet (0.5 meters) from the 12- to 18-inch steel piles; 1 feet (0.3 meters) from the 12- to 18-inch timber piles; and 15 feet (5 meters) from the sheet piles (Appendix D).

Estimates for the ranges to the TTS thresholds for sea turtles are not available from the Multi-Species Pile Driving Calculator too (Appendix D). As discussed in Section 6.3.13.2.1, though animals could reach TTS thresholds prior to reaching behavioral thresholds, the time consideration in the TTS SEL_{24h} metric renders these ranges not fully comparable to the SPL ranges since the approach used assumes any given animal would be stationary for the full pile installation period which is not representative of how an animal would be expected to behave in the wild. Additionally, TTS is a form of auditory fatigue that, unlike PTS, is non-permanent and reversible. Though sea turtles may experience onset of TTS during impact pile during for the O&M Facility, this does not equate to an individual being removed from a population or facing any long-term restrictions on critical behaviors.

The Project O&M Facility is set to be established in Worcester County, Maryland, Ocean City or the unincorporated West Ocean City area on the mainland (Figure 3-11). Positioned inshore, this location is not anticipated to overlap with established sea turtle nesting sites, as detailed in Section 5.1.2. While instances of sea turtle nesting and strandings have been noted near nearshore beaches, it's essential to emphasize that inshore pile driving activities will be limited to inshore waters. Therefore, sea turtles are not expected to occur within the inshore location of the proposed O&M facility where pile driving activities would occur. If a sea turtle happens to enter the inlet near the O&M facility during construction, precautionary measures will be implemented to minimize potential impacts, including the enforcement of shutdown and clearance zones during inshore pile driving. Moreover, both BOEM and the USACE will ensure that US Wind comprehensively monitors the entire area where noise levels exceed the 175 dB re 1 μPa behavioral disturbance threshold for sea turtles. This monitoring will extend throughout all pile driving activities and for 30 minutes following their conclusion, with detailed records maintained to document any observed instances of take. Additionally, a 164-foot (50-meter) shutdown zone will be implemented for sea turtles, fully covering the expected ranges for PTS and behavioral disturbance associated with these pile types (Appendix D). The mitigation measures would be similarly effective at mitigating the risk of noise effects on sea turtles by reducing the overall noise levels produced and establishing PSO monitoring and reporting protocols to minimize the number of individuals present within ranges to the source in which effects could occur. Given the small ranges to both the PTS and behavioral disturbance thresholds estimated by the calculator tool (Appendix D) and unlikely occurrence of sea turtles inshore around the proposed location of the O&M Facility as described in this section, the effects of PTS and behavioral disturbance in sea turtles **discountable**. The effects of noise exposure during inshore pile driving **may affect, but are not likely to adversely affect** ESA-listed sea turtles.

6.3.13.3 Marine Fish

6.3.13.3.1 Offshore Impact Pile Driving

Impact pile driving would occur during construction to install WTG and OSS foundations (Section 3.1.1.5). Impact pile driving generates impulsive underwater noise that may result in physiological or behavioral effects in marine fish. The severity of the effect depends on the received sound level (i.e., the sound level to which the organism is exposed), which is a function of the sound level generated by the noise source, the distance between the source and the organism, and the duration of sound exposure. Underwater sound propagation modeling for impact pile driving was conducted in support of the COP and is described in Section 6.3.5. Impact pile driving noise can cause behavioral changes, physiological effects (including TTS), and mortality in fishes. Behavioral effects vary among individuals and include startle responses, cessation of activity, and avoidance. Extended exposure to mid-level noise or brief exposure to extremely loud sound can cause PTS, which leads to long-term loss of hearing sensitivity. Less-intense noise may cause TTS, resulting in short-term, reversible loss of hearing acuity (Buehler et al. 2015). TTS thresholds for fish are available from Popper et al. (2014) and were modeled by MAI (2023). The modeling resulted in acoustic ranges for the fish groups relevant to the species considered in this BA with 10 decibels noise mitigation of 14,764 feet (4,500 meters) for the WTG monopile foundations; 5,742 feet (1,750 meters) for the OSS skirt pile foundations; and 164 feet (50 meters) for the Met Tower pin pile foundations (MAI 2023). However, TTS thresholds for fish are not considered in the regulatory thresholds defined by NMFS (2023j) and were therefore not carried forward in this BA. Developmental abnormalities in early life stages of fishes resulting from pile driving noise have been documented (Hawkins and Popper 2017; Weilgart 2018). Pile driving noise could also result in reduced reproductive success while pile driving is occurring, particularly in species that spawn in aggregate. Pile driving noise may injure or kill early life stages of finfish and invertebrates at short distances (Hawkins and Popper 2017; Weilgart 2018).

The assumptions for the underwater acoustic propagation modeling used to assess the risk of effects during impact pile driving of the WTG, OSS, and Met Tower foundations is described in Section 6.3.5. Results of the modeling for ESA-listed fish species considered in this BA are provided in Tables 6-30 to 6-32 for each pile type, respectively. As discussed in Section 3.1.1.5.1, US Wind proposes to use noise attenuation systems to achieve a minimum of 10 decibels noise mitigation.

Table 6-30. Summary of acoustic ranges (95th percentile) in meters to recoverable injury (SEL_{24h} and L_{pk}) and behavioral regulatory threshold levels during impact pile driving of the 36.1-foot (11-meter) WTG monopile foundations[a] for ESA-listed fish species with 10 decibel noise attenuation

Faunal Group	Recoverable Injury		Behavior
	L_{pk}	SEL_{24h}	SPL
Fish ≥2 grams	150	4,000	13,650

Source: MAI 2023

[a] The modeling assumed installation of a single monopile foundation requiring up to 2 hours of pile driving per day.

L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL= root-mean-square sound pressure level in units of dB referenced to 1 micropascal

Table 6-31. Summary of acoustic ranges (95th percentile) in meters to recoverable (SEL_{24h} and L_{pk}) and behavioral regulatory threshold levels during impact pile driving of the 9.8-foot (3-meter) OSS skirt pile foundations[a] for ESA-listed fish species with 10 decibel noise attenuation

Faunal group	Recoverable Injury		Behavior
	L_{pk}	SEL_{24h}	SPL
Fish ≥2 grams	<50	1,500	2,650

Source: MAI 2023

[a] The modeling assumed installation of four skirt piles requiring up to 8 hours of pile driving per day.

L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL= root-mean-square sound pressure level in units of dB referenced to 1 micropascal

Table 6-32. Summary of acoustic ranges (95th percentile) in meters to recoverable injury (SEL_{24h} and L_{pk}) and behavioral regulatory threshold levels during impact pile driving of the 5.9-foot (1.8-m) Met Tower pin pile foundations[a] for ESA-listed fish species with 10 decibel noise attenuation

Faunal Group	Recoverable Injury		Behavior
	L_{pk}	SEL_{24h}	SPL
Fish ≥2 grams	<50	50	750

Source: MAI 2023

[a] The modeling assumed installation of three pin piles requiring up to 6 hours of pile driving per day.

L_{pk} = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL= root-mean-square sound pressure level in units of dB referenced to 1 micropascal

Modeling results indicate impact pile driving would exceed the SEL_{24h} physiological injury thresholds for ESA-listed fish species up to 13,123 feet (4,000 meters) from the source for the WTG foundations; 4,921 feet (1,500 meters) from the source for the OSS foundations; and 164 feet (50 meters) from the source for the Met Tower foundations for fish ≥2 grams (Section 6.3.4), which applies to both Atlantic sturgeon and giant manta rays.

Fieldwork by Amaral et al. (2018) measured particle acceleration during impact pile driving of jacket foundations with 4.3-foot (1.3-meter) diameter pin piles. At 1,640 feet (500 meters) from the pile, in-water particle acceleration ranged from 30 to 65 dB re 1 $\mu m/s^2$ in the 10 to 1,000 hertz range, but closer to the seafloor it was significantly higher, at 50 to 80 dB re 1 $\mu m/s^2$. When comparing these received levels to the published hearing capabilities of several fish species, it was surmised that in-water particle acceleration would be barely audible at this distance, while levels near the seafloor would be detectable (Amaral et al. 2018). These field measurements of particle motion are critical for putting other experimental research into context; most of the studies described below focused on acoustic pressure, which is relevant for only a subset of fishes. It also underscores that species that lack hearing specializations are unlikely to experience significant effects from impact pile driving beyond a few hundred meters from the source for similarly sized piles and water depths.

Sigray et al. (2022) measured particle motion during pile driving of a wind farm in the German bight in 2015 which were using 6-megawatt WTG with blade diameters of 505 feet (154 meters) in approximately 98 feet (30 meters) water depth. Measurements were taken during both mitigated and partially unmitigated pile driving events using three mitigation systems; an air Isolated Steel Barrier used in combination with an Internal Bubble Screen and a stand-alone bubble curtain. The Internal Bubble Screen and bubble curtain were deployed outside the air Isolated Steel Barrier to encircle the piling platform in an approximate 328-foot (100-meter) radius circle (Sigray et al. 2022). The air Isolated Steel Barrier consisted of two metallic cylinder casings concentrically wrapped around the pile from the seafloor to the air with an air-filled outer space and a bubble filled inner space which decouples the acoustic radiation from the water (Sigray et al. 2022). The partially unmitigated pile was used as an experimental installation process in which the mitigation was turned on and off or different combinations of the three systems were tested. The particle motion sensors were placed at 1,903 feet (580 meters) from the mitigated pile and 2,887 feet (880 meters) from the unmitigated pile which required a total of 3,323 strikes to install the first pile and 6,308 strikes to install the second pile. The first (mitigated) pile was installed using soft-start techniques in which the hammer energy started at 322 kJ and was then raised to 1,600 kJ, which is lower than the hammer energies under the Proposed Action which would range from 1,100 to 3,300 for the WTG monopile foundations (Table 3-7). Analysis of the data showed an average zero-to-peak acceleration level of 105 dB re 1 micrometer (μm) per second squared (s^2) was reached during the mitigated piling event when the hammer energy was at the maximum level (1,600 kJ). By comparison, the average zero-to-peak acceleration levels of the unmitigated pile was approximately 20 dB re 1 $\mu m/s^2$ higher level for an 800-kJ hammer energy (Sigray et al. 2022). The total acceleration exposure level was also calculated for the full 1-hour installation period of the fully mitigated pile which was estimated to be 123 dB re 1 re (1 $\mu m/s^2)s^2$ (Sigray et al. 2022). The highest acceleration levels were observed between 100 and 200 Hz with decreasing acceleration levels above and below these frequencies (Sigray et al. 2022). The authors also estimated the Lpk sound pressure levels corresponding with these particle acceleration level to be 170 to 175 dB re 1 μPa for unmitigated pile driving (Sigray et al. 2022).

Data are limited regarding the hearing capabilities of elasmobranchs (i.e., sharks, skates, and rays, including the giant manta ray), but available information indicate they are more sensitive to lower frequencies (less than 1,000 hertz), and their primary mode of sound detection is through particle motion rather than sound pressure as they do not have swim bladders (Casper et al. 2012; Popper and Hawkins 2018; Mickle et al. 2020; Mickle and Higgs 2022). Though particle motion has been measured during pile driving events as described previously in this section, there currently are no broadly accepted guidelines or thresholds for particle motion exposure (Popper et al. 2014; Popper and Hawkins 2018). Popper et al. (2014) and Popper and Hawkins (2018) suggested particle motion induced by various impulsive sources could affect fish tissues, though the levels at which received particle motion may incur injury has not been identified. However, particle motion levels sufficient to affect fish tissues is expected to be dominant only within short ranges around the source (Amaral et al. 2018; Mickle and Higgs 2022; Harding and Cousins 2022), beyond which sound pressure physiological injury effects would dominate.

Soft-start procedures included in the Proposed Action would facilitate a gradual increase of equipment energy and, in theory, would allow marine life to leave the area prior to the start of operations at full hammer energy, reducing the risk of physiological injury. However, the effectiveness of soft-start procedures for moving fish away from a sound source is largely assumed with minimal empirical data. Acoustic deterrents have been used to manage fish populations (e.g., keep fish from water intake structures; guide fish toward fish passes), but most of these activities are highly specific to the genera or family of fish species of interest (Putland and Mensigner 2019). In underwater blasting studies, the use of "scare charges" to move fish from zones of mortality were only nominally effective and often temporary (Keevin and Hempen 1997). Therefore, soft-start is not anticipated to be effective universally for Atlantic sturgeon and giant manta potentially present in the ensonified area.

Results of the modeling indicate that giant manta rays may experience the onset of physiological injury, based on the SEL_{24h} metric, out to 13,123 feet (4,000 meters) from the WTG monopile foundations; out to 4,921 feet (1,500 meters) from the OSS skirt pile foundations; and out to 164 feet (50 meters) from the Met Tower pin pile foundations (Tables 6-30 through 6-32). The SEL_{24h} metric assumes giant manta ray would be present within these ranges for the full 2-hour installation period for the WTG monopiles; the full 8-hour installation period for four OSS skirt piles; and the full 6-hour installation period for three Met Tower pin piles (MAI 2023). Furthermore, pile driving noise associated with the Proposed Action would only be present in the Lease Area for up to 22 days during year 1, 58 days during year 2, and 39 days during year 3 (Table 6-11). Given their pelagic nature, giant manta rays could transit an ensonified area during each construction phase (Table 3-2). Feeding bouts may occur in areas of plankton concentrations; however, these events would not predictably occur at the piling location as their preference is deeper waters and thermal fronts associated with the shelf break (Farmer et al. 2022). Individuals may forage in shelf waters, including in the vicinity of the Lease Area, if the right oceanographic conditions that concentrate their preferred prey occur, but these occurrences would be considered opportunistic and relatively uncommon. Additionally, as discussed previously the modeling results are based on sound pressure, and giant manta rays, who don't have a swim bladder, are primarily sensitive to particle motion. Given that particle motion levels sufficient to affect fish tissues is expected to be dominant only within short ranges around the source (Amaral et al. 2018; Mickle and Higgs 2022; Harding and Cousins 2022), the range over which giant manta rays may experience physiological injury are expected to be even smaller. Though there is a risk of physiological injury individual, Given the uncommon occurrence of giant manta ray in the Lease Area, the relatively short duration of piling events over the 3 construction years, and the limited range over which particle motion effects are anticipated, physiological injury in giant manta ray resulting from impact pile driving is extremely unlikely to occur and is therefore **discountable**.

Atlantic sturgeon are able to detect sound pressure as well as particle motion but have a relatively primitive swim bladder that is not directly connected to the inner ear. In addition, they are able to voluntarily release gas from their swim bladder (Logan-Chesney et al. 2018) to accommodate rapid pressure changes in their environment. The risk of non-auditory injury due to exposure to impulsive signals from impact pile driving is therefore reduced for Atlantic sturgeon relative to fish species that cannot release swim bladder gas. However, because range to the physiological injury threshold is relatively large (up to 13,123 feet [4,000 meters]), there is still risk of individuals being present in the physiological injury threshold range, particularly during installation of the WTG monopiles. However, pile driving will only occur between May and October, and available studies indicate only low numbers of Atlantic sturgeon are likely to occur in the Lease Area in the fall and spring, which only partially overlaps with the beginning and end of the proposed pile driving monthly schedule (Table 6-11). Given the low anticipated occurrence of Atlantic sturgeon in the Lease Area during the months when pile driving will occur, physiological injury in Atlantic sturgeon resulting from impact pile driving is extremely unlikely to occur and is therefore **discountable**.

There are no available studies assessing the behavioral responses of giant manta rays to impulsive sound sources. Available studies indicate other elasmobranch species such as stingrays exhibited behavioral responses in the form of increased swimming activity to tonal sounds at low frequencies (less than 1,000 hertz) and at SPLs of 140 to160 dB re 1 µPa (Mickle et al. 2020). As discussed previously, the primary method of hearing for elasmobranchs such as the giant manta ray is through particle motion (Mickle and Higgs 2022). Elasmobranch hearing thresholds in terms of particle motion are estimated to be about 40 dB higher than for teleost fish with swim bladders (e.g., Atlantic sturgeon) (Casper and Mann 2006). Available studies indicate behavioral responses in cod (a fish species who have a swim bladder) were observed when exposed to zero-to-peak acceleration levels ranging from 57 to 76 dB re 1 $\mu m/s^2$ (Mueller-Blenkle et al. 2010; Davidsen et al. 2019), and behavioral response have been observed in sole (a species that does not have a swim bladder) when exposed to zero-to-peak acceleration levels in the range of 60 to 70 dB re 1 $\mu m/s^2$ (Mueller-Blenkle et al. 2010). Measured particle motion from Amaral et al. (2018) and Sigray et al. (2022) indicate that giant manta ray may receive higher acceleration levels during installation of the Proposed Action, particularly given the larger size of the proposed monopile foundations (up to 36 feet [11 meters]); however, Sigray et al. (2022) noted that implementation of noise mitigation systems resulted in an estimated a 26 dB re 1 $\mu m/s^2$ reduction in particle acceleration levels, and when compared to background particle acceleration levels in the German bight, the mitigated pile driving levels were only 10 dB re 1 $\mu m/s^2$ higher at 1,903 feet (580 meters) from the pile. Overall, given the available measurements of particle motion during pile driving and the modeled behavioral threshold ranges extending up to 8.5 miles (13.65 kilometers) for the WTG foundations; 1.65 miles (2.65 kilometers) for the OSS foundations; and 0.47 miles (0.75 kilometers) for the Met Tower foundations (Tables 6-30 through 6-32); it is possible giant manta rays will be encountered in the ensonified areas. However, as discussed previously, giant manta rays are pelagic, and their presence in the Lease Area is irregular and considered opportunistic if the right oceanographic conditions occur for foraging opportunities (Farmer et al. 2022). Additionally, there is no critical habitat designated for the giant manta ray within the Project area indicating this is not an important foraging or reproductive area compared to their larger habitat range. While individuals may be exposed to noise above the behavioral disturbance threshold, the effects of any behavioral disturbances, if they were to occur, would be undetectable, not measurable, or so minor they cannot be meaningfully evaluated, and therefore **insignificant** for the giant manta ray.

A suite of empirical studies has examined behavioral effects in fishes, though most work has focused on commercially important species like the European seabass, which lacks hearing specializations and has a closed swim bladder (similar to Atlantic sturgeon). Adult seabass generally dive deeper and increase swimming speed and group cohesion when exposed to intermittent and impulsive sounds like pile driving (Neo et al. 2014, 2018), but juveniles become less cohesive (Herbert-Read et al. 2017) and generally seem more sensitive to pile driving noise than adults (Kastelein et al. 2017). There is also some evidence that respiration rates may be affected by pile driving noise (Spiga et al. 2017). Importantly, a number of studies have shown that European seabass are likely to habituate to pile driving sounds over repeated exposure (Bruintjes 2016; Neo et al. 2016; Radford et al. 2016). Together, this research suggests that European seabass, and probably other species with closed swim bladders, are likely to exhibit short-term startle or physiological responses but would recover quickly once pile driving is complete.

Results from field studies showed free-swimming cod and sole exhibited changes in swimming behavior in response to pile driving sounds (Mueller-Blenkle et al. 2010). Hawkins et al. (2014) found schools of sprat were more likely to disperse, while mackerel were more likely to change water depth, and both species, despite different hearing anatomy, responded at similar received peak-to-peak sound pressure levels (L_{pk-pk}); 50 percent of the time, they responded to L_{pk-pk} of 163 dB re 1 µPa, which could be expected to occur up to tens of kilometers from the source. Lafrate et al. (2016) did not observe significant displacement in tagged grey snapper, a species with high site fidelity, residing within hundreds of meters of real pile driving operations, while Krebs et al. (2016) saw Atlantic sturgeon seemed to avoid certain areas when pile driving was occurring, suggesting they would not remain in the area long enough to experience detrimental physiological effects. These field studies indicate fishes may be startled, temporarily displaced, or change their schooling behaviors during pile driving noise, but when pile driving is complete, they are likely to resume normal behaviors relatively quickly.

As stated earlier, Atlantic sturgeon are expected to be present in the Lease Area in low numbers during the spring and fall (Section 5.1.3.1.2), which only partially overlaps with the beginning and end months of the proposed pile driving schedule (Table 6-11). Additionally, there are no preferred foraging areas or aggregation areas have been identified in the Project area (Section 5.1.3.1). Atlantic sturgeon could be exposed to noise above behavioral threshold during Project construction as the largest modeled range extends out to 8.5 miles (13.65 kilometers) for the WTG monopile foundations (Table 6-30). However, given their preference for nearshore waters, the low numbers of Atlantic sturgeon expected to occur in the Lease Area, and the limited overlap in their seasonal presence in the Lease Are with the month pile driving will take place, the effects of any behavioral disturbances, if they were to occur, would be undetectable, not measurable, or so minor they cannot be meaningfully evaluated, and therefore **insignificant** for Atlantic sturgeon.

Overall, given the discountable effects of physiological injury and the insignificant effects of behavioral disturbances on Atlantic sturgeon and giant manta ray discussed in this section, the effects of underwater noise during pile driving of the Project foundations **may affect, but are not likely to adversely affect** ESA-listed fish species.

6.3.13.3.2 Inshore Impact Pile Driving

Under the Proposed Action, impact pile driving activities will occur inshore during construction to support the development of the proposed O&M Facility (Section 3.1.2). As discussed previously in Section 6.3.13.3.1, development of the O&M facility will include installation using impact pile driving of up to 170, 12-to-18-inch (30.5 to 45.7 centimeters) diameter steel pipe piles installed over an approximate 6-month period; up to 240, 12-to-18-inch (30.5 to 45.7 centimeters) diameter timber fender system piles installed over an approximate 6-month period; and up to 120 sheet piles installed for the bulkhead over an approximate 3-month period (Section 3.1.2).

Noise produced during these activities would be similar in the characteristics as that described in Section 6.3.13.1.1 for offshore impact pile driving but would produce lower sound levels due to the smaller pile sizes used for the O&M Facility. As described in Section 6.3.5.3, no acoustic modeling is available for this activity from the applicant, so the NMFS Multi-Species Pile Driving Calculator Tool (NMFS 2023k) was used to estimate ranges to the thresholds for fish ≥2 g. Summary pages of both the inputs and results of the calculator tool are provided in Appendix D.

Results from the calculator tool indicate physical injury ranges for fish ≥2 g may be met or exceeded within 11 feet (3 meters) from the source for the 12- to 18-inch steel piles based on the Lpk metric; within 1.5 feet (0.5 meters) from the source for the 12- to 18-inch timber piles based on the SEL_{24h} metric; and within 124 feet (38 meters) from the source for the sheet piles based on the SEL_{24h} metric (Appendix D). Noise levels may exceed the SPL 150 dB re 1 µPa behavioral disturbance threshold for all fish within 82 feet (25 meters) from the 12- to 18-inch steel piles; 45 feet (14 meters) from the 12- to 18-inch timber piles; and 707 feet (215 meters) from the sheet piles (Appendix D).

Giant manta ray are a pelagic species that is not expected to occur inshore near where the proposed O&M facility is located (Figure 3-11) as discussed in Section 5.1.3.3.2, so exposure to noise above both physiological injury and behavioral disturbances are extremely unlikely to occur for this species during inshore pile driving activities.

Within the Project area, shortnose sturgeon are primarily expected to occur in Chesapeake Bay, Delaware Bay, the Delaware River, and the C&D Canal (Section 5.1.3.2). While they can be found outside their natal rivers in Chesapeak and Delaware Bay, they are not likely to occur in the Isle of Wight Bay or near the Ocean City Inlet near where the proposed O&M Facility is located (SSSRT 2010). Therefore, exposure to noise above both physiological injury and behavioral disturbances are extremely unlikely to occur for this species during inshore pile driving activities.

Atlantic sturgeon are more commonly found in nearshore waters (Section 5.1.3.1), but there are no rivers nearby the Isle of Wight Bay or near the Ocean City Inlet where the proposed O&M facility is located that have been designated as critical habitat for either the New York Bight or Chesapeake Bay DPS (Figure 4-5), and individuals traveling to marine waters offshore of Maryland and Delaware from their natal rivers would not be expected to travel through the area inshore of the Ocean City Inlet. Therefore, Atlantic sturgeon are also not expected to occur near the inshore location of the O&M facility and exposure to noise above both physiological injury and behavioral disturbances are extremely unlikely to occur for this species during inshore pile driving activities.

Given the unexpected occurrence of these species within the ensonified area near the proposed O&M Facility (based on the ranges provided in Appendix D), effects from physical injury and behavioral disturbances are extremely unlikely to occur due to inshore pile driving noise and effects on ESA-listed fish would be **discountable**. Therefore, exposure to noise above both the physiological injury and behavioral thresholds during inshore impact pile driving for the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed fish species.

6.3.14 Foundation Relief Drilling

As discussed in Section 3.1.1.5, in the unlikely event the pile meets refusal prior to the embedment depth, relief drilling of the pile may be required. Relief drilling would be conducted using a TSHD which would suction sediments from around the pile. Whilst the main installation vessel continues with subsequent pile installations, a TSHD would be mobilized to site. Upon completion, normal pile hammering would resume until the pile has reached target penetration. Based on current drivability assessment there is a very low likelihood that the piles will not reach penetration depth. The total number of piles that may require relief drilling are not currently available, but only a small number, if any, foundations will require this activity so the overall duration of this activity is anticipated to be less than that expected for impact pile driving during installation of the foundations (Section 3.1.1.5).

Dredging produces distinct sounds during each specific phase of operation: excavation, transport, and placement of dredged material (Central Dredging Association 2011; Jiménez-Arranz et al. 2020). Engines, pumps, and support vessels used throughout all phases may introduce low-level, continuous noise into the marine environment. The sounds produced during excavation vary depending on the sediment type; the denser and more consolidated the sediment is, the more force the dredger needs to impart, and the higher sound levels that are produced (Robinson et al. 2011). Sounds from mechanical dredges (which include TSHD) occur in intervals as the dredge lowers a bucket, digs, and raises the bucket with a winch. During the sediment transport phase, many factors including the load capacity, draft, and speed of the vessel, influence the sound levels that are produced (Reine et al. 2014). SPL source levels during backhoe dredge operations range from 163 to 179 dB re 1 µPa m (Nedwell et al. 2008; Reine et al. 2012). As a whole, dredging activities generally produce low-frequency sounds; with most energy below 1,000 Hz and frequency peaks typically occurring between 150–300 Hz (McQueen et al. 2018). Additional detail and measurements of dredging sounds can be found in (Jiménez-Arranz et al. 2020; McQueen et al. 2018; Robinson et al. 2011).

6.3.14.1 Marine Mammals

Given the low source levels described above and infrequency and transient nature of dredging sources during foundation relief drilling, exceedance of PTS thresholds are not likely, but TTS and behavioral thresholds could be exceeded (Nedwell et al. 2008; Reine et al. 2012; Todd et al. 2015). Anticipated noise levels for foundation relief drilling activities described above would exceed the behavioral threshold for marine mammals of 120 dB re 1 µPa out to 2,923 feet (891) which introduces a relatively large range for behavioral disturbance and exposures above thresholds. However, relief drilling events are expected to be short term and irregular as they will not be required for all foundations.

Todd et al. (2015) provide an extensive review of the impacts of dredging on marine mammals. Some studies, primarily on seals and sea lions, found no observable response (Blackwell et al. 2004; Environment 2008; Gilmartin 2002), while several other studies showed temporary to long-term avoidance behavior for bowhead, gray, humpback, and minke whales (Anderwald et al. 2013; Borggaard et al. 1999; Richardson et al. 1990; Todd et al. 2015; Tyack 2008). For example, gray and humpback whales seem to avoid certain areas, even key breeding habitats, when dredging was occurring (Borggaard et al. 1999; Tyack 2008). These studies suggest that dredging does not produce sounds sufficient to cause permanent hearing injuries, but at close ranges the sounds are at levels that have the potential to cause behavioral disturbance or temporary hearing impairment to marine mammals.

While behavioral responses may occur from site preparation activities, they are expected to be short term and of low intensity. Masking and behavioral reactions from dredging may be more likely for baleen whales and pinnipeds due to the low-frequency spectrum over which the sounds occur and the overlap with their best hearing sensitivity. The noise produced would have the greatest acoustic energy in the lower frequency bands (less than 1 kHz), which overlaps best with the hearing range of the LFC species present in the Project area. While behavioral responses may occur from relief drilling, they are not expected to be long lasting or biologically significant to ESA-listed LFCs given the spatial extent of the above-threshold noise described previously and the fact that not all foundations would require relief drilling. Noise during foundation relief drilling would partially overlap with the hearing sensitivity for sperm whales, though it is not within their peak sensitivity range (Section 6.3.2).

Given the estimated threshold ranges and limited occurrence of this activity for the foundations, any behavioral effects that do occur are not expected to have biological consequences and would be so minor they cannot be measured or meaningfully evaluated and would be considered **insignificant**. Thus, exposure to noise during foundation relief drilling under the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals.

6.3.14.2 Sea Turtles

While the acoustic impacts of the TSHD used during foundation relief drilling on sea turtles are expected to be similar to other continuous, non-impulsive sound sources, the response thresholds for sea turtles are not well researched and are poorly understood relative to marine mammals (Section 6.3.14.1). Even right at the source, sound exposure levels from dredging are not expected to exceed the recommended sea turtle cumulative sound exposure threshold for TTS or PTS (Section 6.3.3.1). Behavioral responses are possible close to the source, as suction dredging may produce sounds up to an SPL of 190 dB re 1 μPa (Robinson et al. 2011; Todd et al. 2015), which exceeds the behavioral response threshold of 175 dB re 1 μPa (Section 6.3.3.1) out to approximately 20 feet (6 meters).

There is currently no information on the effects of dredging noise on sea turtles (Popper et al. 2014). There is evidence, however, of potentially positive impacts of dredging to breeding flatback turtles, which increased their use of a dredging area and made longer and deeper resting dives during dredging operations (Whittock et al. 2017). The most likely driver for the observed behavioral response was speculated to be the absence of predators which were displaced by the noise from dredging operations. Despite the presence of active dredge vessels (which can often pose a risk to turtles), no events of injury or mortality were recorded. This was attributed to control measures (e.g., drag head chains) in place that seemed to be effective in preventing entrainment (Whittock et al. 2017). In general, sound emitted by dredging operations is sporadic and typically short-term, and given the small estimated threshold range, exposures to noise above the behavioral disturbance threshold for foundation relief drilling are very unlikely for any sea turtle species.

Overall, the risks of foundation relief drilling noise effects on sea turtles would be limited to short-term, temporary behavioral disturbances, and the individuals that do alter their behavior in response foundation relief drilling noise would be expected to return to normal once the activity has ceased. Therefore, any behavioral effects on sea turtles are extremely unlikely to occur due to foundation relief drilling noise and effects on ESA-listed sea turtles would be **discountable**. Thus, exposure to noise during foundation relief drilling under the Proposed Action **may affect, not likely to adversely affect** ESA-listed sea turtles.

6.3.14.3 Marine Fish

Given the physical qualities of dredging noise comparable to the TSHD that would be used during foundation relief drilling described previously, injury and auditory impairment are unlikely, but fishes could experience behavioral disturbance or masking close to these activities. No research has specifically looked at responses to these noise sources, but impacts are likely to be similar, though less intense, than those observed with vessel noise (Section 6.3.7.3), since these activities are not as widespread or frequent as vessel transits. Because foundation relief drilling would only occur over a short duration for a subset of the foundations included under the Proposed Action, long-term changes in behaviors are not expected for Atlantic sturgeon or giant manta rays. Shortnose sturgeon are not expected to occur in the Project Lease Area (Section 5.1.3.2) so they would not be present during relief drilling under the Proposed action.

Overall, the risks of foundation drilling noise effects on Atlantic sturgeon and giant manta ray would be limited to short-term, temporary behavioral disturbances, and the individuals who do alter their behavior in response to foundation drilling noise would be expected to return to normal once the activity has ceased. Therefore, any behavioral effects that do occur would be so minor they cannot be measured or meaningfully evaluated and would be considered **insignificant** for Atlantic sturgeon and giant manta ray. Thus, exposure to noise during foundation relief drilling under the Proposed Action **may affect, not likely to adversely affect** Atlantic Sturgeon and giant manta ray. **No effect** is expected for shortnose sturgeon during foundation relief drilling because they are not found in the Lease Area (Section 5.1.3.2).

6.3.15 Seabed Preparation Activities

As discussed in Section 3.1.1.5.2, US Wind does not anticipate seabed preparation would be necessary to provide a level surface at any of the post-piled jacket or jacket on suction bucket foundation locations for the OSSs (figure 3-1). In the unlikely event that seabed leveling is needed, US Wind anticipates using equipment such as a TSHD to level the seabed and estimates a maximum case scenario of approximately 5,000 cubic yards (3,823 cubic meters) of dredge material at each OSS location. Dredged material would be placed or moved aside within the immediate vicinity within the defined OSS construction footprint. Up to four OSS each requiring four 9.8-foot (3-meter) skirt piles will be installed under the Proposed Action (Table 3-1); the first OSS would be installed in 2025, the next two would be installed in 2026, and the final OSS would be installed in 2027 (Table 6-11).

Dredging equipment could be used prior to installation of the OSS foundations to remove disturbed or unconsolidated sediment and create a firm and level base in the footprint of the foundation. Noise produced during this activity would be similar to that described for dredging of the Inshore Exposure Cable in Section 6.3.9, except seabed preparation activities would occur entirely in the Project Lease Area.

ESA-listed marine mammals, sea turtles, and fish species (except shortnose sturgeon) are expected to occur in the Lease Area (Section 5.1) and may be present during the proposed seabed preparation activities. Shortnose sturgeon are not expected to occur in the Lease Area and therefore **no effects** are expected during seabed preparation activities.

Sound exposure levels from dredging (Nedwell et al. 2008; Reine et al. 2012; de Jong et al. 2010) are not expected to exceed the recommended acoustic thresholds for PTS or physiological injury for marine mammals, sea turtles, or fish (Sections 6.3.2, 6.3.3, and 6.3.4). Dredging activities for seabed preparation may produce source levels up to an SPL of 190 dB re 1 μPa (Nedwell et al. 2008; de Jong et al. 2010) which could exceed the behavioral disturbance thresholds for marine mammals, sea turtles, and fish (Sections 6.3.2, 6.3.3, and 6.3.4). However, because these activities would only be used at the locations of the four OSS foundations, both the spatial and temporal extent of these activities are expected to be extremely limited and therefore exposure to above-threshold noise for all ESA-listed marine mammals and sea turtles, Atlantic sturgeon, and giant manta rays is extremely unlikely to occur. Potential effects from seabed preparation noise under the Proposed Action are therefore **discountable**, and **may affect, not likely to adversely affect** ESA-listed marine mammals and sea turtles, Atlantic sturgeon, and giant manta rays.

6.4 Vessel Strike Risk (C, O&M, D)

Vessel strikes are a known source of injury and mortality for marine mammals, sea turtles, and Atlantic sturgeon. Increased vessel activity in the Action Area associated with the construction, O&M, and decommissioning of the Proposed Action would pose a theoretical risk of increased collision-related injury and mortality for ESA-listed species. In general, large vessels traveling at high speeds pose the greatest risk of mortality to ESA-listed marine mammals, whereas sea turtles and Atlantic sturgeon are vulnerable to a range of vessel types and speeds depending on the environment. Table 6-33 provides an overview of the ESA-listed species that may occur in vessel transit areas relative to potential primary port of origin regions.

Vessel strike is relatively common with cetaceans (Kraus et al. 2005) and one of the primary causes of anthropogenic mortality in large whale species (Waring et al. 2011, 2015; Hill et al. 2017; Hayes et al. 2020). NARWs are particularly vulnerable to vessel strikes based on the distribution of preferred coastal region habitats and their feeding, diving, and socializing behaviors (Baumgartner et al. 2017). Risk of collision injury is commensurate with vessel speed; the probability of a vessel strike increases significantly as speeds increase above 10 knots (5.1 m/s) (Laist et al. 2001; Kite-Powell et al. 2007; Vanderlaan and Taggart 2007; Conn and Silber 2013). Vessels operating at speeds exceeding 10 knots (5.1 m/s) under poor visibility conditions have been associated with the highest risk for vessel strikes of NARWs (Vanderlaan and Taggart 2007), though collisions at lower speeds are still capable of causing serious injury, even when smaller vessels (less than 66 feet [20 meters] in length) are involved (Kelley et al. 2020).

Vessel strikes are also implicated in sea turtle mortality, with collision risk similarly commensurate with vessel speed although at much lower speeds (Hazel et al. 2007; Shimada et al. 2017). Hazel et al. (2007) found green sea turtles were unlikely to actively avoid vessels traveling faster than 2.1 knots (1.1 m/s), indicating that 10-knot (5.1 m/s) speed restrictions may not be protective for this and potentially other sea turtle species.

Atlantic sturgeon are vulnerable to vessel collisions within restricted riverine habitats, resulting in potential mortality (Balazik et al. 2012), though vessel strikes of elasmobranch species such as the giant manta ray are, in general, extremely rare.

Table 6-33. Threatened and endangered species that may occur in vessel transit areas relative to potential primary port of origin regions

Species	Scientific Name	ESA Listing Status	Project Area	Gulf of Mexico	Maine	Europe
Fin whale	*Balaenoptera physalus*	Endangered	X	X	X	X
North Atlantic right whale	*Eubalaena glacialis*	Endangered	X	X	X	X
Sei whale	*Balaenoptera borealis*	Endangered	X	—	X	X
Sperm whale	*Physeter macrocephalus*	Endangered	X	X	X	X
Green sea turtle (North Atlantic DPS)	*Chelonia mydas*	Threatened	X	X	—	X
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	X	X	—	—
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	X	X	X	X

Species	Scientific Name	ESA Listing Status	Project Area	Gulf of Mexico	Maine	Europe
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)	*Caretta caretta*	Threatened	X	X	X	X
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered	X	X	X	—
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered	X	X	X	—
Giant manta ray	*Manta birostris*	Threatened	X	X	—	—

DPS = distinct population segment; ESA = Endangered Species Act; X = applicable; — = not applicable

6.4.1 Overview of Vessel Traffic under the Proposed Action

6.4.2 Construction, O&M, and Decommissioning Vessel Traffic

Proposed Action construction would generate vessel transits throughout the three construction phases, including by specialized equipment vessels (scour protection installation, survey, jack-up heavy lift, and transport vessels), CTVs (crew change, accommodation vessels), and support vessels (tugboat and barge). The primary and alternate ports and associated project vessels US Wind anticipates using are provided in Table 3-10. The vessels that would be used for Project construction are described in Section 3.1.1.6 and Table 3-11 of this BA. Vessels of a variety of sizes would be used during Proposed Action construction, ranging from CTVs (30 to 100 feet [10 to 30 meters] in length) to jack-up, heavy-lift, and heavy transport vessels (maximum lengths may exceed 700 feet [213 meters]) (COP, Volume I, Section 4.0, Table 4-1; US Wind 2023). Proposed Action construction would require an average of 37 and a maximum of 39 vessels operating in the Lease Area or over the Offshore Export Cable Route at any given time (COP, Volume II, Appendix C1; US Wind 2023). Many construction vessels would remain in the Lease Area or along the Offshore Export Cable Route for days or weeks at a time, potentially making infrequent trips to port for bunkering and provisioning, as needed. These vessels would largely remain on station or travel at speeds well below 10 knots (5.1 m/s) during construction activities. Therefore, although an average of 37 vessels would be present in the Lease Area during construction of each phase, fewer vessels would transit to and from port each day.

Approximately 2,355 total vessel round trips are expected during the offshore construction period, which equates to an average of 2.1 vessel round trips per day over a 3-year construction period (Table 3-11). During the most active month of construction, an average of approximately 6.2 daily vessel round trips could occur. Project vessels within the Lease Area would usually be stationary during construction or traveling at slow speeds, although transits between ports and the Lease Area may result in speeds greater than or equal to 10 knots (5.1 m/s). Baltimore (Sparrows Point), Maryland and Ocean City, Maryland are expected to be the most heavily used primary ports that support construction activities. Although ports in Europe, Maine, and the Gulf of Mexico may be used during construction, transits from these would compose a very small percent of overall vessel transits during Proposed Action construction. In total, 6 vessel roundtrips are expected for vessels originating in Europe, 4 vessel roundtrips for vessels originating in Brewer, Maine, and 1 vessel roundtrip for the vessel origination in the Gulf of Mexico throughout the entire three-year construction schedule, representing less than one half of one percent of all vessel transits during Project construction, combined. The largest number of Project construction trips is expected between the Lease Area and Baltimore (Sparrows Point), Maryland, with an average of 1.3 round trips per day and representing approximately 59 percent of all construction-related vessel transits over the 3-year construction period.

The maximum daily average of 6.2 Project vessel round trips would represent a 55 percent increase over the current number of daily average vessel transits in the vicinity of the Lease Area. However, as discussed in Section 3.1.1.6, AIS data do not capture all vessel activity in a region and likely underestimate actual vessel transits, particularly for smaller vessels. Additionally, the maximum daily average is represented by Project vessel activity during the busiest month of Project construction and is not representative of vessel activity for each day during the 3-year construction period for which these numbers were estimated. To approximate this, the daily average of 2.1 Project vessel round trips would represent a 19 percent increase over the current number of daily average vessel transits in the vicinity of the Lease Area.

During O&M, the Proposed Action would primarily generate trips by CTVs (30 to 100 feet [10 to 30 meters] in length) and multipurpose offshore supply vessels (210 to 295 feet [65 to 95 meters] in length). An overview of the number and types of vessels anticipated to be used and the estimated number of transits and home ports for O&M are provided in Table 3-17. The specific vessels selected to perform the required tasks during development and construction will depend on availability at the commencement of each activity; US Wind will secure vessel supply in advance to prevent delays to the construction schedule (COP, Volume I, Section 4.0; US Wind 2023).Additionally, as noted in Section 6.3.7, there would likely be an overlap in the construction and O&M vessel traffic for adjacent construction phases (e.g., phase 1 O&M traffic would partially overlap with phase 2 construction traffic), but during these periods of overlap, the construction traffic, which consists of a higher volume of vessels of larger sizes would pose a greater relative risk to ESA-listed species compared to O&M vessel traffic. Approximately 822 vessel round trips are estimated to occur annually during O&M, which equates to an average of 2.3 vessel round trips per day. A maximum of 4.5 vessel round trips per day are expected for the months of highest anticipated activity during O&M. The majority (more than 90 percent) of vessel transits are anticipated to originate from the O&M Facility in Ocean City, Maryland. Additional ports include Lewes, Delaware; Baltimore (Sparrows Point); Maryland; Hope Creek, New Jersey; and Port of New York/New Jersey. CTVs have typical operational speeds of 10 to 25 knots (5.1 to 12.9 m/s), whereas the larger multipurpose offshore supply vessels are slower, likely operating at 10 to 12 knots (5.1 to 6.2 m/s). There is no planned use of Maine, Gulf of Mexico, or European ports throughout O&M, though use of other U.S. ports could occur to support an unplanned event. While the same limitations discussed above for construction activities exist for comparing Project O&M vessel activity to current baseline levels, an approximately 10 percent increase in average daily vessel activity over baseline is expected as a result of the Proposed Action O&M.

Decommissioning vessel activities are expected to be comparable or less than those anticipated for construction.

6.4.3 Monitoring Program Survey Vessel Traffic

US Wind will conduct surveys as part of the COP as well as monitoring activities after COP approval, including pre-, during, and post-construction nearshore and offshore fisheries monitoring surveys with both commercial and recreational survey components (Section 3.1.6.2). Additionally, a marine mammal monitoring survey (Section 3.1.6.3) and a near-real time whale buoy monitoring program (Section 3.1.6.4) will be conducted under the Proposed Action. A total of 116 vessel days are anticipated for the commercial pot study between March and November, and 74 total vessel days anticipated for the recreational survey between May and October over the six-year study timeframe. It is estimated that two vessel trips per year will be conducted for the marine mammal monitoring program, totaling up to 16 total vessel days over the 8-year study. Finally, yearly vessel transits are planned for the near-real time whale buoy monitoring program, totaling four vessel days over the four-year study. Based on these estimates, fisheries resource, marine mammal, and near real-time whale buoy monitoring programs will collectively total 210 vessel days through 2029. Weather, contingency, and unexpected vessel trips are not included in this total as they are unpredictable and inclusion would only be speculative at best. Monitoring surveys funded by US Wind would be conducted by the University of Maryland's Center for Environmental Science (UMCES) and may utilize the following vessels: University of Delaware's R/V *Daiber*, UMCES' R/V *Rachel Carson,* or from a fishing vessel in Ocean City, MD (such as the F/V *Seaborn* and F/V *Integrity*.

As discussed in Section 6.4.1, vessel strikes are a known source of injury and mortality for marine mammals, sea turtles, and some ESA-listed fish. Increased vessel activity in the Project area associated with the Proposed Action, including vessel traffic associated with fisheries and habitat monitoring surveys, would pose a theoretical risk of increased collision-related injury and mortality for ESA-listed species. In general, large vessels traveling at high speeds pose the greatest risk of mortality to ESA-listed marine mammals, whereas sea turtles and ESA-listed fish are vulnerable to a range of vessel types and speeds depending on the environment. Vessels conducting fisheries and habitat monitoring surveys may range in size from 45 to 350 feet (13 to 112 meters) (COP, Volume I, Section 4.0, Table 4-1; US Wind 2023). Operational survey speeds are not known at this time but would depend on survey type and vessel and may range between 0 and 10 knots (0 and 5.1 m/s), though transit speeds may exceed this range. The number of vessels conducting fisheries and habitat monitoring surveys is not known at this time but is expected to be a very small proportion of the number of vessels and transits analyzed for construction, O&M, and decommissioning activities (Section 6.4.1).

6.4.4 Vessel Traffic Displacement

Regional vessel traffic may become displaced due to the physical presence of offshore infrastructure, including the Project's WTGs and OSSs within the Lease Area. Vessel traffic displacement includes vessels displaced out of the Project area into surrounding waters as well as attraction to the Lease Area from surrounding waters. While no data currently exist to fully assess potential vessel traffic displacement as a result of the Proposed Action, generalizations can be inferred based on regional traffic data and trends. Section 3.2.1.1.7 provides an analysis of baseline vessel traffic in the vicinity of the Project area.

Displacement of large shipping vessel traffic (i.e., cargo/carriers and tankers) is expected to be minimal, as the majority of vessels in these classes use established shipping lanes and Traffic Separation Schemes to the north and east of the Lease Area. Based on the NSRA prepared for this Project (COP, Volume II, Appendix K1; US Wind 2023), traffic exiting the outbound lane of the Traffic Separation Schemes and heading south, and traffic coming from the south and entering the inbound lane of the Traffic Separation Scheme, pass though the Lease Area. These vessels will likely be displaced east and outside of the Lease Area during Project construction and O&M.

Commercial fishing, recreational fishing, and pleasure vessels may experience displacement out of the Lease Area as well as into the Lease Area in association with a shift in fishing resources (Section 6.5.5.3 discusses the reef effect). If there is an increase in recreational fishing in the Project area, this likely will represent a shift in fishing effort from areas outside the Project area to within the Project area and an increase in overall vessel traffic within the Lease Area. Additionally, commercial fishing within the Lease Area may become displaced to regions outside the Lease Area, resulting in a shift in vessel traffic. However, based on data presented in the NSRA (COP, Volume II, Appendix K1; US Wind 2023), commercial fishing activity within the Lease Area appears minimal, though the Lease Area is transited by vessels traveling to farther offshore fishing grounds. Commercial fishing vessel transits may be displaced to waters outside the Lease Area during Project construction, but minimal displacement is predicted during O&M given the separation distances between WTG and OSS foundations. As a result, the majority of displaced fishing traffic is expected to result from an increase in recreational fishing activities within the Lease Area, though the extent of potential changes remains uncertain.

6.4.5 Marine Mammals

Project vessels working during all phases of the Proposed Action pose a potential collision risk to marine mammals. Vessel strikes are a well-documented threat to large whales worldwide and are a measurable 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. 2022), indicating the importance of protective measures to minimize risks to vulnerable species. Vessel strikes are of particular concern for mysticetes due to their size, relatively slow maneuverability, proportion of time spent at the surface between dives, lack of clear and consistent avoidance behavior, and relatively low detectability by vessels without focused observation efforts (Gende et al. 2011; Martin et al 2016; Rockwood et al. 2017; Garrison et al. 2022). Vessel strikes are a known or suspected contributor to three active Unusual Mortality Events in the Atlantic Ocean for cetaceans (humpback whale, minke whale, and NARW) (NMFS 2023b).

If a vessel strike occurs, the impact would range from minor injury to mortality, depending on the species and strike severity. Injuries are typically the result of one of two mechanisms: blunt force trauma from impact with the vessel, or lacerations from contact with the propellers (Wiley et al. 2016). Depending on the strike severity and the injuries inflicted, the animal may or may not recover (Wiley et al. 2016). The size of the vessel and the animal, speed of the vessel, and the orientation of the marine mammal with respect to vessel trajectory will all affect the severity of the injury (Vanderlaan and Taggart 2007; Martin et al. 2016).

The ability to detect a marine mammal within the path of a moving vessel can reduce vessel strike risk and depends on a variety of factors, including atmospheric/visibility conditions, observer training and experience, and vessel size and speed. Vessel speed is inversely correlated with detection rates, such that slower transit speeds, especially those below 9.7 knots (5.0 m/s), generally lead to a higher in-time detection rates for most vessel sizes provided adequate (greater than 3,281 feet [1,000 meters]) reliable detection ranges (Baille and Zitterbart 2022).

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-watching vessels, research vessels, and even jet skis (Dolman et al. 2006; Winkler et al. 2020).

Primary factors that affect the probability of a marine mammal-vessel strike include:

- Density, distribution, species, age, size, speed, health, and behavior of animal(s) (Vanderlaan and Taggart 2007; Martin et al. 2016);
- Number, speed, and size of vessel(s) (Vanderlaan and Taggart 2007; Martin et al. 2016);
- Vessel path (Vanderlaan and Taggart 2007; Martin et al. 2016);
- Operator's ability to detect and avoid collision (Martin et al. 2016; Williams et al. 2016); and
- Animal's ability to detect an approaching vessel and propensity to avoid collisions (Nowacek et al. 2004; McKenna et al. 2015; Gende et al. 2019).

A marine mammal's ability to detect and actively avoid a vessel collision is poorly understood. An individual's aversion to an approaching vessel likely depends on the age and behavioral state of the animal and will differ among species (Nowacek et al. 2004; McKenna et al. 2015; Gende et al. 2019). Auditory recognition of a vessel by a marine mammal such that timely avoidance is triggered is likely highly variable and contextual. The following factors can impair the ability of a marine mammal to detect and locate the sound of an approaching vessel:

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

- Ambient (background) sound interfering with the sound of an approaching vessel (i.e., acoustic masking).

Vessel speed and size are two of the most important factors for determining the probability and severity of vessel strikes. The size and bulk of large vessels inhibits the ability for crew to detect and react to marine mammals along the vessel's transit route. In 93 percent 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 the most lethal or severe injuries are caused by ships 262 feet (80 meters) or longer traveling at speeds greater than 13 knots (6.7 m/s). An 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; the probability of a vessel strike increases significantly as speeds increase above 10 knots (5.1 m/s) (Laist et al. 2001; Kite-Powell et al. 2007; Vanderlaan and Taggart 2007; Conn and Silber 2013). 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; Jensen and Silber 2003).

In general, ESA-listed marine mammal densities are relatively low in the Project area. Fin whale densities are the greatest, while NARW and sei whale densities are comparatively lower, and sperm whale densities are the lowest. Fin whales are most abundant during the winter and spring, though year-round presence is likely. The highest regional density of NARWs in the Project area occurs during the winter, though the species may also occur year-round. Their heightened abundance during the winter coincides with seasonal pile driving restrictions. The highest densities of sei whales in the Project area are expected during the summer and spring, which coincides with the peak construction period. Sperm whales may occur in the Project area in very low numbers, mostly during the spring, though they are more likely to occur in the deep waters of the Gulf of Mexico, which may overlap with vessel transit routes from that area. Table 6-12 provides the monthly average densities for marine mammals included in the acoustic modeling (TRC 2023). These densities, and corresponding abundances expected for the US Wind Lease Area, are summarized below:

- Fin whale density estimates have a high of 0.0021 animals per square kilometer in January and a low of 0.0003 animals per square kilometer in August. This equates to fewer than one fin whale within the 79,707-acre (322.5-square kilometer) Lease Area during their period of expected maximum abundance in the winter.
- NARW density estimates have a high of 0.0008 animals per square kilometer in February and a low of 0.00001 animal per square kilometer in July and August. This equates to fewer than one NARW within the 79,707-acre (322.5-square kilometer) Lease Area during their period of expected maximum abundance in the winter.
- Sei whale density estimates have a high of 0.0006 animals per square kilometer in April and a low of zero animals per square kilometer in August. This equates to fewer than one sei whale within the 79,707-acre (322.5-square kilometer) Lease Area during their period of expected maximum abundance in the spring.
- Sperm whale density estimates have a high of 0.00006 animals per square kilometer in May and a low of zero animals per square kilometer in August, September, and October. This equates to fewer than one sperm whale within the 79,707-acre (322.5-square kilometer) Lease Area during their period of expected maximum abundance in the spring.

US Wind has committed to a range of mitigation and monitoring measures to minimize the potential for vessel collisions and impacts to marine mammals (Section 3.3). A final Vessel Strike Avoidance Plan will be submitted to NMFS and BOEM at least 90 days prior to commencement of vessels used for any Project construction activities. Additionally, US Wind will adhere to all mandatory and voluntary NOAA NARW vessel speed restrictions. This includes vessels 65 feet (19.8 meters) or longer that will operate at 10 knots (5.1 m/s) or slower in NARW Slow Zones, Seasonal Management Areas, and Dynamic Management Areas. US Wind will incorporate the proposed revision to the NARW speed rule (87 *Federal Register* 46921) for vessels 35 to 65 feet (10.6 to 19.8 meters) in length upon rule adoption. In addition, US Wind will rely on trained observers within the Project area and adhere to additional minimum separation distances to minimize collision risk with ESA-listed species. These measures would be implemented throughout all construction, O&M, and decommissioning activities associated with the Proposed Action and will reduce risk to ESA-listed marine mammals.

The number of vessel trips under the Proposed Action compared to current baseline levels would be moderate to high during construction. As a result, there is a moderate risk of interaction between marine mammals and Project vessel traffic during construction based on the density of marine mammals in the Action Area and the estimated vessel activity over the construction period. The highest levels of Project-related vessel activity would occur during peak construction (i.e., pile driving activities during the summer). With implementation of seasonal restrictions for pile driving (Section 3.3), these high levels of vessel activity would not occur when NARW presence is predicted to be the highest (January through March), thereby lowering NARW encounter potential. There is a slightly lower risk of vessel interaction with marine mammals during O&M based on the density of marine mammals in the Project area and the estimated activity over the operational life of the Project. However, this risk would be present throughout O&M and is therefore considered long term.

While the baseline encounter rate for vessels and animals to be within a strike risk with one another is already low, several factors are expected to further reduce the probability of a Proposed Action-related vessel strike. The communication and reporting procedures outlined in Section 3.3 are designed to increase awareness of the presence of marine mammals, NARWs in particular. All Project-related vessels operating in the Project area are required to post trained and dedicated lookouts (i.e., PSOs) on board who will use the best available tools and technology to continuously monitor the vessel strike zone. All protected species sightings will be shared among all Project vessels to increase situational awareness of the presence of marine mammals. Although the Proposed Action will result in temporarily high numbers of vessels operating in the Project area during peak construction, data sharing among all vessels will be beneficial to each PSO. When combined with the effective implementation of vessel strike avoidance mitigation measures, encounters that have a high risk of resulting in collision or injury would be minimized by reducing both the encounter potential (e.g., separation distances, seasonal restrictions, avoidance of aggregations) and severity potential (e.g., speed reduction, vessel positioning parallel to animals). Operational speeds of less than or equal to 10 knots (5.1 m/s) would allow whales to avoid vessels, vessels to avoid whales, or both to take evasive actions. Additionally, slower vessel speeds are generally correlated with a reduction in injury extent and reduced instances of mortality when compared to faster vessel speeds (Vanderlaan and Taggart 2007). All vessels, including those traveling faster than 10 knots (5.1 m/s), are required to maintain minimum separation distances of 1,640 feet (500 meters) from all observed ESA-listed whales (Section 3.3). While this measure cannot entirely eliminate an undetected marine mammal from entering this zone, a reduction in strike/injury risk ultimately relies on the ability for a responsive action to be taken if there is an encounter with a marine mammal. Deployment of PSOs on all vessels along with operable and effective monitoring equipment, including equipment specialized for low-light conditions (e.g., thermal imaging, night vision devices) in order to effectively monitor at night, will minimize the collision and injury risk of any encounters that may occur.

The Action Area also includes potential transit routes of vessels transporting offshore WTG, OSS, and Met Tower components from Europe, Maine, and the Gulf of Mexico during Project construction. The number of Project-related vessels transiting from ports outside the Project area, estimated at 11 total round trips over the 3-year construction period for which this estimate was provided (Section 3.1.1.6), is considered relatively small compared to the existing high level of commercial vessel traffic in the North Atlantic. Risk to ESA-listed marine mammals from vessels traveling from Europe, Maine, or the Gulf of Mexico would be limited to the 3-year construction period for which these estimates were provided and would not constitute a long-term impact. Vessels on cross-ocean transits are not anticipated to employ trained PSOs or travel at reduced speeds. However, given the low densities of ESA-listed whales throughout the North Atlantic and the relatively low number of vessel transits from ports outside the Project area, the likelihood of an encounter resulting in a ship strike is very low. Additionally, no Gulf of Mexico, Maine, or European vessel transits are anticipated during Project O&M; in the rare case in which such a transit is needed during O&M, the risk to ESA-listed marine mammal populations would be exceedingly small given the rarity of such transits over the 35-year O&M phase. An encounter due to the temporary increase in vessel traffic to and from ports outside the Project area would, therefore, be an extremely rare event during all Project phases.

The risk of vessel strike cannot be fully eliminated due to the unpredictable nature of animal-vessel interactions, even with dedicated PSOs. However, vessel strike risk, and importantly, injury resulting from vessel strikes, can be reduced to a negligible level by strict adherence to the guidelines and proposed mitigation measures outlined in the vessel strike avoidance measures in Section 3.3. Therefore, vessel strike risk is low, but not eliminated, when monitoring and mitigation activities are effectively implemented, as outlined; and trained, dedicated PSOs are used on all vessels. With full implementation of mitigation measures, the potential for injury-causing vessel strikes to ESA-listed marine mammals is considered **insignificant**.

The same mechanisms and stressors associated with vessel strike risk analyzed previously in this section for Project construction, O&M, and decommissioning activities would apply to vessel activity associated with fisheries and habitat monitoring surveys under the Proposed Action. In addition, the same monitoring and mitigation measures for all ESA-listed species would be implemented during all fisheries and habitat monitoring surveys. The extent of monitoring surveys will not significantly increase regional vessel traffic as the number and duration of surveys will be minimal in comparison to other Project-related vessel activities occurring in the Project area. In consideration of Project-related fisheries and habitat monitoring surveys, vessel strike risk, and implementation of mitigation and monitoring measures, the potential for vessel strikes would be **discountable**.

As discussed in Section 6.4.4, large shipping vessel traffic, commercial fishing traffic, recreational fishing traffic, and pleasure vessel traffic may be displaced due to the presence of the Project structure. However, on a small distance of displacement is expected for large shipping vessel traffic, and the overall volume of shipping vessel traffic will not be affected, this displacement is unlikely to result in a change in risk to any ESA-listed marine mammal. Additionally, given the regionally high levels of baseline vessel traffic (Section 3.2.1.1.7), a shift in fishing vessel activity is unlikely to result in a substantial change in risk to ESA-listed marine mammals; potential effects from vessel traffic displacement are therefore considered **discountable.**

Overall, based on the risk of effect from Project construction, O&M, and decommissioning vessel traffic; fisheries and habitat monitoring survey vessel traffic; and vessel traffic displacement described in this section, as well as the proposed mitigation measures, vessel traffic **may affect,** but it is **not likely to adversely affect** ESA-listed marine mammals.

6.4.6 Sea Turtles

Vessel traffic operating during all phases of the Proposed Action poses a potential collision risk to sea turtles. Vessel-animal collisions are a measurable and increasing source of mortality and injury for sea turtles. The percentage of stranded loggerhead sea turtles with injuries apparently caused by vessel strikes increased from approximately 10 percent in the 1980s to more than 20 percent in 2004, although some stranded sea turtles may have been struck postmortem (NMFS and USFWS 2008). Sea turtles likely are most vulnerable to vessel strikes in coastal foraging areas and may not be able to avoid collisions when vessel speeds exceed 2 knots (1 m/s) (Hazel et al. 2007). The recovery plan for loggerhead sea turtles (NMFS and USFWS 2008) notes that, from 1997 to 2005, 14.9 percent of all stranded loggerheads in the U.S. Atlantic Ocean 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 sea turtle died. Regardless, increased vessel traffic associated with the Proposed Action may increase the potential for impacts from vessel strikes.

Vessels traveling at greater speeds pose a higher risk to sea turtles. Relative to marine mammals (discussed in Section 6.4.5), 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 percent, Sapp (2010) found that small vessels (10 to 30 feet [3 to 6 meters] in length) had to slow down to 7.5 knots (3.9 m/s); the probability of lethal injury decreased by 60 percent for vessels idling at 4 knots (2.1 m/s). Foley et al. (2008) further indicated that vessel speed greater than 4 knots (2.1 m/s) may cause serious injury or mortality to sea turtles. 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 fail to flee approaching vessels. Hazel et al. (2007) concluded green sea turtles rarely fled when encountering fast vessels (greater than 10 knots [5.1 m/s]), infrequently fled when encountering vessels at moderate speeds (6 knots [3.1 m/s]), and frequently fled when encountering vessels at slow speeds (2 knots [1 m/s]). Based on the observed responses of green sea turtles to approaching boats, Hazel et al. (2007) concluded 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 (less than 2 knots [1 m/s]) due to the relatively low rate of flee responses of sea turtles.

The number of vessel trips under the Proposed Action compared to current baseline levels within the Lease Areas would be moderate to high during construction. As a result, there is a moderate risk of interaction between ESA-listed sea turtles and Project vessel traffic during construction based on the relative occurrence of sea turtles in the Project area (Section 5.1.2) and the estimated vessel activity over the construction period (Section 3.1.1.6). The highest levels of Project-related vessel activity would occur during peak construction (i.e., pile driving activities during the summer). There is a slightly lower risk of vessel interaction with sea turtles during O&M based on the estimated vessel activity over the operational life of the Project. However, this risk would be present throughout O&M and is therefore considered long term. The relative risk throughout all phases of the Project is expected to be proportional to sea turtle occurrence and densities within the Action Area relative to Project-related vessel traffic. For example, risk is expected to be highest in the nearshore regions of the Project area where sea turtles occur in greatest numbers and for longer periods of the year (Section 5.1.2). Conversely, risk would be lower in areas with lower relative densities sea turtles. The majority of vessel traffic during all phases of the Project would occur within the Project area, with comparatively few transits from other regions such as the Gulf of Mexico and Europe. As a result, vessel strike risk to sea turtles from these regions is considered low, especially along European transit routes where low Project-related vessel traffic occurs in areas with very low sea turtle densities.

Few measures have proven effective at reducing collisions between sea turtles and vessels (Schoeman et al. 2020). The relatively small size of sea turtles and the significant time spent below the surface makes their observation by vessel operators extremely difficult, therefore reducing the effectiveness of trained PSOs to mitigate vessel strike risk on sea turtles. Nevertheless, the use of trained PSOs would reduce the risk of potential collisions.

Although vessel strike risk to sea turtles is expected to be reduced with the application of monitoring and mitigation measures (Section 3.3), some unavoidable effects on sea turtles may occur, primarily due to the difficulty in detecting sea turtles. Though vessel speed restrictions are designed primarily to reduce impact to marine mammals (Section 6.4.5), they would also reduce potential impacts to sea turtles. However, sea turtle collisions may still occur at slow speeds, and individuals would still be vulnerable when vessels travel faster than 2 knots (1 m/s). Additionally, effective detection of sea turtles in low-visibility conditions (e.g., nighttime, fog, inclement weather) is likely low, even with the application of alternative monitoring technologies (e.g., PAM). Therefore, the vulnerability of sea turtles to vessel strike increases during these periods, even with mitigation measures implemented.

The increase in vessel traffic associated with the Proposed Action is likely to increase the relative risk of vessel strike for sea turtles, particularly during nighttime and periods of reduced visibility. Based on this analysis, vessel traffic leading to collisions with sea turtles cannot be discounted. Seasonal patterns of sea turtles in the region will result in reduced risk during periods when individuals are less likely to be present, such as during the winter. Mitigation measures (e.g., minimum vessel separation distances, vessel speed restrictions) would reduce the overall encounter potential. The deployment of trained PSOs on all vessels, along with operable and effective monitoring equipment, would minimize collision risk with sea turtles. As a result of these measures, the probability of a vessel strike between Project vessels and sea turtles throughout all Project stages would be reduced but not eliminated.

The same mechanisms and stressors associated with vessel strike risk analyzed previously in this section for Project construction, O&M, and decommissioning activities would apply to vessel activity associated with fisheries and habitat monitoring surveys under the Proposed Action. In addition, the same monitoring and mitigation measures for all ESA-listed species would be implemented during all fisheries and habitat monitoring surveys. The extent of monitoring surveys will not significantly increase regional vessel traffic as the number and duration of surveys will be minimal in comparison to other Project-related vessel activities occurring in the Project area. In consideration of Project-related fisheries and habitat monitoring surveys, vessel strike risk, and implementation of mitigation and monitoring measures, the potential for vessel strikes would be **discountable**.

As discussed in Section 6.4.4, large shipping vessel traffic, commercial fishing traffic, recreational fishing traffic, and pleasure vessel traffic may be displaced due to the presence of the Project structure. However, on a small distance of displacement is expected for large shipping vessel traffic, and the overall volume of shipping vessel traffic will not be affected, this displacement is unlikely to result in a change in risk to any ESA-listed sea turtles. Additionally, given the regionally high levels of baseline vessel traffic (Section 3.2.1.1.7), a shift in fishing vessel activity is unlikely to result in a substantial change in risk to ESA-listed sea turtles; potential effects from vessel traffic displacement are therefore considered **discountable**.

Overall, based on the risk of effect from Project construction, O&M, and decommissioning vessel traffic; fisheries and habitat monitoring survey vessel traffic; and vessel traffic displacement described in this section, as well as the proposed mitigation measures, the effects of vessel traffic, specifically due to Project construction, O&M, and decommissioning are not discountable or insignificant and **may affect, likely to adversely affect** ESA-listed sea turtles.

6.4.7 Marine Fish

Propeller-driven vessels and barges pose a risk to fishes that swim near the water surface and are a potential source of mortality for Atlantic sturgeon and shortnose sturgeon due to direct collisions with the vessel's 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 [4.6 meters]), which increases the probability of vessel collision with demersal fishes like Atlantic sturgeon, even in deep water (Brown and Murphy

2010). Although smaller vessels and those with relatively shallow drafts provide more clearance with the river bottom, they can operate at higher speeds, which likely limits a sturgeon's ability to avoid being struck. The same potential for vessel strikes is expected for shortnose sturgeon even though the species is more restricted to riverine and estuarine habitats.

Atlantic sturgeon strikes are most likely to occur where populations overlap with abundant boat traffic such as large ports or areas with relatively narrow waterways (ASSRT 2007). Brown and Murphy (2010) indicated the loss of only a few adult female Atlantic sturgeon from the Delaware River population because of vessel strikes would hinder recovery of that riverine population. 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 vessel propellers and hulls (BOEM 2019). The representative ports and vessels under consideration for the Project are described in Sections 3.1.1.6 and 3.1.4.6; vessel transits within Chesapeake Bay and Delaware Bay are likely. Both regions support adult and juvenile Atlantic and shortnose sturgeon populations. Occurrence of Atlantic sturgeon within the area is expected to be dispersed as they also inhabit the marine environment (Section 5.1.3.1). Ports and shallow navigation channels are expected to be the areas of highest risk for vessel interaction with both sturgeon species. However, their limited presence at the water's surface and the dispersed nature of vessel traffic and animals reduce the potential for co-occurrence of sturgeon and vessels.

Over an 8-year span from 2008 to 2016, 53 shortnose sturgeon carcasses were recovered in the Delaware Bay and Delaware River, collectively (NMFS 2021a citing unpublished data). Of those recovered from the Delaware River, 6 of the 11 (55%) had indications of interaction with a vessel. Only two salvaged shortnose sturgeon were recovered in Delaware Bay from 2019 to 2020, with zero reported in the Delaware River during that timeframe (NMFS 2021a citing unpublished data). A simple mathematical extrapolation of these data indicates 55 shortnose sturgeon mortalities over a non-continuous ten-year timeframe, or 5.5 individual mortalities per year. Further, conservatively assuming that 55% of these mortalities are the result of vessel strike suggests an annual mortality rate of 3 individuals per year within the Delaware Bay and Delaware River system. It should be noted that this estimate is highly simplistic and not all dead sturgeon are observed or recovered; any count can be expected to be a fraction of the total number of vessel struck sturgeon.

In 2014, there were 42,398 one-way trips reported for commercial vessels in the Delaware River Federal navigation channel (USACE 2014), though this figure does not include any recreational or other non-commercial vessels, ferries, tugboats assisting other larger vessels or any Department of Defense vessels (e.g., Navy, USCG). Cooper (2018) estimated that more than 25,000 vessel transit the C&D Canal every year. Under the Proposed Action, up to 270 roundtrips are anticipated between Baltimore (Sparrows Point), Maryland and the Lease Area during year 1; 668 roundtrips during year 2; and 451 roundtrips during year 3 (Table 3-11). In total, 1,390 vessel transits would overlap with shortnose sturgeon occurrence over a three-year construction timeframe, or an average of 463 transits per year. Using the above referenced vessel traffic data, Project vessels during the construction phase would represent an annual 1% increase in vessel traffic within the Delaware River and 1.9% increase within the C&D Canal. However, it is worth noting that Project-related vessel traffic is expected to be limited within the Delaware River itself during these transits and few up-river transits would occur. During Project O&M, less than one annual roundtrip is anticipated between Baltimore (Sparrows Point) and the Lease Area.

Even in a worst-case scenario that assumes that all three annual mortalities occur in the waters that will be transited by Project vessels, the proportional increase over baseline traffic levels resulting from the Proposed Action in the Delaware River and C&D Canal correspond to an exceedingly small annual increase in the number of shortnose sturgeon struck and killed by Project vessels (i.e., maximum hypothetical scenario of an additional 0.012 individuals struck and killed within the C&D Canal and 0.006 individuals struck and killed within the Delaware River).

Recently, NMFS GARFO analyzed the US Army Corp of Engineers Permit for the Development of the Paulsboro Marine Terminal Roll-on/Roll-off Berth (NAP-2007-1125-39) (NMFS 2022). In their Opinion, NMFS determined that the increase of vessel traffic for this project over 10 years of construction, operation and maintenance could result in the mortality of one shortnose sturgeon and up to 7 Atlantic sturgeon. Their mortality estimates were based on carcasses recovered for each species and the potential to attribute mortality to vessel strikes (e.g., propeller scars). These mortalities were then used as a metric to estimate the number of mortalities based on the number of vessels trips per year. NMFS also indicated that these mortality estimates were probably too low and underrepresented the actual mortalities. NMFS GARFO determined that the adjusted mortality rates (per vessel trip) were 0.0078 for Atlantic sturgeon (n=7) and 0.0005 (n=1) for shortnose sturgeon over 10 years of operation (880 vessel trips in total). These estimates are close to those estimated for Sparrows Point and C&D canal above and would be representative of the Paulsboro Marine Terminal if used. Other potential ports would be expected to be lower given their proximity to the ocean and lack of shortnose sturgeon habitat.

As a worst-case scenario, the adjusted mortality rates from the USACE BiOP above of 0.0078 for Atlantic sturgeon and 0.0005 for shortnose sturgeon to the 1,390 vessels trips were applied to estimate mortalities for both sturgeon species. This resulted in one (0.7) shortnose sturgeon and 11 (10.8) Atlantic sturgeon mortalities from construction vessel trips over the three-year period. These numbers are likely higher than would be expected and are based on all vessel trips coming from the alternate location (Paulsboro Marine Terminal) using the higher adjusted mortality rates for that location that were based on 10 years for the USACE BiOp.

Few mitigation measures would be effective at reducing collisions between ESA-listed fish and vessels; the time spent below the surface makes their observation extremely difficult, therefore reducing the effectiveness of trained PSOs to mitigate vessel strike risk. Nevertheless, mitigation measures such as vessel speed restrictions could reduce the risk of potential collisions. However, some unavoidable effects on ESA-listed fish may occur, primarily due to the difficulty in detecting individuals. Therefore, the measures discussed above are assumed to provide limited effectiveness at reducing vessel strike risk to ESA-listed fish. Given these adjusted mortality rates for Paulsboro Marine Terminal (NMFS 2022), Sparrows Point and the C&D Canal to the Lease Area (above) the potential for vessel strikes of Atlantic or shortnose sturgeon to occur is not insignificant or discountable. Therefore, the potential for adverse effects (vessel strike) from the Proposed Action **may affect, likely to adversely affect** Atlantic sturgeon and shortnose sturgeon.

Vessel strikes of elasmobranch species, in general, are extremely rare. Giant manta rays are found in open water, feeding over reefs, or visiting shallow cleaning stations in certain areas. Although data are limited, there is some evidence of vessel strikes on giant manta rays. Researchers in Florida reported five giant manta rays that showed propeller scars (NOAA 2021). Giant manta rays may be agile enough to avoid most vessel collisions; however, there is little evidence supporting this theory (NOAA 2021). There is a very small likelihood that giant manta rays would be expected to occur within the vessel transit areas and at the surface at the same time vessels may be present. Relatively few trips between the Gulf of Mexico and the Project area may occur depending on the port of origin for WTG components and vessel availability. This low likelihood of interaction results in an unlikely occurrence of a vessel strike. Based on the best available information on vessel strike risks associated with the Proposed Action, the risk of vessel strike with a giant manta ray is extremely unlikely to occur. Therefore, potential adverse effects from the Proposed Action to giant manta ray would be **discountable,** and vessel strikes resulting from Proposed Action **may affect, but it is not likely to adversely affect** giant manta rays.

The same mechanisms and stressors associated with vessel strike risk analyzed previously in this section for Project construction, O&M, and decommissioning activities would apply to vessel activity associated with fisheries and habitat monitoring surveys under the Proposed Action. In addition, the same monitoring and mitigation measures for all ESA-listed species would be implemented during all fisheries and habitat monitoring surveys. The extent of monitoring surveys will not significantly increase regional vessel traffic as the number and duration of surveys will be minimal in comparison to other Project-related vessel activities occurring in the Project area. In consideration of monitoring program survey effort, and with the implementation of mitigation and monitoring measures, the potential for vessel strikes would be **discountable** for Atlantic sturgeon, shortnose sturgeon, and giant manta rays.

As discussed in Section 6.4.4, large shipping vessel traffic, commercial fishing traffic, recreational fishing traffic, and pleasure vessel traffic may be displaced due to the presence of the Project structure. However, on a small distance of displacement is expected for large shipping vessel traffic, and the overall volume of shipping vessel traffic will not be affected, this displacement is unlikely to result in a change in risk to any ESA-listed fish. Additionally, given the regionally high levels of baseline vessel traffic (Section 3.2.1.1.7), a shift in fishing vessel activity is unlikely to result in a substantial change in risk to ESA-listed fish; potential effects from vessel traffic displacement are therefore considered **discountable** for Atlantic sturgeon, shortnose sturgeon, and giant manta rays.

Overall, based on the risk of effect from Project construction, O&M, and decommissioning vessel traffic; fisheries and habitat monitoring survey vessel traffic; and vessel traffic displacement described in this section, as well as the proposed mitigation measures, the effects of vessel traffic **may affect, likely to adversely affect** shortnose and Atlantic sturgeon and **may affect, but it is not likely to adversely affect** giant manta ray.

6.5 Habitat Disturbance (C, O&M, D)

6.5.1 Temporary Seafloor Disturbances (C)

Temporary disturbances of the seafloor during construction could occur during installation of the WTG, OSS, and Met Tower foundations and associated scour protection; cable installation activities; vessel anchoring and jack-up; seabed preparation activities at the OSS locations; fisheries monitoring survey activities; and cofferdam installation using gravity-based structures. The total area of temporary seafloor disturbance resulting from the Proposed Action during all 3 construction phases is provided in Table 6-34.

Table 6-34. Estimated temporary seafloor disturbance resulting from Project construction for all 3 phases of the Proposed Action

Component	Disturbance Area (acres)	Disturbance Area (km^2)
Vessel anchoring	15.57	0.06
Offshore export cable installation	34.00	0.14
Inter-array cable installation	29.98	0.12
Jack-up vessels (used during WTG, OSS, and Met Tower foundation installation)	62.27	0.25
Inshore export cable installation	168.27	0.68
HDD gravity-based cofferdam installation (barrier beach landfall and onshore substation HDDs)	1.78	0.00
Total Temporary Disturbance	**311.87**	**1.13**

Source: COP, Volume II, Section 1.3, US Wind 2023

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). In areas of seafloor disturbance, benthic habitat recovery and mobile and sessile benthic infaunal and epifaunal species abundances may take 1 to 3 years to recover to preimpact levels (e.g., Hirsch et al. 1978; Germano et al. 1994; Kenny and Rees 1994; Collie et al. 2000; Department for Business, Enterprise and Regulatory Reform 2008; Gerdes et al. 2008; AKRF et al. 2012; Carey et al. 2020; Guarinello and Carey 2022). Based on a review of impacts of sand mining in the U.S. Atlantic and Gulf of Mexico, soft-bottom communities within the cable routes would recover within 3 months to 2.5 years (Brooks et al. 2006; Kraus and Carter 2018; Normandeau Associates 2014). A separate review of case studies from cable installations in Atlantic and Pacific temperate zones concluded that recovery of benthic communities on the OCS (less than a 262-feet [80-meters] depth) occurs within a few weeks to 2 years after plowing, depending on the available supply of sediment (Brooks et al. 2006). Recovery time varies somewhat with the method of installation, with more rapid recovery after plowing than jetting (Kraus and Carter 2018). However, the actual mechanisms of recovery are highly complex and site-specific; recovery to baseline conditions may take much longer in some areas and for some benthic species. Generally, soft-bottom habitats are more rapidly restored following a disturbance compared to complex or hard-bottom habitats (Collie et al. 2000).

Benthic habitat recolonization rates depend on the benthic communities in the area surrounding the affected region. Sand sheet and mobile sand with gravel habitats are often more dynamic in nature; therefore, they are quicker to recover than more stable environments, such as fine-grained (e.g., silt) habitats and rocky reefs (Dernie et al. 2003). Species inhabiting these dynamic habitats are adapted to deal with physical disturbances (e.g., frequent sedimentation associated with strong bottom currents and ground swell). As such, these communities are expected to recolonize more quickly after a disturbance than communities not well-adapted to frequent disturbance (e.g., cobble and boulder habitats). Mobile species may be indirectly affected by the temporary reduction of benthic forage species; however, given the prevalence of similar habitat in the area, this is likely to have a nominal effect.

Seafloor-disturbing activities during O&M of the Proposed Action are only expected during non-routine maintenance that may require uncovering and reburying the cables or the maintenance of the cable protection. These O&M activities are expected to result in similar impacts on benthic resources as those discussed for construction and could therefore temporarily displace ESA-listed species due to decreased available forage; however, the extent of disturbance would be limited to specific areas along the Offshore Export Cable Route centerline. The footprint of the Offshore Export Cable Route is relatively small compared to the surrounding available benthic/prey habitat.

Only intermittent, localized cable maintenance is predicted during the O&M phase of the Proposed Action. In case of insufficient burial or cable exposure, whether attributable to natural or human causes, appropriate remedial measures will be taken, including reburial or placement of additional protective measures. If a cable failure occurs, an appropriate cable repair spread will be mobilized. During these remedial activities, if they occur, sediment plumes would be limited to directly above the seafloor and not extend into the water column. Suspended sediments due to jet plowing are expected to remain localized to the area of disturbance and settle quickly to the seafloor. Elevated turbidity levels would be short term, highly localized, and temporary.

Many vessels for the Project would be equipped with dynamic positioning systems, but some anchoring would be required to support specific construction activities. Increased vessel anchoring, along with cable laying and other construction activities during construction and decommissioning, would cause increased turbidity levels, which would be staggered, localized, and short term.

6.5.1.1 Marine Mammals

Given the range of benthic habitat present in the Project area (Section 3.2.1.1.2), some displacement of benthic prey resources for marine mammals may occur, but this is expected to be temporary. Seafloor disturbances for the Proposed Action would be up to 311.87 acres (1.13 km^2), and recovery following the disturbance would be expected within 1 to 3 years. The only forage fish species for marine mammals expected to be impacted by physical disturbance of sediment would be the sand lance. The only marine mammal species that may feed on benthic prey species are fin whales, which may feed on sand lance in the Project area (Section 5.1.1.1). However, there are no identified BIAs for foraging for any marine mammal species within the Project area; the nearest BIA is for fin whale foraging between Montauk, New York, and Nantucket, Massachusetts, which would not be affected by any temporary disturbances resulting from the Proposed Action. Additionally, there is no evidence to suggest that fin whales occurring within this region feed exclusively on sand lance; the species is expected to utilize other pelagic prey resources within the Project area, which would minimize impacts as a result of potential seafloor disturbances.

Given the limited overlap with important benthic feeding habitats for ESA-listed marine mammals, and the temporary, localized nature of the disturbance, effects from seafloor disturbance would be so small that they could not be meaningfully measured, detected, or evaluated and are **insignificant**. Therefore, effects of seafloor disturbance from the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed marine mammals.

6.5.1.2 Sea Turtles

Construction of the Proposed Action would result in temporary disturbances of the seafloor within the Project area, as provided in Table 6-34. After Project construction activities are completed, areas of temporary disturbance should return to the baseline state. Seafloor disturbances could directly impact benthic species such as mollusks and crabs, which are prey for some sea turtle species. Leatherback sea turtles (Section 5.1.2.3) are dietary specialists, feeding almost exclusively on pelagic jellyfish, salps, and siphonophores, rather than prey species affected by benthic habitat alteration.

Green, Kemp's ridley, and loggerhead sea turtles all may feed on benthic organisms, though some degree of behavioral plasticity is evident for all species. Once mature, green sea turtles leave pelagic habitats and enter benthic foraging grounds, primarily feeding on seagrasses and algae (Bjorndal 1997), although they will occasionally feed on sponges and invertebrates (NMFS 2022d). 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). Although loggerhead sea turtles are dietary specialists, the species demonstrates the ability to adjust its diet in response to changes in prey availability in different geographies (Plotkin et al. 1993; Ruckdeschel and Shoop 1988); juvenile loggerhead sea turtles are likely better adept at responding to changing environmental conditions than adults (Cardona et al. 2017).

Benthic habitat disturbances are anticipated to be temporary, localized, and unlikely to affect the availability of prey resources for these species. Although the Project would temporarily impact benthic prey resources, those effects would be temporary and limited very small percentage of the Project area, and an even smaller percentage of suitable foraging habitat in nearshore areas of the Atlantic OCS. No seagrass beds were observed within the Project Lease Area, along the Offshore Export Cable, inter-array cable, or Inshore Export Cable Routes (US Wind 2023), and seagrasses would therefore not be affected by any temporary seafloor disturbances under the Proposed Action. Given the Project area is naturally dynamic and exposed to anthropogenic disturbance (Section 3.2.1.1), the species that occur in this region likely are able to adjust their foraging behavior based on prey availability. Green and Kemp's ridley sea turtles are omnivorous species with flexible diets, and loggerhead sea turtles readily target new prey species to adapt to changing conditions.

Given the limited amount of foraging habitat exposed to construction disturbance, the temporary and localized nature of these effects, and the ability of these sea turtle species to adjust their diet in response to resource availability, the resulting effects of temporary seafloor disturbance on these species would be **insignificant** and **may affect, but are not likely to adversely affect** ESA-listed sea turtles.

6.5.1.3 Marine Fish

Construction of the Proposed Action would result in temporary and permeant disturbances of the seafloor within the Project area, as provided in Table 6-34. After Project construction activities are completed, areas of temporary disturbance should return to the baseline state. Although Proposed Action construction would kill or displace preferential prey organisms (invertebrates such as crustaceans, worms, and mollusks; bottom-dwelling fish such as sand lance) within the footprint of the foundations, scour protection, and cable routes, these effects would be temporary and limited to a very small area of available foraging habitat in the Project area.

Atlantic sturgeon are known to eat a variety of benthic organisms and are believed to be opportunistic feeders based on 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). As discussed in Section 5.1.3.2, shortnose sturgeon forage on invertebrates in the sandy and muddy bottoms of rivers. 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 and shortnose sturgeon. Given their generalist feeding behaviors and the limited total area of potential habitat disturbance, Atlantic sturgeon are unlikely to be affected by the effects of short-term, localized, seafloor disturbance. Given their habitat preferences, shortnose sturgeon are also unlikely to be affected by the effects of short-term, localized, seafloor disturbance. The giant manta ray is a pelagic species that feeds on planktonic organisms and, therefore, will not be affected by seafloor disturbances. Therefore, seafloor disturbance as a result of one project will have **no effect** on giant manta ray.

Given the limited extent of effects and the likelihood of rapid recovery to baseline benthic community conditions, the effects of seafloor disturbance from the Proposed Action are likely to be **insignificant** and **may affect, but are not likely to adversely affect** Atlantic and shortnose sturgeon.

6.5.2 Turbidity (C)

Construction of the Proposed Action is likely to result in elevated levels of turbidity in the immediate proximity of seafloor disturbing activities like pile driving, placement of scour protection, seabed preparation activities at the OSS locations, vessel anchoring, and burial of the inter-array and offshore export cables. There would be temporary increases in sediment suspension and deposition during activities that involve seafloor disturbance. The Proposed Action would include up to 311.87 acres (1.13 km^2; Table 6-34) of temporary seafloor disturbance from cable installation, which would result in turbidity effects potentially having temporary impacts on some marine mammal prey species. In general, plumes generated during trenching of offshore areas would be limited to directly above the seafloor and not extend into the water column. Suspended sediments due to jet plowing are expected to remain localized to the area of disturbance and settle quickly to the seafloor.

The sediment transport model conducted for the COP (Volume II, Appendix B2; US Wind 2023) indicated sediment displacement would generally remain in a narrow corridor along the Offshore Export and Inter-array Cable Routes. Most fluidized sediment in the water column is expected to settle quickly back to the seafloor following jet plow activities. Suspended sediment concentrations are predicted to be less than 200 mg/L at distances greater than 450 feet (137 meters) during trenching for the offshore export and inter-array cables. Concentrations greater than 10 mg/L over ambient conditions are anticipated for a short duration (hours); all sediment plumes are expected to settle out of the water column entirely within 24 hours after completion of jetting operations (COP, Volume II, Appendix B2; US Wind 2023). In conclusion, the sediment transport modeling results indicate the proposed jet plow embedment process for cable installation will result in short-term and localized effects (COP, Volume II, Appendix B2; US Wind 2023).

6.5.2.1 Marine Mammals

The NMFS Greater Atlantic Region has developed a white paper on turbidity and total suspended solids (TSS) effects on ESA-listed species for the purpose of Section 7 consultation (Johnson 2018). The agency concluded that elevated TSS could result in effects on ESA-listed whale species under specific circumstances (e.g., high TSS levels over long periods during dredging operations), but insufficient information is available to make ESA effect determinations. In general, marine mammals are not subject to effects mechanisms that injure fish (e.g., gill clogging, smothering of eggs and larvae), so injury-level effects are unlikely. Behavioral effects, including avoidance or other changes in behavior, increased stress, and temporary loss of foraging opportunity, could occur but only at excessive TSS levels (Johnson 2018). Todd et al. (2015) postulated that dredging and related turbidity effects could affect the prey base for marine mammals, but the significance of those effects would be highly dependent on site-specific factors. Small-scale changes from one-time, localized activities are not likely to have significant effects.

Data are not available regarding whales' avoidance of localized turbidity plumes; however, Todd et al. (2015) suggested that since marine mammals often live in turbid waters, significant effects from turbidity are not likely. If elevated turbidity caused any behavioral responses (e.g., avoiding the turbidity zone, changes in foraging behavior), such behaviors would be temporary, and any negative effects would likewise be short term and temporary. Cronin et al. (2017) suggested NARWs may use vision to find copepod aggregations, particularly if they locate prey concentrations by looking upwards. However, Fasick et al. (2017) indicated NARWs 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). These studies indicate whales, including NARWs, are likely able to forage in low-visibility conditions and could continue to feed in elevated turbidity. 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 the turbidity zone or once the suspended sediment settled out of the water column.

Increased turbidity effects during construction and decommissioning could impact the prey species of marine mammals. Studies of the effects of turbid water on fish suggest 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 ceases.

NARWs feed almost exclusively on copepods. Of the different kinds of copepods, NARWs feed especially on late-stage *C. finmarchicus*, a large calanoid copepod (Baumgartner et al. 2007), as well as *Pseudocalanus* spp. and *Centropages* spp. (Pace and Merrick 2008). Because a NARW's mass is 10 or 11 orders of magnitude larger than that of its prey, this species is very specialized and restricted in their habitat requirements, i.e., 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 (NMFS 2022d). Fin whales feed by lunging into schools of prey with their mouth open, gulping large amounts of food and water. A fin whale eats up to 4,000 pounds (1,814 kg) of food every day during the summer (NMFS 2022d). 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 (e.g., copepods, krill), small schooling fish, and cephalopods (e.g., squid) by gulping and skimming (NMFS 2023h).

Anticipated TSS levels for the Project are below those expected to result in mortality of fish preyed on by fin or sei whales. 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, 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).

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 percent 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 Project 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 forage fish is expected; therefore, no reduction in fish as prey for fin or sei whales is anticipated.

Sperm whales hunt for food during deep dives, with feeding occurring at depths of 1,640 to 3,281 feet (500 to 1,000 meters) (NMFS 2023i). Deepwater squid make up the majority of sperm whales' diet (NMFS 2023i). Given the relatively shallow depths of the Project area where sedimentation would occur (Section 3.2), it is extremely unlikely sperm whales would be foraging in the area affected by sedimentation and any potential sperm whale prey would be affected by sedimentation.

Elevated suspended sediment concentrations are expected to be limited in magnitude, short term in duration, and likely within the range of natural variability. This limited temporal effect over a relatively small area is not expected to interfere with foraging success of ESA-listed species. Therefore, effects from increased turbidity are expected to be localized, temporary, non-measurable, and **insignificant**. Increased turbidity associated with the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed marine mammals.

6.5.2.2 Sea Turtles

NMFS concluded that although scientific studies and literature are lacking, the effects of elevated TSS on ESA-listed sea turtles are likely to be similar to the expected effects on marine mammals (Johnson 2018). Physical or lethal effects of increased turbidity during Project construction and decommissioning are unlikely because sea turtles are air-breathing and land-brooding, and, therefore, do not share the physiological sensitivities of susceptible organisms like fish and invertebrates. Additionally, sediment transport modeling conducted for the Proposed Action indicated short-term, localized increases in turbidity around the cable routes that would be expected to settle quickly once jet plow activities had ceased (COP, Volume II, Appendix B2; US Wind 2023).

Elevated suspended sediment concentrations may cause individuals to alter normal movements and behaviors (e.g., moving away from an affected area). Affected animals may also experience behavioral stressors, such as 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 limited in severity and extent without consequence. As a result, these behavioral changes are expected to be limited in extent, short term in duration, and likely too small to be detected (NOAA 2021). Moreover, many sea turtle species routinely forage in nearshore and estuarine environments with periodically high natural turbidity levels. Therefore, short-term exposure to elevated suspended sediment levels is unlikely to measurably inhibit foraging (Michel et al. 2013). However, elevated levels of turbidity may negatively affect sea turtle prey items, including benthic mollusks, crustaceans, sponges, and sea pens, by clogging respiratory apparatuses. More mobile prey items like crabs may also be negatively affected by turbidity by clogging their gills, though likely to a lesser extent due to their ability to leave the turbid area (BOEM 2021). Only short-term, limited impacts to fish and invertebrates are expected from suspended sediments; therefore, secondary effects on sea turtle prey availability are not expected. Any effects from increased turbidity levels from construction activities on sea turtles, their habitat, or their prey would be isolated, temporary, and so small that they could not be measured and are, therefore, **insignificant**. Increased turbidity associated with the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed sea turtles.

6.5.2.3 Marine Fish

Studies of the effects of turbid water on fish suggest concentrations of suspended solids can reach thousands of milligrams per liter before an acute reaction is expected (Wilber and Clarke 2001). Johnson (2018) recommended 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 that 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 percent survived the test, indicating the impacts of sediment plumes in natural settings are minimal where fish can move or escape. 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). Given this, adult and subadult sturgeon expected to occur in the Project area are likely tolerant of elevated suspended sediment levels.

The giant manta ray is a pelagic species that is able to swim through or temporarily avoid areas of elevated turbidity. The ability for the giant manta ray to inhabit varying water depths, including offshore waters, will allow it to seek favorable water quality conditions if exposed to localized sediment plumes. Any increases in turbidity as a result of the Proposed Action are expected to be temporary and localized; as a result, no impact to primary production would occur and foraging resources for the giant manta ray would not be adversely affected to a measurable or detectable level.

Atlantic and shortnose sturgeon are benthivores that feed primarily on various invertebrates; therefore, suspended sediment and turbidity could result in some temporary avoidance of turbid areas or feeding challenges. Any effects from elevated turbidity levels from the Proposed Action on Atlantic and shortnose sturgeon or their prey are considered so small that they could not be measured. Fish 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, but short-term increases in turbidity (COP, Volume II, Appendix B2; US Wind 2023) are expected to result in minor, non-measurable effects. In addition, suspended sediment concentrations during activities other than cable emplacement would be within the range of natural variability for this location. The effects of elevated turbidity on Atlantic and shortnose sturgeon and giant manta rays would be so small that they could not be measured and are, therefore, **insignificant**. Increased turbidity associated with the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed fish species.

6.5.3 Dredging During Installation of the Inshore Export Cable

As described in Section 3.1.3, US Wind has determined that dredging will be required to support installation of the inshore export cables to precede cable installation along portions of the cable route for barge access. The proposed Inshore Export Cable Route would traverse through Indian River Bay, as depicted in Figure 3-8.

Dredging would be conducted using mechanical, or most likely, hydraulic means. The specific type of hydraulic method to be used is not known yet. The maximum volume of dredging, assuming all four cables were installed within both the northern and southern Inshore Export Cable Routes is estimated to approximately 390,648 cubic yards (298,6712 cubic meters). Installation of the four inshore export cables associated with all Project development phases would occur within and along the same Inshore Export Cable Route

Under the Proposed Action, it is anticipated that the dredged material would be deposited within the construction corridor approximately 633 feet (193 meters) on either side of the centerline of the Inshore Export Cable Route using a floating pipeline system, barge, or scow. Dredge material disposal would occur within the surveyed Inshore Export Cable Route in areas with compatible physical and chemical characteristics. The sediment habitat within the Indian River Bay consists of a 100% soft bottom (Section

3.2.1.1.2). Furthermore, the sediments will have to meet State standards prior to placement. Installation of the inshore export cable is anticipated to occur over an approximate 21-month period between the third quarter of 2024 and the second quarter of 2026 (Table 3-14). US Wind assumes all construction within Indian River Bay, including any dredging, would occur in the October through March window, observing the general time of year restrictions for summer flounder and other species. Time of year restrictions would be determined through consultations with DNREC.

Dredging, by definition, is the mechanical alteration or removal of seafloor sediments; therefore, potential impacts from seafloor disturbance can be expected as a result of inshore dredging activities. Impacts from seafloor disturbance during Project construction activities are described in Section 6.5.1; however, inshore dredging presents different impacts from those expected during offshore construction. The ESA-listed species that may occur within Indian River Bay and, therefore, may potentially be affected by seafloor disturbance during inshore dredging include green, Kemp's ridley, and loggerhead sea turtles as well as Atlantic and shortnose sturgeon. However, pelagic species that typically do not inhabit or utilize inshore areas (i.e., ESA-listed marine mammals, leatherback sea turtles, and giant manta rays) are not expected to occur in any potential inshore dredge location in Indian River Bay and therefore are not expected to be affected by seafloor disturbance during inshore dredging.

Based on the characteristics of expected dredging locations and the likelihood these locations have already been subject to maintenance dredging and currently support commercial vessel traffic, seafloor impacts to sea turtles and Atlantic sturgeon and potentially shortnose sturgeon are expected to be temporary and localized. Dredging may impact soft-bottom benthic habitats and invertebrates; however, the effect on invertebrates would likely be minor and have insignificant impacts to prey resources. Sea turtles and sturgeon may be indirectly affected by the temporary reduction of benthic forage species, but these impacts are expected to be minimal given that foraging habitat in the expected dredge areas is already disturbed, would be seasonally impacted (seasonal exclusion), and probably does not represent significant foraging habitat.

Turbidity effects on ESA-listed species are discussed in Section 6.5.2. Dredging is expected to result in temporary increases in turbidity. Most marine species have some degree of tolerance to higher concentrations of suspended sediment because storms, currents, and other natural processes regularly result in increases in turbidity (Minerals Management Service 2007). The potential effects of turbidity during dredging for the installation of the inshore export cables would be the same as that described in Section 6.5.2, except for the species present.

As discussed previously, ESA-listed marine mammals, leatherback sea turtles, and giant manta rays would not be exposed to inshore dredging activities; therefore, there would be **no effect** on these species. Based on the expected scale of potential dredging activities described earlier, it is reasonable to conclude that the risk impacts to green, loggerhead, and Kemp's ridley sea turtles as well as Atlantic and shortnose sturgeon resulting from seafloor disturbance for the Proposed Action would be **insignificant**. Effects of seafloor disturbance from dredging during installation of the inshore export cables under the Proposed Action **may affect, but it is not likely to adversely affect** green, loggerhead, and Kemp's ridley sea turtles as well as Atlantic and shortnose sturgeon.

6.5.4 Permanent Seafloor Habitat Loss (O&M)

Installation of WTGs, OSSs, the Met Tower, submarine cables, and associated scour and cable protection during construction would result in permanent habitat conversion and loss. Some soft-bottom seafloor habitat would be lost and converted to hard-bottom habitat due to the presence of permanent Project infrastructure. This habitat loss and conversion would last through the O&M phase and into decommissioning. An overview of the permanent footprint of the Proposed Action due to all Project components from all 3 phases is provided in Table 6-35. Habitat conversion of the pelagic environment due to the presence of vertical structures in the water column is considered in Section 6.5.5 and not assessed within this section.

Table 6-35. Estimated permanent habitat loss resulting from construction and operations of all 3 phases of the Proposed Action

Component	Disturbance Area (acres)	Disturbance Area (km^2)
WTGs, OSSs, and Met Tower foundations and scour protection	26.08	0.10
Cable protection	74.08	0.28
Total permanent footprint	**100.16**	**0.38**

Source: COP, Volume II, Section 1.3, US Wind 2023

6.5.4.1 Marine Mammals

The permanent loss of soft-bottom habitat in the Project area would not have substantial effects on ESA-listed marine mammals. The only forage fish anticipated to be negatively affected by this habitat loss would be sand lance. As discussed in Section 6.5.1.1, the only species considered in this BA that is known to feed on sand lance is the fin whale, and though these effects would be long term, the small area of converted habitat is not likely to have substantial effects on prey availability for fin whales. Additionally, there is no evidence to suggest fin whales occurring in this region feed exclusively on sand lance, and as discussed in Section 5.1.1.1 they may also feed on krill and other schooling fish such as capelin and herring (Borobia et al. 1995). The species likely would utilize other pelagic prey resources within the Project area, thereby minimizing potential impacts as a result of soft-bottom habitat loss. Effects from habitat loss would be so small that they could not be meaningfully measured, detected, or evaluated and are **insignificant** for fin whales. Changes in prey species relevant to all other ESA-listed marine mammals would largely result from the presence of structures, which is discussed and analyzed in Section 6.5.5. Given there are no BIAs for foraging identified within the Project area, the loss of soft-bottom habitat is not likely to affect prey or habitat availability for marine mammals, and the effects would be **discountable** for NARWs, sei whales, and sperm whales. Overall, permanent habitat loss due to the construction and operations of the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed marine mammals.

6.5.4.2 Sea Turtles

The permanent loss of soft-bottom habitat in the Project area could affect sea turtles. All species except the leatherback sea turtle are known to forage either partially or exclusively on benthic prey items (Section 5.1.2), which would be removed or altered following construction of the Project components listed in Table 6-35. However, there is no identified critical foraging habitat or biologically important foraging areas identified for any sea turtles within the Project area, and benthic prey items likely would return to the altered area to settle nearby (discussed further in Section 6.5.5.3). For green sea turtles specifically, there were no seagrass beds identified within the Project area (COP, Volume II, Section 7.0; US Wind 2023), so availability of food for this species is unlikely to be substantially affected. Additionally, all sea turtle species likely would have food available in areas outside the permanently altered footprint within the Project area. Given the limited extent of permanent habitat loss and the availability of prey resources outside the altered areas, the resulting effects of permanent habitat loss would be **insignificant** and **may affect, but are not likely to adversely affect** ESA-listed sea turtles.

6.5.4.3 Marine Fish

Long-term habitat loss from soft-bottom to hard-bottom conversion during O&M of the Project would occur through placement of monopiles, jacketed piles, scour protection, and cable protection. The presence of the WTGs, OSSs, Met Tower, scour protection, and cable protection would convert 100.16 ac

(0.38 km^2; Table 6-35) of existing soft-bottom to new hard-bottom habitat, which could lead to potential changes in foraging habitat for Atlantic sturgeon (Section 5.1.3.1). New, permanent hard-bottom habitat and vertical structures in a soft-bottom habitat can create artificial reefs, thus inducing the reef effect (Taormina et al. 2018), which is discussed and analyzed in Section 6.5.5.3.

The only forage fish anticipated to be negatively affected by habitat loss would be sand lance, where the Project would reduce habitat availability for sand lance. Although these effects would be long term, the small area of converted habitat is not likely to affect Atlantic sturgeon. Given the small, localized reduction in sand lance and that sand lance is only one of many species the Atlantic sturgeon may feed on in the Project 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 shortnose sturgeon is not expected to occur in the offshore areas (Baker and Howsen 2021), which is where the WTGs, OSSs, and Met Tower would be sited, but could occur in the nearshore waters where cables and cable protection would be installed. Therefore, the total extent of permanent habitat loss for the shortnose sturgeon is largely reduced and localized in comparison to the species' overall habitat extent. In addition, the shortnose sturgeon is a benthic-dwelling species that forages mainly invertebrates, including mollusks and crustaceans, the latter of which are not limited to only soft-bottom habitat and may actually benefit from an increase in hard-bottom substrate due to the reef effect. Given these feeding preferences, long-term habitat loss from soft-bottom to hard-bottom conversion is not likely to affect the shortnose sturgeon or their prey resources. As such, effects on shortnose sturgeon from permanent habitat loss are extremely unlikely to occur and **discountable**. The giant manta ray is a pelagic, migratory species often occurring at upwellings and is mainly a filter feeder. As a result, giant manta rays will not be directly impacted the loss of soft-bottom habitat. Effects due to the permanent presence of vertical structures in the water column may affect the giant manta ray, which is addressed in Section 6.5.5. Given this, effects on giant manta rays from permanent habitat loss are extremely unlikely to occur and **discountable**.

Based on the above analysis, permanent habitat loss as a result of the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed fish.

6.5.5 Presence of Structures (O&M)

Under the PDE includes up to 121 WTGs would be installed in a grid-like pattern with approximate spacing of 0.77 and 1.02 nautical miles (1.43 and 1.89 kilometers) between positions. The Project would also install up to four OSSs that would serve as common collection points for power from the WTGs as well as the origin for the offshore export cables that deliver power to shore. Additionally, one Met Tower would be installed at the western edge of the southernmost row within the Lease Area.

6.5.5.1 Behavioral Changes Due to the Presence of Structures (O&M)

The WTG, OSS, and Met Tower foundations are vertical structures that constitute obstacles in the water column that could alter the normal behavior of marine mammals in the Project area during operations, whereas cable protection would predominantly affect benthic prey species through the introduction of new hard-bottom habitat, as discussed in Section 6.5.4.

6.5.5.1.1 Marine Mammals

The long-term presence of Project structures could displace marine mammals from preferred habitats or alter movement patterns; however, there are limited data on the potential effects directly associated with the presence of physical structures in the water column. The evidence for long-term displacement is unclear and varies by species. Five turbines constituting Block Island Wind Farm and two pilot turbines for the Coastal Virginia Offshore Wind Pilot Project have not presented data with observable changes in marine mammal movement (NMFS 2015a,b). Russel et al. (2014) found clear evidence that seals were attracted to a European wind farm, apparently exploiting the abundant concentrations of prey produced by reef effects, while Teilmann and Carstensen (2012) documented the apparent long-term displacement of harbor porpoises from previously occupied habitats within and around a wind farm in the Baltic Sea. 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 available data were insufficient to determine the presence or absence of significant effects. Displacement effects remain a focus of ongoing study (Kraus et al. 2019).

Research on the behavioral and displacement effects of offshore structures is equivocal. Delefosse et al. (2018) reviewed marine mammal sighting data around oil and gas structures in the North Sea and found no clear evidence of species attraction or displacement. Marine mammals, including baleen whales, have been regularly sighted around offshore oil and gas platforms (Barkaszi and Kelly 2019; Delefosse et al. 2018; Todd et al. 2020), suggesting the physical presence of a structure in OCS waters did not deter individuals from utilizing the same area of habitat. Increased localized biomass, which includes clupeid species, has been documented for oil and gas installations operating at less than 100 feet (30 meters) in the North Sea (Delefosse et al. 2018), which indicates a key prey item for fin and sei whales would not be negatively affected.

The upper range of whale lengths are as follows: NARW (59 feet [18 meters]), fin whale (79 feet [24 meters]), sei whale (59 feet [18 meters]), and sperm whales (59 feet [18 meters]) (Wynne and Schwartz 1999). For reference, approximately 80, 59-ft (18-m) long NARWs (large females) would fit end-to-end between two foundations spaced at 0.77 and 1.02 nautical miles (1.43 and 1.89 kilometers). Based on a simple assessment of spacing, it does not appear the WTGs would be a barrier to the movement of any ESA-listed marine mammal species in the Project area.

As discussed in Section 5.1.1.2, NARWs engage in a common social behavior called a SAG, in which two or more individuals interact at the surface (Kraus and Hatch 2001). Reported group sizes can be quite large; Parks (2003) reported a range of group sizes, from 2 to 40 individuals with a mean of 3.7 individuals, in SAGs in the Bay of Fundy. SAGs have been observed in calving grounds off the Southeast U.S. and in foraging grounds off the Northeast U.S., occur year-round, and likely serve a range of behavioral and social functions (Parks et al. 2007). While no published reports exist that indicate the presence of SAGs in the vicinity of the Lease Area, SAG occurrence in habitat areas other than foraging and calving grounds (including the mid-Atlantic) cannot be ruled out; however, mid-Atlantic waters do not appear to represent a significant portion of SAG behavior for individuals migrating though the Project area. As such, if they were to occur, group sizes would be expected to be closer to the mean (3.7 individuals), and the physical distance between turbines would therefore not likely pose a barrier or obstruction to individuals engaged in SAG behaviors.

The presence, spacing, and size of the offshore wind structures are not expected to pose barriers to movement of ESA-listed marine mammals. Furthermore, cetaceans are documented around similar offshore structures in other parts of the world. Based on the limited information available regarding habitat use and changes in behavior resulting from the physical presence of offshore structures, any effects would be so minor they cannot be meaningfully measured and, therefore, **insignificant** for ESA-listed marine mammals. Behavioral changes due to the presence of structures under the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed marine mammals.

6.5.5.1.2 Sea Turtles

Sea turtles are known to be attracted to offshore energy structures (Lohoefener et al. 1990; Valverde and Holzwart 2017; Viada et al. 2008). Studies have shown that sea turtles incorporate oil and gas platforms in core areas within their home ranges (Valverde and Holzwart 2017) and utilize offshore structures for foraging, resting, and other behaviors (Klima et al. 1988). The presence of structures create an artificial habitat that can provide multiple benefits for sea turtles, including foraging habitats, shelter from predation and strong currents, and methods of removing biological buildup from their carapace (NRC 1996; Barnette 2017). High concentrations of sea turtles have been reported around oil platforms (NRC 1996); during a surface survey at a platform off the coast of Galveston, Texas, approximately 170 sea turtle sightings were reported (Gitschlag 1990). Multiple species, including green, hawksbill, and loggerhead sea turtles, have been observed using anthropogenic structures and submerged rocks to remove biological buildup from their flippers and carapace (Barnette 2017). In the Gulf of Mexico, loggerhead and leatherback sea turtles were often observed resting at oil and gas platforms, and it is possible these species may behave similarly at wind farm structures (Gitschlag and Herczeg 1994; NRC 1996). These studies suggest anthropogenic structures on the OCS may provide a beneficial habitat resource for sea turtles in the region.

Based on the expected WTG spacing (0.77 and 1.02 nautical miles [1.43 and 1.89 kilometers] between positions), ESA-listed sea turtles present in the Project area would not be obstructed from transiting through the wind farm, and the structures would not be a barrier to the movement of any ESA-listed sea turtle species through the Project area.

The presence, spacing, and size of the offshore wind structures are not expected to pose barriers to movement of ESA-listed sea turtles. Furthermore, sea turtles are well-documented around similar offshore structures in the Gulf of Mexico, California, and other parts of the world. Based on the ability to move among structures and documented use of offshore structures, the effects from the physical presence of offshore structures, if any, would be considered highly unlikely and **discountable**. Therefore, behavioral changes due to the presence of structures from the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed sea turtles.

6.5.5.1.3 Marine Fish

Based on the expected WTG spacing (0.77 and 1.02 nautical miles [1.43 and 1.89 kilometers] between positions), ESA-listed fish species present in the Project area would not be obstructed from transiting through the wind farm, and the structures would not be a barrier to the movement of any ESA-listed fish species through the Project area. As primarily demersal species, Atlantic sturgeon may be displaced by WTGs and their scour protection; however, the area occupied by the WTGs and their scour protection is an extremely small portion of sturgeon's available habitat. Furthermore, Atlantic sturgeon are not limited by prey or marine habitat availability. Giant manta rays are pelagic and feed on planktonic organisms, and the largest documented wingspan for this species is 29 feet (9 meters; NMFS 2022a). Movements associated with feeding and migrating would not be obstructed by the placement of Project infrastructure foundations.

The presence, spacing, and size of the offshore wind structures are not expected to pose barriers to movement of ESA-listed fish species. Based on the ability to move among structures, the effects from the physical presence of offshore structures, if any, would be considered highly unlikely and **discountable**. Therefore, behavioral changes due to the presence of structures under the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed fish species. Shortnose sturgeon are not present in the Lease Area and **no effect** is therefore expected for this species due to the presence of Project WTG foundations.

6.5.5.2 Changes in Oceanographic and Hydrologic Conditions Due to Presence of Structures (O&M)

Offshore wind facilities could impact atmospheric and oceanographic processes through the presence of structures and the extraction of energy from the wind. The presence of vertical structures in the water column, such as WTG and OSS foundations and associated scour protection, could affect hydrodynamic circulation at local scales. Vertical structures extending from the water surface will affect currents as they flow by the structures, creating turbulence. That turbulence can increase mixing between bottom and surface layers, potentially affecting stratification, nutrient circulation, and larval dispersal (Carpenter et al. 2016; Floeter et al. 2017; Schultze et al. 2020). Additionally, WTGs intercept wind energy that would otherwise contribute to ocean mixing (van Berkel et al. 2020). While considerable uncertainty remains, these conclusions are most likely applicable to offshore wind facilities developed in environments with strong seasonal stratification (Miles et al. 2021; van Berkel et al. 2020).

Waters in the Project area are seasonally stratified, with warmer waters and higher salinity leading to strong stratification in the summer (Section 3.2.1.1.3). This stratification effect contributes to the formation of the Cold Pool, a band of cold, near-bottom water extending across much of the Middle Atlantic Bight from spring through fall (Lentz 2017). Mixing effects around pile foundations are masked in strongly stratified environments as the presence of the foundations reduces wind speed and stress within the wind farm which leads to less mixing (Schultze et al. 2020; Afsharian et al. 2020; van Berkel et al. 2020), meaning the same factors that form and maintain the Cold Pool are likely to limit the extent of measurable hydrodynamic effects. Localized mixing will still occur, however, bringing nutrients to the surface that can enhance phytoplankton growth and primary productivity at local scales (Floeter et al. 2017). However, Dorrell et al. (2022) hypothesized that the presence of offshore wind turbines can increase mixing in stratified waters which could result in a strengthened thermocline that would affect surface water characteristics across the ocean-atmosphere interface. This effect could have consequences for heat storage, CO_2 uptake and benthic O_2 resupply, though data on these are currently limited and will likely depend on local conditions and infrastructure specifics (Dorrell et al. 2022).

The implications of these hydrodynamic effects for ESA-listed species are unclear. The limited research conducted to date has not been able to distinguish hydrodynamic effects on the fish and invertebrate community from natural variability (van Berkel et al. 2020). Filter-feeding invertebrate colonies that form on the monopile foundations likely would benefit from hydrodynamic effects that lead to localized increases in phytoplankton production (Slavik et al. 2019; Dorrell et al. 2022). Stronger mixing at the thermocline could also alter the light available for phytoplankton which could hinder photosynthesis, so the net effect on phytoplankton would depend on some balance between these two effects (Dorrell et al. 2022).

Additionally, studies have shown that the presence of turbines can alter water surface temperatures within a wind farm. Afsharian et al. (2020) examined the effects of offshore wind in Lake Erie and found that the reduced wind speeds and wind stress from the turbines with hub heights of approximately 459 feet (140 meters) increased the surface temperatures. Conversely, Golbazi et al. (2022) found that turbines with hub heights between 328 and 492 feet (100 and 150 meters) decreased temperatures at the water's surface on average approximately 0.06 Kelvin likely as a result of altered wind speeds and heat fluxes at the hub height.

The general understanding of offshore wind-related impacts on hydrodynamics is derived primarily from European studies. A synthesis of European studies by van Berkel et al. (2020) summarized the potential effects of WTGs on hydrodynamics, the wind field, and fisheries. Local to a wind facility, the range of potential impacts include increased turbulence downstream, remobilization of sediments, reduced flow inside wind farms, downstream changes in stratification, redistribution of water temperature, and changes in nutrient upwelling and primary productivity.

Manmade structures, especially tall vertical structures such as foundations, alter local water flow at a fine scale by potentially reducing wind-driven mixing of surface waters or increasing vertical mixing as water flows around the structure (Segtnan and Christakos 2015; Carpenter et al. 2016; Cazenave et al. 2016; Forster et al. 2018). When water flows around the structure, turbulence is introduced that influences local current speed and direction. Turbulent wakes have been observed and modeled at the kilometer scale (Vanhellemont and Ruddick 2014; Cazenave et al. 2016; Forster et al. 2018; Johnson et al. 2021). While impacts on current speed and direction decrease rapidly around monopiles, there is a potential for hydrodynamic effects out to a kilometer from a monopile (Li et al. 2014). Direct observations of the influence of a monopile extended to at least 984 feet (300 meters) but was indistinguishable from natural variability in a subsequent year (Schultze et al. 2020). The range of observed changes in current speed and direction 984 to 3,281 feet (300 to 1,000 meters) from a monopile is likely related to local conditions, wind farm scale, and sensitivity of the analysis.

The presence of vertical structures in the water column could 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) exhibited 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 WTGs (Carpenter et al. 2016; Grashorn and Stanev 2016; Forster et al. 2018; Schultze et al. 2020; Dorrell et al. 2022).
3. Up- 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 (Brostörm 2008; Paskyabi and Fer 2012; Ludewig 2015; Floeter et al. 2022). Mean surface variability is between 1 and 10 percent.
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; Floeter et al. 2022). This observation also suggests impacts on seasonal stratification, as documented by 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 affect nutrient cycling and could influence the distribution and abundance of fish and planktonic prey resources (van Berkel et al. 2020). Daewel et al. (2022) modeled the effects of offshore wind farm projects in the North Sea on primary productivity and found that there were areas with both increased and decreased productivity within and around the wind farms. There was a decrease in productivity in the center of large wind farm clusters but an increase around these clusters in the shallow, near-coastal areas of the inner German Bight and Dogger Bank (Daewel et al. 2022). However, the authors noted that when integrated over a larger area, the local decreases and increases averaged to a nominal (0.2 percent) increase across the entire North Sea.

In the U.S. two available studies, summarized in Hogan et al. (2023), are available which modeled the effects of offshore wind in southern New England may affect zooplankton. Chen et al. (2021) modeled sea scallop larval transport and dispersal was affected by the Vineyard Wind project offshore Massachusetts and found that the presence of the WTG foundations altered the local vertical mixing and horizontal advections which affected the dispersal of sea scallop larvae. Specifically, the change in local hydrodynamics shifted larval dispersal to new locations that could affect sea scallop abundance in the region (Chen et al. 2021). Johnson et al. (2021) modeled water flow and turbulent wakes at turbine foundations in the Rhode Island-Massachusetts Wind Energy Area and found modifications in the current magnitude, water temperature, and wave heights resulting from the presence of the structures. The hydrodynamic models were also coupled with agent-based modeling of target species larval stages which found discernible increases and decreases in larval settlement associated with altered current directions and speeds from the WTG foundations (Johnson et al. 2021). However, these studies acknowledge the limited temporal coverage of their models which make it difficult to assess potential impacts at an ecosystem level.

Several other 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.

In general, the discussion above describes varying scales of impacts on the oceanographic and hydrologic processes as a result of the presence of structures. These impacts, mainly resulting from the extraction of kinetic wind energy by turbine operations and reduction in wind stress at the air-sea interface, can lead to changes in horizontal and vertical water column mixing patterns (Miles et al. 2021). These effects are likely to occur over a range of temporal and spatial scales, but the current information makes it difficult to discern project-specific related effects from the natural variability of oceanographic conditions in the Project area.

6.5.5.2.1 Marine Mammals

As discussed earlier, the presence of vertical structures in the water column could cause a variety of long-term hydrodynamic effects during O&M, which could impact prey species of ESA-listed whales. Increased mixing could impact seasonal stratification (Carpenter et al. 2016), which could affect prey presence and distribution. As aggregations of plankton are concentrated by physical and oceanographic features, increased mixing may disperse aggregations and decrease efficient foraging opportunities.

Potential effects of hydrodynamic changes in prey aggregations will primarily affect the NARW, which feeds on plankton whose movement is largely controlled by water flow, as opposed to the sperm, fin, and sei whale that feed predominantly on a range of prey species, including fish and cephalopods. Friedland et al. (2023) mapped forage fish species habitat preference throughout the Northeast Shelf Ecosystem and found that there is an overlap between the Project Lease Area and the preferred habitat for species like Atlantic mackerel and longfin inshore squid. However, the Lease Area only makes up a portion of what was identified as the core habitat areas for these species (Friedland et al. 2023), so the presence of the Project structures and hydrodynamic changes that alter local plankton distribution would not be expected to affect the overall distribution and subsequent availability as prey for marine mammal species throughout the larger habitat. Furthermore, the degree of effect on planktonic prey species for forage fish and NARW is expected to be limited to an area within a few hundred meters of individual turbines (Miles et al. 2017; Schultze et al. 2020). However, while broadscale hydrodynamic impacts could alter zooplankton distribution and abundance (van Berkel et al. 2020), there is considerable uncertainty as to the magnitude and extent of these changes, especially when coupled with broader ecological changes such as climate change (Section 3.2.1.1.8).

Given the highly localized area of potential impact, the effects on ESA-listed species’ prey availability resulting from changes in oceanographic and hydrologic conditions due to presence of structures would be so small that they could not be meaningfully evaluated and are **insignificant**. Therefore, changes in oceanographic and hydrologic conditions as a result of the presence of structures from the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed marine mammals.

6.5.5.2.2 Sea Turtles

Hydrodynamic changes in prey aggregations would primarily affect the leatherback sea turtle, which feeds on planktonic prey that have limited independent movement, as opposed to green, loggerhead, and Kemp's ridley sea turtles, whose diets include organisms that are sessile or can actively swim against ocean currents. The abundance and distribution of jellyfish are influenced by factors other than just currents, including sea surface temperature and prey (zooplankton) availability (Gibbons and Richardson 2008). Leatherback sea turtle prey such as jellyfish may be affected by changes in nutrient cycling and currents as a result of changes in oceanographic and hydrologic changes due to the presence of Project structures. However, these changes would be highly localized and would not affect regional jellyfish aggregations outside the Project area. Foraging resources for leatherback sea turtles would be available outside the Project area if any alterations to jellyfish abundance were to occur as a result of the Proposed Action. The effects on ESA-listed sea turtle prey availability resulting from changes in oceanographic and hydrologic conditions due to the presence of structures, if there were effects, would be so small that they could not be meaningfully evaluated and are, therefore, **insignificant**. Changes in oceanographic and hydrologic conditions as a result of the presence of structures from the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed sea turtles.

6.5.5.2.3 Marine Fish

The greatest concern for ESA-listed fish species due to changes in oceanographic and hydrologic conditions resulting from structures in the open ocean would be potential impacts to prey sources. Atlantic sturgeon prey, such as sand lance, mollusks, polychaete worms, amphipods, isopods, and shrimp, which are not expected to be closely affected by physical oceanographic features. Potential impacts on larval dispersion and survival of Atlantic sturgeon prey species could be affected by hydrologic conditions on a very localized level. As described in Section 6.5.5.2, the potential hydrodynamic effects identified from the presence of vertical structures in the water column affect nutrient cycling and mixing patterns, which could influence the distribution and abundance of fish and planktonic prey resources throughout O&M, although the full effects of the structures on plankton are not fully known (van Berkel et al. 2020). Given the colonization seen on the Block Island Wind Farm foundations (HDR 2020), recruitment of mollusk and decapod larvae do not appear to be negatively affected by hydrologic conditions at the WTG; therefore, recruitment of larval prey species for Atlantic sturgeon likely would not be affected.

Densities of planktonic organisms are typically spatially and temporally patchy and highly dependent on many factors, all of which could be influenced by the presence of structures. Giant manta ray feeding, therefore, could be affected by the presence of WTG and OSS foundations. However, giant manta rays are pelagic and exhibit high plasticity in their use of water depths and habitats (NMFS 2022a). This species would likely adapt to prey variability that would not likely be any more variable than natural conditions without these structures.

Since shortnose sturgeon are not expected to occur in the Lease Area, the species would not be affected by changes in oceanographic and hydrological conditions due to the presence of structures. Therefore, **no effect** is expected for shortnose sturgeon. The anticipated hydrodynamic effects of structures are expected to be localized and not extend beyond a few hundred meters from the foundation (Miles et al. 2017; Schultze et al. 2020). Any effects resulting from oceanographic and hydrographic conditions produced by the foundations and structures would be small, unlikely to be meaningfully evaluated, and considered **insignificant**. Therefore, changes in oceanographic and hydrologic conditions as a result of the presence of structures from the Proposed Action **may affect, but are not likely to adversely affect** Atlantic sturgeon and giant manta ray.

6.5.5.3 Reef Effect

Though the installation of WTGs and OSSs would result in the loss of soft-bottom habitat (Section 6.5.4), it would also result in the conversion of open-water habitat to hard, vertical habitat, which can, through a series of successional changes, aggregate prey species that attract larger species (Causon and Gill 2018; Taormina et al. 2018). The addition of hard-bottom habitat is expected to result in a shift in the area immediately surrounding each monopile to a structure-oriented system, including an increase in fouling organisms (Degraer et al. 2020; Mavraki et al. 2021). Over time (weeks to months), areas with scour protection are likely to be colonized by sessile or mobile organisms (e.g., sponges, hydroids, crustaceans) (Degraer et al. 2020). This results in a modification of the benthic community in these areas from primarily infaunal organisms (e.g., amphipods, polychaetes, bivalves). The addition of new hard-bottom substrate in a predominantly soft-bottom environment will enhance local biodiversity (Pohle and Thomas 2001; Mavraki et al. 2021). Hard-bottom habitat and vertical structures in a soft-bottom habitat can create artificial reefs, thus inducing the reef effect (Taormina et al. 2018). Studies of operating offshore wind farms have shown this reef effect results in increased species density, biomass, and biodiversity in the vicinity of offshore wind structures compared to the surrounding habitat (Dong Energy et al. 2006; Degraer et al. 2020).

6.5.5.3.1 Marine Mammals

The reef effect is a habitat-related result of in-water structures that may have long-term effects on marine mammal prey species during operations and potentially after decommissioning. Russell et al. (2016) found clear evidence that seals were attracted to a European wind farm, apparently due to the abundant concentrations of prey created by the reef effect. The artificial reefs created by structures forms biological hotspots that could support species range shifts and expansions as well as changes in the biological community structure resulting from a changing climate (Raoux et al. 2017; Methratta and Dardick 2019; Degraer et al. 2020). However, there is no example of an existing, large-scale offshore renewable energy project, or combination of projects, within the Action Area to evaluate this potential.

Hayes et al. (2021) noted marine mammals are following shifts in the spatial distribution and abundance of their primary prey resources driven by increased water temperatures and other climate-related impacts. These range shifts are primarily oriented northward and toward deeper waters. The widespread development of offshore renewable energy facilities may facilitate climate change adaptation for certain marine mammal prey and forage species.

The NARW is primarily a pelagic filter feeder that would not be impacted by the reef effect to any measurable degree. Sperm whales are deep-diving species feeding primarily on cephalopods in the water column and are also not expected to be affected by the reef effect associated with the Proposed Action. The primary feeding activity for fin and sei whales in the mid-Atlantic OCS is expected to be on pelagic schooling fishes such as clupeids (e.g., herrings, menhaden) (Engelhaupt et al. 2019; Zoidis et al. 2021). Based on their foraging preferences, a reef effect from the Proposed Action is not expected to result in a measurable increase in the abundance or aggregation of species preyed on by NARWs or sperm whales. However, the reef effect could result in an increase in prey abundance or aggregation of fish preyed upon by fin whales and sei whales. Fisheries studies conducted over 7 years at the Block Island Wind Farm showed a marked increase in black sea bass and Atlantic cod over the maturity of the foundation installation (Wilber et al. 2022). During the Block Island Wind Farm study, catches of schooling fishes such as herring, which would be more indicative of fin and sei whale prey effects, declined throughout the survey period; however, these declines were also reflected regionally (i.e., outside the wind farm) and, thus, not attributable to foundation effects (Wilber et al. 2022). Furthermore, fish that prey heavily upon herring (e.g., spiny dogfish) showed large peaks in abundance during survey trawls, indicating periodic high prey availability (Wilber et al. 2022). Similar periodic peaks in the abundance of fin and sei whale prey could be expected. However, competition for certain prey resources (e.g., keystone species such as herring) may increase as a result, with subsequent and additional trophic-level consequences. However, the magnitude, extent, and consequence of this on ESA-listed marine mammals is unknown at this time.

The presence of Project infrastructure could provide a long-term beneficial impact to some marine mammals by increasing prey species attracted to the proposed Project structures (Wilson and Elliott 2009; Langhamer 2012). Although the reef effect may aggregate fish species and potentially attract an increased number of opportunistic predators, the reef effect from structures is not anticipated to result in a measurable effect on ESA-listed marine mammals. There may be an increase in abundance of schooling fish that sei or fin whales may prey on, but this increase does not likely represent a measurable increase in prey abundance throughout the Project area and Action Area more broadly. NARWs and sperm whales, given their preferred prey types, would not be expected to benefit from increased fish aggregations resulting from the reef effect. Based on available information, the impact, if any, would be considered **insignificant** for all ESA-listed marine mammals, with potential **beneficial** effects for fin and sei whales. Any increase in prey resources for fin and sei whales due to the reef effect would be removed following decommissioning. Therefore, a change in prey resources as a result of the reef effect due to presence of structures from the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed marine mammals.

6.5.5.3.2 Sea Turtles

The reef effect is expected to lead to an increase in colonizing organisms on the surface of the pile, namely blue mussels (*Mytilus edulis*), which likely enhance food availability and food web complexity to the base of the structure and laterally away from the foundation through an accumulation of organic matter (Degraer et al. 2020; Mavraki et al. 2021). The accumulation could lead to an increased importance of the detritus-based food web, which could increase the availability of some sea turtle prey such as mollusks and crustaceans (Degraer et al. 2020). However, although the reef effect increases the total amount of biomass at each foundation, thereby increasing food resources and attraction by predators, significant, broad-scale changes to the regional trophic structure are considered unlikely (Raoux et al. 2017).

High concentrations of sea turtles have been observed in the vicinity of offshore structures such as oil platforms, foraging and resting under the platforms (Gitschlag 1990; Gitschlag and Herczeg 1994; NRC 1996). Sea turtles with increased habitat and foraging opportunities could remain in an area longer than they typically would and become susceptible to cold stunning or death, which occurs when water temperatures fall below 50°F (10°C) (NMFS 2021); however, no quantitative evidence of this exists that this would be a result of offshore wind infrastructure.

Leatherback sea turtles primarily feed on pelagic soft-bodied animals such as jellyfish and salps. The primary effect that could alter leatherback prey distribution would be the presence of structures and any changes in the hydrodynamic processes within the Proposed Action (Section 6.5.5.2.2). The reef effect due to presence of structures is not expected to affect prey species for the leatherback sea turtle. Therefore, effects, if any, would be so small that they could not be meaningfully evaluated and are **insignificant** for leatherback sea turtle prey.

Adult green sea turtles primarily forage on seagrass and marine algae but occasionally will consume marine invertebrates. Benthic invertebrates would be beneficially impacted by the reef effect due to the presence of structures. However, no seagrass beds were observed within the Project Lease Area, along the Offshore Export Cable, inter-array cable, or Inshore Export Cable Routes (US Wind 2023), and given their preferred feeding behaviors, any effects on green sea turtles and their forage sources are expected to be **discountable**.

Loggerhead and Kemp's ridley sea turtles are the only species whose diet consists predominantly of benthic species such as mollusks and crustaceans. Available information suggests the predominant prey base for loggerhead and Kemp's ridley sea turtles may increase in the Proposed Action Area due to the reef effect following the temporary disturbances during construction activities; an increase in crustaceans and other forage species would be **beneficial** to those species. Loggerhead sea turtles are likely to benefit more than Kemp's ridley sea turtles due to the nature of their distribution, with Kemp's ridleys being primarily nearshore and loggerheads being primarily offshore. Although both may benefit, the effect would be greatest for the loggerhead sea turtle. Any beneficial impact due to the reef effect would be removed following decommissioning. A change in prey resources as a result of the reef effect due to presence of structures from the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed sea turtles.

6.5.5.3.3 Marine Fish

As discussed earlier, WTG and OSS foundations, scour protection, and cable protection would introduce new, stable hard surfaces to the marine environment, producing a reef effect (Wilson and Elliott 2009; Langhamer 2012). These surfaces would be available for colonization by algae and sessile organisms and would concentrate fish and other species, potentially altering predator-prey dynamics near the structures. The reef effect is 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 Atlantic sturgeon compared to the surrounding soft-bottom habitat.

Since shortnose sturgeon are not expected to occur in the Lease Area, the species would not be affected by the reef effect. Therefore, **no effect** is expected for shortnose sturgeon. Due to the increase in prey availability, the reef effect is considered a **beneficial** impact for Atlantic sturgeon. The giant manta ray is a pelagic, migratory species often occurring at upwellings and is mainly a filter feeder. As a result, giant manta ray prey will not be directly impacted by the reef effect surrounding the offshore structure foundations. Effects on the giant manta ray as a result of the reef effect are unlikely and **discountable**. Therefore, the effects of the reef effect as a result of the Proposed Action **may affect, but are not likely to adversely affect** Atlantic sturgeon and giant manta ray.

6.5.6 Electromagnetic Fields and Heat from Project Cables (O&M)

Once operational, the Project's inter-array and export cables would generate induced magnetic and electrical field effects adjacent to the seafloor along their respective lengths. Electricity transmission through the cables would also generate heat, sufficient to increase the temperature of the surrounding sediments and potentially the water column in immediate proximity to the cable. These effects would be most intense where the cables cannot be buried and are laid on the seafloor surface covered by an armoring blanket. Potential EMF and heat effects on the environmental baseline are described below.

As discussed in Section 3.2.1.1.5, the marine environment continuously generates an ambient EMF, which is driven by the movement of saltwater. The motion of electrically conductive seawater through Earth's magnetic field induces voltage potential, thereby creating electrical currents. Surface and internal waves, tides, and coastal ocean currents all create weak induced EMFs. Their magnitude at a given time and location depends on the strength of the prevailing magnetic field, site, and time-specific ocean conditions. Magnetic fields are naturally created. They are relatively weak currents though they can be increased or diminished based on ocean conditions, solar events, electrical storms, and variables in the magnetic field.

The strength of the DC magnetic field is approximately 549 mG (54.9 µT) in the vicinity of the US Wind Lease Area (NOAA n.d.). This is the static magnetic field of Earth oriented to magnetic north at a declination of approximately 26 degrees west (NOAA n.d.). The interaction of currents and surface waves with Earth's magnetic field are also likely to induce variable EMF effects on the order of 1 to 10 mG and 10 to 100 mV/m, respectively, at the seafloor. These field effects operate at or near a frequency of 0 hertz, consistent with Earth's static magnetic field. The biological EMF produced by fish and other marine organisms ranges from 0 to approximately 10 hertz (Bedore and Kajiura 2013). Unlike natural magnetic field sources, alternating current (AC) electrical power transmission generates EMF effects at 60 hertz. Therefore, sufficiently strong EMF effects are potentially detectable by some marine organisms even when EMF levels that are weaker than natural levels are present under baseline conditions.

As discussed earlier, as ocean currents and organisms move through Earth's magnetic field, a weak DC electric field is produced. For example, the electric field generated by the movement of ocean currents through Earth's magnetic field is reported to be 0.075 mV/m or less (CSA Ocean Sciences Inc. and Exponent Engineering, P.C. 2019). 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 could induce a steady-state electrical field on the order of 51.5 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, 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).

Submarine transmission or communication cables can 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. Cable insulation, sheathing, and bundling arrangement contribute to reductions in the EMF, causing levels to weaken and decrease more rapidly with distance (CSA Ocean Sciences Inc. and Exponent Engineering, P.C. 2019). While seafloor sediments do not shield magnetic fields, burial of power cables substantially reduces the levels of magnetic and induced electric fields in the marine environment. EMF from undersea power cables decreases rapidly with distance from the cable; deeper burial depths are associated with lower EMF levels that may reach the seafloor and overlying water (CSA Ocean Sciences Inc. and Exponent Engineering, P.C. 2019). The target depth for the inter-array and export cables is up to 13.1 feet (4 meters) and 3.3 to 9.8 feet (1 to 3 meters), respectively. Where hard-bottom seafloor conditions or existing infrastructure is encountered that prevent sufficient cable burial, cables would be laid on the seafloor and covered with concrete mattresses (Section 3.1.1.4). Because the coverage depth of these cable protections is generally limited compared to cables at the target burial depths, higher EMF levels will enter the marine environment surrounding the cable (CSA Ocean Sciences Inc. and Exponent Engineering, P.C. 2019).

Because no quantitative EMF modeling was conducted for the Proposed Action, this section draws on existing EMF modeling prepared for other offshore wind projects in the region. Inter-array cables will be 66 kilovolt three-core, solid dielectric (XLPE23 or EPR24) construction, and the offshore export cables will be a single 230 to 275 kilovolts, three-core cable up to 12 inches (300 millimeters) in diameter. In comparison, the inter-array cable for the South Fork Wind Farm was also a 66 kilovolt three-phase cable, while the offshore export cable for South Fork Wind Farm was a 138-kilovolt three-phase cable up to 12 inches (300 millimeters) in diameter (Jacobs Engineering Group Inc. 2021). Both project cables have similar shielding included in the insulation and armoring built into the cable themselves (Jacobs Engineering Group Inc. 2021; US Wind 2023), and both projects targeted a burial depth of at least 3.3 to 6.6 feet (1 to 2 meters) deep. Therefore, the cables between these two projects are expected to produce comparable marine EMF levels and the modeling for the South Ford Wind Farm project can be used as a proxy for the risk of effects resulting from the Proposed Action.

Exponent Engineering, P.C. (2018) modeled EMF levels that could be generated by the South Fork Wind Farm export and inter-array cables. The model estimated induced magnetic field levels ranging from 13.7 to 76.6 mG (1.37 to 7.66 µT) on the seafloor surface above the buried and exposed South Fork Wind Farm export cable and 9.1 to 65.3 mG (0.91 to 6.53 µT) above the inter-array cable, respectively. Induced field strength would decrease effectively to 0 mG (0 µT) within 25 feet (7.6 meters) of each cable. Modeling conducted for the 34.5 kilovolt Block Island Wind Farm AC transmission cable, buried up to 6 feet (1.8 meters) below the seafloor, estimated induced magnetic field levels of approximately 22 mG (2.2 µT), with similar rapid attenuation with distance above and horizontally away from the cable

(Exponent Engineering, P.C. 2012). By comparison, Earth's natural magnetic field produces more than five times the maximum potential EMF effect from typical offshore wind projects. Background magnetic field conditions would fluctuate by 1 to 10 mG (0.1 to 1 μT) from the natural field effects produced by waves and currents.

Exponent Engineering, P.C. (2018) also calculated induced electrical field strength in marine organisms exposed to the South Fork Wind Farm export cable magnetic field under maximum transmission voltage. Induced field strength is a function of body size, with larger organisms having greater electrical potential across their longest body axis. The maximum induced electrical field experienced by any organism was determined to be no greater than 0.48 mV/m.

Based on the modeling discussed for the South Fork Wind Farm, induced magnetic field strength attenuates rapidly with distance, becoming indistinguishable from natural variability within 25 feet (7.6 meters) on either side of the cable path. The magnetic field effect from unburied cable segments would dissipate below the general 50-mG (5-μT) detection threshold within 3 feet (0.9 meters) of either side of the cable path (Exponent Engineering, P.C. 2018). These results indicate that, at the seafloor, the magnetic field produced by buried cable segments would be below the 50-mG (5-μT) detection threshold except in a few specific locations where it would fall below 50-mG (5 μT) within 3 feet (0.9 meters) of the cable. The biological significance of EMF exposure above this detection threshold is unclear but likely negligible for most species at the levels (less than or equal to 76.6 mG [7.66 μT]) and distances (less than 3 feet [0.9 meters]) involved. For example, Woodruff et al. (2012) exposed a variety of fish and invertebrate species to magnetic fields ranging from 1,500 to 30,000 mG (150 to 3,000 μT), hundreds to thousands of times stronger than the EMF effects likely to result from renewable energy electrical transmission cables, and were unable to detect any significant physiological or behavioral changes from any test species.

Species-specific sensitivity and the potential effects of EMF exposure on ESA-listed species are summarized by species groupings in the following sections. The information and conclusions presented are drawn from an analysis of potential EMF effects on marine life conducted by Exponent Engineering, P.C. (2018), an analysis of potential EMF effects from offshore renewable energy projects conducted by Normandeau et al. (2011), and other available reviews and studies (CSA Ocean Sciences Inc. and Exponent Engineering, P.C. 2019; Gill et al. 2005, 2012; Kilfoyle et al. 2018; Woodruff et al. 2012).

Heat generated by underwater transmission cables is emerging as a potential concern for wind energy facility development (Taormina et al. 2018). Buried transmission cables generate heat at levels sufficient to raise sediment and potentially water temperatures in immediate proximity to the cable, depending on the type of transmission (AC or DC), power levels, and the types of substrates involved (Emeana et al. 2016; Taormina et al. 2018). The biological significance of these heat effects is unclear but likely depends on local conditions. Substrate type has a strong influence on the extent of heat effects. Emeana et al. (2016) found electrical cables buried in mixtures of fine to coarse sands and silts, the dominant substrate types present in the Action Area, increased substrate temperatures by more than 18°F (10°C) within 1.3 to 3.2 feet (0.4 to 1 meters) of the cable. Müller et al. (2016) modeled heat transmission from buried submarine cables and determined heat effects were highly localized and within the range of natural seasonal variability in temperate environments. Exposed cables had no measurable effect on water temperatures more than a few inches from the cable in well-flushed, open-water environments. Therefore, while heat transfer into surrounding sediment associated with buried submarine high-voltage cables is possible (Emeana et al. 2016), it is not expected to extend to any appreciable effect into the water column due to the use of thermal shielding, the cable's burial depth, and additional cable protection, such as scour protection or concrete mattresses, for cables unable to achieve adequate burial depth.

During Project operations, powered transmission cables would produce EMFs (Taormina et al. 2018). To minimize EMFs generated by cables, all cabling would be contained in grounded metallic shielding and buried to a target depth of 13.1 feet (4 meters) and 3.3 to 9.8 feet (1 to 3 meters) below the seafloor for the inter-array and export cables, respectively. These measures will reduce but will not entirely eliminate the effects of EMFs and cable heat.

6.5.6.1 Marine Mammals

Although the scientific evidence is generally limited, available studies suggest baleen and toothed whales, including the ESA-listed species known or likely to occur in the Project area, are likely sensitive to magnetic fields based on the presence of magnetosensitive anatomical features and observed behavioral and physiological responses (Normandeau et al. 2011). Marine mammals are likely to orient to Earth's magnetic field for navigation and migration, suggesting they may have the ability to detect induced magnetic fields from underwater electrical cables. There is, therefore, a potential for individuals to react to local variations of the geomagnetic field caused by power cable EMFs. Marine mammals are capable of detecting magnetic field gradients of 0.1 percent of Earth's magnetic field (i.e., 0.5 mG [0.05 μT]) (Kirschvink 1990). However, marine mammals are unlikely to detect AC magnetic fields below 50 mG (5 μT) based on their magnetite-based detection mechanism (Adair 1994).

Depending on the magnitude and persistence of the confounding magnetic field, such an effect could cause a temporary change in swim direction or a longer detour during the animal's migration (Gill et al. 2005). An effect on marine mammals is more likely to occur with DC cables than with AC cables (Normandeau et al. 2011). However, no EMF impacts on marine mammals associated with underwater cables have been documented. Assuming a 50-mG (5-μT) detection threshold (Normandeau et al. 2011), marine mammals could theoretically detect EMF effects from electrical transmission cables, but only in close proximity to cable segments lying on the seafloor surface. Individual marine mammals would have to be within 3 feet (0.9 meters) or less of cable segments to encounter EMF above the 50-mG (5-μT) detection threshold. This, however, is unlikely to occur for durations of time that may affect an individual's ability to navigate or orient during migrations or other biologically necessary movements. The only ESA-listed marine mammals that may forage in close proximity to the seafloor are fin whales, which prey on sand lance. However, fin whales do not feed exclusively on sand lance and are believed to utilize other pelagic prey resources within the Project area as well. The mobile nature and surfacing behavior of ESA-listed marine mammals within the Project area likely limit time spent near transmission cables. As such, navigation and migration patterns are not likely to be affected in any measurable sense. ESA-listed marine mammals are not expected to experience biologically meaningful effects due to transmission cable EMFs.

Modeled EMF levels specific to the Proposed Action are not available; therefore, this assessment is based on available modeling, as discussed earlier. Given the low field intensities expected and the limited extent of detectable effects relative to swimming speed, dive durations, feeding patterns, and overall movement patterns, effects of EMFs on marine mammals that could disrupt biologically relevant behaviors are extremely unlikely to occur and would be **discountable**.

Heat transfer into surrounding sediment associated with buried submarine high-voltage cables is possible (Emeana et al. 2016). However, heat transfer is not expected to extend to any appreciable effect into the water column due to the use of thermal shielding, the cable's burial depth, and additional cable protection such as scour protection or concrete mattresses for cables unable to achieve adequate burial depth. Although the composition and availability of benthic prey resources could be affected by cable heat, the physical extent of these effects would be limited relative to the amount of unaffected foraging habitat available in and near the Project area. As a result, heat from submarine high-voltage cables is not likely to affect marine mammals and would be **discountable**.

In summary, the effects of EMF exposure and cable heat from the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed marine mammals.

6.5.6.2 Sea Turtles

Sea turtles are known to be geomagnetic-sensitive but not electrosensitive (Normandeau et al. 2011). Sea turtles use their magneto-sensitivity for orientation, navigation, and migration; they use Earth's magnetic fields for directional (compass-type) information to maintain a heading in a particular direction and for positional (map-type) information to assess a position relative to a specific geographical destination (Lohmann et al. 1997). Additional non-magnetic cues are also likely used by sea turtles during navigation and migration. Multiple studies have demonstrated magneto-sensitivity and behavioral responses to field intensities ranging from 0.0047 to 4,000 µT for loggerhead sea turtles and 29.3 to 200 µT for green sea turtles (Normandeau et al. 2011). However, based on a review by Normandeau et al. (2011), sea turtles are unlikely to detect AC magnetic fields below 50 mG (5 µT) due to their magnetite-based detection mechanism. While green and Kemp's ridley sea turtles have not been studied, anatomical, life history, and behavioral similarities suggest they could be responsive at similar threshold levels. Although the specific mechanisms of leatherback sea turtle navigation are not currently known, it is believed they possess a compass sense similar to hardshell sea turtle species, possibly related to geomagnetic cues (Luschi et al. 2007; Eckert et al. 2012; NMFS and USFWS 2013).

Hatchling sea turtles are known to use Earth's magnetic field (and other cues) to orient and navigate from their natal beaches to their offshore habitat (Lohmann et al. 1997). Juvenile and adult sea turtles may detect EMFs when foraging on benthic prey or resting on the bottom in relatively close proximity to cables. Confounding EMF effects on sea turtles could range from trivial changes in swim direction to more significant migration alterations; the extent and magnitude of these potential effects are unclear, however, and may be compensated against to some degree by sea turtle's use of non-magnetic spatial cues.

There are no data regarding impacts on sea turtles from EMFs generated by underwater cables, although anthropogenic magnetic fields can influence migratory deviations (Luschi et al. 2007; Snoek et al. 2016). Lohmann et al. (2008) speculated that navigation methods used by adult and juvenile sea turtles depend on the stage of migration, initially relying on magnetic orientation. Any deviations are expected to be minor (Normandeau et al. 2011), and any increased energy expenditure due to these deviations would not be biologically significant.

As discussed earlier, modeled magnetic field levels specific to the Proposed Action are not available. However, based on other modeled EMFs for comparable projects, the magnetic field effect from unburied cable segments would dissipate below the general 50-mG (5-µT) detection threshold within 3 feet (0.9 meters) of either side of the cable path (Exponent Engineering, P.C. 2018). Sea turtles may detect the EMF over relatively small areas near cables (e.g., when resting on the bottom or foraging on benthic organisms). However, the sea turtle would have to be in close proximity to the cable (i.e., less than 3 feet [0.9 meters]) to potentially detect the cable's magnetic field.

Loggerhead, green, and Kemp's ridley sea turtles all may forage on benthic organisms; leatherback sea turtles are pelagic feeders and likely would not utilize habitat close to transmission cables. Due to their life history and presence within the Project area (Section 5.1.2.3), loggerhead sea turtles would face the highest risk of exposure to EMF during Project O&M. Though desktop studies suggest sea turtles are capable of sensing magnetic fields from submarine cables (Normandeau et al. 2011), there is little evidence supporting that these small EMFs along a cable route would affect sea turtles under natural conditions. Potential effects from project EMFs would be limited to minor deviations in migratory direction; biologically relevant behaviors such as foraging or mating are not likely to be affected. Effects on sea turtles from potential exposure to EMFs from Project cables are not expected to disrupt biologically relevant behaviors and would be so minor that they cannot be meaningfully evaluated, or **insignificant**.

Heat transfer into surrounding sediment associated with buried submarine high-voltage cables is possible (Emeana et al. 2016). However, heat transfer is not expected to extend to any appreciable effect into the water column due to the use of thermal shielding, the cable's burial depth, and additional cable protection, such as scour protection or concrete mattresses for cables unable to achieve adequate burial depth. Although the composition and availability of invertebrate prey resources for benthic-feeding species such as the loggerhead sea turtle may be affected by cable heat, the physical extent of these effects would be limited relative to the amount of unaffected foraging habitat available in and near the Project area. Potential effects on ESA-listed sea turtles from heat transfer from Project cables is unlikely to occur and would be **discountable**.

In summary, the effects of EMF exposure and cable heat from the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed sea turtles.

6.5.6.3 Marine Fish

Atlantic and shortnose 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 and 2,000 µT), well above the levels likely to result from renewable energy electrical transmission cables (i.e., less than 100 mG [10 µT]). This indicates Atlantic and shortnose sturgeon are likely insensitive to magnetic field effects that would result from the Proposed Action. Sturgeon may be sensitive to the induced electrical field generated by the cable, however. Marine fish have specialized electrosensory organs capable of detecting electrical fields on the order of 0.5 mV/m (Normandeau et al. 2011; Gill et al. 2012). However, 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. BOEM evaluated commercially and recreationally important fish and invertebrate species regarding their susceptibility to EMF levels generated by commercial wind farm transmission cables on the OCS (CSA Ocean Sciences Inc. and Exponent Engineering, P.C. 2019). While fish would likely be able to detect induced electrical fields in immediate proximity to exposed cable segments, many species likely would not show quantifiable impacts from transmission cable EMFs and would not experience significant physiological or behavioral effects. Based on these studies, Atlantic and shortnose sturgeon are not expected to experience biologically meaningful effects due to transmission cable EMFs.

Elasmobranch species (e.g., sharks, rays, skates) have electrosensitive capabilities used for detecting prey, mates, and predators (Kalmijn 1971). This subclass of fish, which includes giant manta rays, may be responsive to electric fields induced by magnetic fields from submarine power cables, which could disrupt or mask an individual's electroreception. Although giant manta rays may be more sensitive to underwater EMFs than Atlantic sturgeon due to their dermal electrosensory system, they are a pelagic species and would spend very little time in proximity to the seafloor. This behavioral characteristic would limit their exposure to EMFs from Project cables. Giant manta rays are not expected to experience physiological or behavioral effects due to transmission cable EMFs.

Given the range of baseline variability and limited area of detectable effects relative to available habitat elsewhere, the effects of fish's exposure to Project-related EMFs are likely to be **insignificant** for Atlantic sturgeon, shortnose sturgeon, and giant manta rays.

Given the Project cables would be buried to target depths of 13.1 feet (4 meters) and 3.3 to 9.8 feet (1 to 3 meters) for the inter-array and export cables, respectively, most heat effects would likely be undetectable at the seafloor surface, and any heat effects from unburied cable segments would be highly localized and limited in extent. Although cable heat could theoretically affect benthic community structure, recolonizing invertebrate species may be displaced laterally or vertically in avoidance of temperatures they are sensitive to. These changes could affect the composition and availability of invertebrate prey resources for benthic feeding species like Atlantic and shortnose sturgeon, though the physical extent of these effects would be limited relative to the amount of unaffected foraging habitat available elsewhere in and near the Project area. Further, based on their habitat preferences, shortnose sturgeon overlap with Project cables would be minimal, thereby limiting any potential impact to foraging resources. Additionally, as discussed in Section 5.1.3.1, Atlantic sturgeon are generalist feeders and are unlikely to be affected by temporary and spatially limited impacts to some prey species. Giant manta rays are pelagic feeders and would not be affected by cable heat. Therefore, although cable heat effects remain a data gap, the available evidence suggests any associated effects on ESA-listed fish would be **insignificant**.

In summary, the effects of EMF exposure and cable heat from the Proposed Action **may affect, but are not likely to adversely affect** ESA-listed fish.

6.6 Capture/Impingement Entrainment During Installation of the Inshore Export Cable

Dredging for installation of the inshore export cables under the Proposed Action is expected to be primarily limited to Indian River Bay as shown in Figure 3-8. US Wind does not anticipate seabed preparation would be necessary to provide a level surface at any of the post-piled jacket or jacket on suction bucket foundation locations for the OSSs (figure 3-1). In the unlikely event that seabed leveling is needed, US Wind anticipates using equipment such as a TSHD to level the seabed and estimates a maximum case scenario of approximately 5,000 cubic yards (3,823 cubic meters) of dredge material at each OSS location. Dredged material would be placed or moved aside within the immediate vicinity within the defined OSS construction footprint. The area and duration of seabed preparation for the OSS foundation locations is anticipated to be smaller relative to the dredging proposed for the inshore export cables, so the risk of capture and impingement for ESA-listed species will primarily be driven by the dredging in Indian River Bay.

Installation of the inshore export cable is anticipated to occur over an approximate 21-month period between the third quarter of 2024 and the second quarter of 2026 (Table 3-13). US Wind assumes that cable installation in Indian River Bay would be occur over two construction seasons (Campaign 1 – one cable, associated with MarWin and Campaign 2 – up to three cables, associated with Momentum and future development). US Wind assumes all construction within Indian River Bay, including any dredging, would occur in October to March window, observing the general time of year restrictions for summer flounder and other species. Time of year restrictions would be determined through consultations with DNREC. Construction of alternative Inshore Export Cables Routes is not included under the Proposed Action.

As discussed previously in Section 6.5.2, ESA-listed marine mammals, leatherback sea turtles, and giant manta rays are not expected to occur in the area of inshore dredging from the installation of inshore export cables. Therefore, there is **no effect** on ESA-listed marine mammals, leatherback sea turtles, or giant manta rays due to entrainment risk from inshore dredging associated with the Proposed Action.

6.6.1 Sea Turtles

As discussed in Section 3.1.3, US Wind anticipates dredging to be conducted using mechanical or most likely, hydraulic means. The specific type of hydraulic method to be used is not known yet during installation of the inshore export cables. Sea turtles are generally not known to be vulnerable to entrainment in cutterhead dredges given the small size of their intake and relatively low intake velocity (NMFS 2018b). Mechanical dredging, including the use of a clamshell dredge, is also not expected to capture, injure, or kill sea turtles (USACE 2020). Therefore, physical interactions with the dredge associated with the Proposed Action are extremely unlikely to occur.

If US Wind decides to use a TSHD during installation of the inshore export cables, the effects to sea turtles would be greater. Therefore, the use of TSHD is used for this assessment. Sea turtles of all sizes can become entrained or entrapped by the TSHD drag head suction as it moves along the seafloor. Most encounters with the TSHD drag head result in mortality, and there are few effective mitigation measures outside of pre-dredge trawling, time of year and location restrictions, and optimal operation of the drag head to reduce mortality from hydraulic dredging activities.

The 2020 South Atlantic Regional Biological Opinion (SARBO) for Dredging and Material Placement Activities in the Southeast U.S. and associated Incidental Take Statement (NMFS 2020b) assessed the risk to sea turtles and other ESA-listed species for activities under the jurisdiction of the USACE and sand source activities under the jurisdiction of BOEM from the North Carolina/Virginia border through Florida. Although the northeast region does not currently have a regional biological opinion for dredging and the Project area is not included in the SARBO, the general assessment contained in the SARBO relating to sea turtles in the southeast can be used for comparing relative dredging risk to sea turtles in the Project area. In the SARBO, the only type of dredging expected to result in adverse effects to sea turtles is hopper dredging, which is expected to result in take of sea turtles (green, Kemp's ridley, and loggerhead). In the southeast region, the maximum estimated annual take from hopper dredging was 150 sea turtles comprising green, Kemp's ridley, loggerhead, and unidentified sea turtles. This estimate is based on a dredging volume of 27,386,533 cubic yards (20,938,507 cubic meters) of material from inshore and offshore dredging in the southeast region.

It is anticipated that dredging during installation of the inshore export cables under the Proposed Action would require a smaller scale (both in terms of timing and spatial extent) of dredging volume (390,648 cubic yards [298,6712 cubic meters]) under the Proposed Action vs. approximately 32 million cubic yards(245 million cubic meters) each year in the SARBO Action Area; NMFS 2020b), which would reduce the potential for sea turtles to interact with Project dredging. Applying the SARBO data provides an estimate of 5 turtle mortalities per 182,577 CY (27,386,533 cubic yards /150 = 182,577 CY). This estimate was for all three species of turtles (green, Kemp's ridley, and loggerhead sea turtles) in an area where the densities are far greater than in Indian River Bay during October to December. Using this mortality estimate as a maximum case scenario, we determined that for Indian River Bay there would be no more 2 sea turtle mortalities (390,648 CY/182,577 CY =2.14) for dredging operations during the Proposed Action.

Adult and juvenile sea turtles are expected to be present within Indian River Bay from May through the end of November and may be foraging. However, sea turtles are not known to be vulnerable to capture in mechanical or cutterhead dredges, presumably because they are able to avoid the dredge bucket or cutterhead. Thus, if a sea turtle were to be present at the dredge sites, it would be extremely unlikely to be captured, injured, or killed due to these types of dredging operations carried out by a mechanical dredge, because of the anticipated behavioral response. During October to December there is the potential for cold-stunned sea turtles to be within the Action Area. Cold-stunned turtles would not be expected to avoid dredging operations. Furthermore, assuming TSHD dredging is used there is an even greater potential for sea turtle entrainment, injury, and/or mortality [as discussed in the SARBO (NMFS 2020b)]. Based on the potential for cold-stunned turtles and the uncertainty of dredging methods, the most prudent effects analysis (as mentioned above) is to analyze the TSHD as done with the SARBO information. As a result, interactions between sea turtles and dredging activities that could cause entrainment, injury, and/or mortality cannot be discounted.

Therefore, the effects of dredge interactions with sea turtles under the Proposed Action and the potential risk of entrainment **may affect, likely to adversely affec**t green, Kemp's ridley, and loggerhead sea turtles. As discussed earlier, leatherback sea turtles are not expected to occur in the inshore areas where dredging during installation of the inshore export cables would occur, so there would be **no effect** to this species.

6.6.2 Marine Fish

Hydraulic dredging is a known risk to Atlantic sturgeon; in addition to TSHD, cutterhead dredges can pose an entrainment risk to sturgeon (Reine et al. 2014). Like sea turtles, mechanical dredging poses minimal impact risk to sturgeon species. Since 1990, there has been only one verified record of a live Atlantic sturgeon entrained in a mechanical dredge along the U.S. East Coast (NMFS 2018). Dredging in and near the mouth of spawning rivers poses a higher risk to Atlantic sturgeon. Because Atlantic sturgeon stocks are highly specific to individual regions, comparisons with dredge takes in the southeast are not as applicable as comparisons for sea turtles. Shortnose sturgeon are not expected to occur within these areas during the time of dredging based on their propensity to move further upstream in their natal rivers as temperatures decrease (Section 5.1.3.1.3). Older data from the USACE sea turtle data warehouse (2013), showed that for 18 years of reporting, there were 42 sturgeon takes by dredging projects and out of those 42, only 2 takes were from the New York District. Recent Atlantic sturgeon tagging studies by Balazik et al. (2021) demonstrated minimal interaction between sturgeon and a cutterhead dredge operating in the James River, Virginia; none of the 110 tagged sturgeon were entrained by the dredge. Data regarding Atlantic sturgeon capture in dredging equipment is predominantly for the southeastern U.S. and associated with navigational dredging projects (Reine et al. 2014; USACE 2020).

It is generally assumed that non-larval sturgeon (i.e., juveniles, sub-adults, and adults) are mobile enough to avoid the suction of an oncoming TSHD and that any sturgeon in the vicinity of such an operation would be able to avoid the intake and escape. An individual sturgeon would need to be in the immediate area where the dredge is operating to be entrained (i.e., within one meter of the dredge head) for there even to be the potential for interaction with the draghead; as such, the overall risk of entrainment is low.

However, as discussed above there is the potential for hydraulic dredging to be used. If TSHD is chosen there is a greater likelihood of entrainment, injury, and/or mortality of Atlantic sturgeon. Therefore, the most conservative approach is to base the effects analysis on TSHD.

Atlantic sturgeon would have the potential to be present withing Indian River Bay from October to December prior to migrating further offshore to deeper waters. Given the likelihood of Atlantic sturgeon presence in Indian River Bay during October through December, the potential for an Atlantic sturgeon entrainment, injury, or mortality occurring from dredging activities cannot be discounted. Therefore, the effects of dredge interactions (specifically TSHD) under the Proposed Action and the potential risk of entrainment, injury, and/or mortality **may affect, likely to adversely affect** Atlantic sturgeon.

For shortnose sturgeon, given the October through March window for dredging combined with the migration of shortnose sturgeon upstream, and the limited extent (Indian River Bay) over which potential dredging for installation of the inshore export cables may occur (Figure 3-8), it is reasonable to conclude that any effects of inshore dredge interactions and entrainment on shortnose sturgeon under the Proposed Action would be unlikely and **discountable**. Therefore, the effects of dredge interactions under the Proposed Action **may affect, but it is not likely to adversely affect** shortnose sturgeon.

As discussed earlier, giant manta rays are not expected to occur in the inshore areas where dredging for installation of the inshore export cables would occur, so there would be **no effect** to this species.

6.7 Entanglement (pre-C, C, O&M, D)

Secondary entanglement, and entanglement more broadly, is a risk for all ESA-listed marine mammals, sea turtles, and fish species. Several mechanisms are in effect that may increase or alter exposure to entanglement risk, potentially leading to injury or death. The long-term presence of WTG structures could displace ESA-listed species from preferred habitats or alter movement patterns, potentially changing exposure to commercial and recreational fishing activity. Offshore structures and the anticipated reef effect could lead to increased recreational fishing within the Lease Area. Conversely, some commercial and recreational fishing activities may be displaced outside the Lease Area. Some potential exists for a shift in gear types from fixed to mobile gear, or vice versa, due to fishing effort displacement and modification from the presence of offshore wind farm infrastructure. Abandoned or lost fishing gear, including that associated with pre- and post-construction fisheries monitoring surveys, may get tangled with foundations. These stressors are discussed in further detail in the following subsections.

6.7.1 Secondary Entanglement from Derelict Fishing Gear

Abandoned or lost (derelict) fishing gear, including that associated with pre- and post-construction fisheries monitoring surveys, may get tangled with foundations, depending on the gear type. Although this would result in a reduction in entanglement risk from free-floating abandoned gear, debris tangled with WTG foundations will still pose an entanglement risk to ESA-listed species in the vicinity of the foundations. These potential long-term and intermittent impacts would persist until decommissioning is complete and the structures are removed.

6.7.1.1 Marine Mammals

Current data suggest seals (Russell et al. 2014) and harbor porpoises (Scheidat et al. 2011) may be attracted to future offshore wind development infrastructure, likely because of foraging opportunities due to the reef effect (Section 6.5.5.3) and shelter provided. While the reef effect from the Proposed Action is not expected to result in increased aggregations or abundance of species preyed on by NARWs or sperm whales, aggregations or abundance of fish preyed upon by fin whales or sei whales may increase. These species may use habitat between the WTGs, as well as other offshore wind infrastructure, for feeding, resting, and migrating.

Ghost gear and lost commercial fishing nets may tangle around WTG foundations. Both could indirectly increase the potential for marine mammal entanglement leading to injury and mortality due to infection, starvation, or drowning (Moore and van der Hoop 2012). Derelict fishing gear that becomes tangled with foundations would reduce the chance that free-floating 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. However, the potential impact on marine mammals from these changes is uncertain. Currently, published data do not exist on the amount or type of debris that accumulates on offshore wind foundations in the U.S. Atlantic; therefore, the scale of entanglement risk is not known.

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). An estimated 83 percent of NARWs show evidence of at least one entanglement in fishing gear (Knowlton et al. 2012). Additionally, recent literature indicates 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, including fin whales (Read et al. 2006; Henry et al. 2020).

Secondary entanglement of ESA-listed whale species would be unlikely, as contact with or presence in close proximity to the foundations is not expected. Unlike other marine mammals such as dolphins, porpoise, and seals, the ESA-listed whales are not expected to opportunistically forage on the foundations where contact with fishing gear caught on foundations would occur. Wind farm mitigation measures include annual inspections of WTG foundations and surroundings to find and remove derelict fishing gear and debris. This would reduce entanglement risk for ESA-listed species foraging around the foundations. Importantly, these mitigation measures would provide a new mechanism for removing derelict gear from the environment, incrementally reducing entanglement risk for all species in the analysis area. The likelihood of an ESA-listed whale becoming entangled in fishing gear around the WTGs is so low as to be

discountable. Therefore, secondary entanglement due to derelict fishing gear for the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed marine mammals.

6.7.1.2 Sea Turtles

Secondary entanglement due to derelict fishing gear becoming entangled on Project foundations would pose a risk to loggerhead sea turtles, who have the greatest propensity for occupying the pelagic WTG area and foraging in the vicinity of the foundations. Although leatherback sea turtles would not be expected to feed off the foundations, their pelagic nature and high degree of fisheries interactions indicate they would also be at risk of secondary entanglement. It is uncertain how much Kemp's ridley sea turtles will use offshore structures; however, their low occurrence in the pelagic WTG area would result in a low likelihood of entanglement. Additionally, the green sea turtle primarily forages on seagrasses which have not been observed in the Project area (COP, Volume II, Section 7.0; US Wind 2023), and is less likely to forage in close proximity to offshore Project infrastructure, thus posing a low likelihood of interactions with foundations resulting in entanglement.

Implementation of monitoring surveys would provide data regarding the presence of gear on structures that will help assess secondary entanglement risk. Through this monitoring, removal actions could be taken if entanglement risk appears high, thus reducing, but not eliminating, the likelihood of sea turtle entanglements. Currently, published data do not exist on the amount or type of debris that accumulates on offshore wind foundations in the U.S. Atlantic. Therefore, though the scale of entanglement risk is not known, the risk would remain present throughout the entire O&M phase and is considered long term.

Because of their lower expected use of the pelagic waters in the Lease Area and their foraging strategies that would not cause aggregation or attraction to Project infrastructure, exposure of Kemp's ridley and green sea turtles to entanglement in fishing gear around WTG and OSS foundations is **discountable**. Therefore, secondary entanglement due to derelict fishing gear for the Proposed Action **may affect, but it is not likely to adversely affect** Kemp's ridley and green sea turtles.

Based on available information, secondary entanglement due to derelict fishing gear caught around Project foundations is possible and cannot be discounted for leatherback or loggerhead sea turtles. Entanglement would likely lead to the loss of individuals but is not expected to have population-level effects. Therefore, secondary entanglement due to derelict fishing gear for the Proposed Action **may affect, likely to adversely affect** leatherback and loggerhead sea turtles.

6.7.1.3 Marine Fish

As discussed in the preceding sections, abandoned or lost recreational and commercial fishing gear may become entangled with foundations, resulting in increased risk of entanglement for ESA-listed fish. Currently, published data do not exist on the amount or type of debris that accumulates on offshore wind foundations in the U.S. Atlantic; therefore, the scale of entanglement risk is not known. Abandoned lines in the water column pose the greatest risk to giant manta rays, while lines that have consolidated at the bottom pose the greatest risk to Atlantic sturgeon. Although there are unpublished, ancillary reports of sturgeon and manta ray entanglement in fishing line, recreational bycatch is not noted as a significant threat to these species. In the U.S. Gulf of Mexico where oil platforms and manta rays significantly overlap, recreational fishing near the platforms is a common activity. To date, no published reports exist regarding assessment and enumeration of fishing gear, or the associated entanglement risk for manta rays or sturgeon. Given this long history of oil platforms and fishing exist, the incidents of secondary entanglement associated with the Proposed Action are expected to be low.

Since shortnose sturgeon are not expected to occur in the Lease Area, the species would not be affected by secondary entanglement due to derelict fishing gear. Therefore, **no effect** is expected for shortnose sturgeon. Secondary entanglement would pose a low risk to Atlantic sturgeon and giant manta rays due to their relatively low occurrences in the Project area and expected minimal direct use of or foraging at the foundations. The consequences of any entanglement are high in that it often results in mortality; however, the expectation for secondary entanglement in gear snagged on offshore foundations by Atlantic sturgeon and giant manta ray is extremely low such that it is **discountable**. Therefore, secondary entanglement due to derelict fishing gear for the Proposed Action **may affect, but it is not likely to adversely affect** Atlantic sturgeon and giant manta ray.

6.7.2 Entanglement from Fisheries Monitoring Surveys

As discussed in Section 3.1.6, US Wind will conduct pre- and post-construction fisheries monitoring surveys. A ventless commercial fishing pot survey will be conducted with pots spaced proximate and distant to turbine structures to capture both turbine- and project-scaled changes in black sea bass catch rates. The ventless pot surveys will be conducted monthly between March and November, consisting of six sets (four in the Project area and two in an adjacent control area) of 15, 40-inch commercial pots each. All sets will use ropeless EdgeTech devices to eliminate the use of buoy lines. Pots will be soaked without bait for a single night and recovered the following day.

An additional recreational fisheries survey will be conducted, consisting of six monthly surveys (May through October) in each sampling year using standard angling techniques to obtain catch rates at two reference artificial reef sites and at two sites where turbine foundations will be constructed. For each month, one control and one turbine site are visited per day across two days, with the order of site visits randomized within a day and all sites visited within a 2-day window. Effort will consist of a 3-minute drop, with each site fished for 45 minutes (15 drops/angler). At each site, a jigging trial is conducted by the mate upon arrival for a 15-minute period prior to the onset of the drift, near-bottom angling.

Implementation of monitoring and mitigation measures under the Proposed Action would help reduce entanglement or capture risk for ESA-listed species in Project-related fisheries monitoring surveys. These measures, including the use of ropeless gear technology (e.g., EdgeTech devices), pre-deployment monitoring for whales, and short deployment periods (e.g., single-day soak times) are considered in the assessment of impact for ESA-listed species in the following subsections.

6.7.2.1 Marine Mammals

Theoretically, any line in the water column, including line resting on or floating above the seafloor set in areas where whales occur, could entangle a marine mammal (Johnson et al. 2005; Hamilton et al. 2019). Entanglements may involve the head, flippers, or fluke, and effects range from no apparent injury to death. 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; NMFS 2023g). Current estimates indicate 83 percent of NARWs show evidence of at least one past entanglement and 60 percent show evidence of multiple fishing gear entanglements, with rates increasing over the past 30 years (Knowlton et al. 2012; King et al. 2021). Of documented NARW entanglements in which gear was recovered, 80 percent was attributed to non-mobile fishing gear (e.g., lobster and gillnet gear) (Knowlton et al. 2012). Additionally, recent literature indicates 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, including fin whales (Read et al. 2006; Henry et al. 2020).

Large whales are vulnerable to entanglement in stationary vertical and ground lines associated with trap and pot gear, including ventless trap surveys. The Final EIS, Regulatory Impact Review, and Initial Regulatory Flexibility Analysis for Amending the Atlantic Large Whale Take Reduction Plan (ALWTRP): Risk Reduction Rule (NOAA 2021) provides an analysis of data showing entanglement in commercial fisheries gear represents the highest proportion of all documented serious and non-serious incidents reported for humpback, NARW, fin, and minke whales. Entanglement was the leading cause of serious injury and mortality for NARW, humpback, fin, and minke whales from 2010 to 2018 for cases where the cause of death could be identified (NOAA 2021).

Under the Proposed Action, ropeless gear technology (i.e., EdgeTech acoustic release devices) will be used for all pot surveys, which eliminates the use of vertical buoy lines in the water column. This effectively reduces the entanglement risk for marine mammals. Furthermore, monitoring done prior to gear deployment to ensure pots are not set within an area being actively used by whales, and the short soak time (<24 hours) for gear further lowers the potential co-occurrence rate between ESA-listed marine mammals and fisheries monitoring gear, thereby reducing the overall entanglement risk. ESA-listed marine mammals are not considered at risk of entanglement in angling-type fishing gear (i.e., hand or hook-and-line), such as that used for the recreational fisheries survey under the Proposed Action.

Given the expected limited frequency and duration of Project-related fisheries surveys and the application of mitigation measures such as ropeless gear for all pot surveys, pre-deployment monitoring, and short soak times, marine mammal entanglement is highly unlikely and the risk is considered **discountable**. Therefore, gear utilization as part of Project-related fisheries monitoring surveys **may affect, but it is not likely to adversely affect** ESA-listed marine mammals.

6.7.2.2 Sea Turtles

A primary threat to sea turtles is their unintended capture in fishing gear, which can result in drowning or injuries that lead to mortality (e.g., swallowing hooks). Trawl fishing is among the greatest continuing primary threats to the loggerhead sea turtle (NMFS and USFWS 2008), and sea turtles are caught as bycatch in other fishing gear, including longlines, gillnets, hook and line, pound nets, pot/traps, and dredge fisheries. A substantial impact of commercial fishing on sea turtles is the entrapment or entanglement that occurs with a variety of fishing gear, including both mobile (e.g., trawl) and stationary (e.g., pots).

Stationary gear such as the commercial pots included under the Proposed Action (Section 3.1.6.2) poses a risk of entanglement for ESA-listed sea turtle species due to buoy and anchor lines. Of all the ESA-listed sea turtles included in this assessment, the leatherback seems to be the most vulnerable to entanglement in trap and 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 2016). 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 2016).

As described above for marine mammals, ropeless gear technology (i.e., EdgeTech acoustic release devices) will be used for all pot surveys, which eliminates the use of vertical buoy lines in the water column. This effectively reduces the entanglement risk for sea turtles. Furthermore, the short soak time (<24 hours) for gear further lowers the potential co-occurrence rate between ESA-listed sea turtles and fisheries monitoring gear, thereby reducing the overall entanglement risk. Sea turtles may also be at risk of entanglement in angling-type fishing gear (i.e., hand or hook-and-line), such as that used for the recreational fisheries survey under the Proposed Action. However, all recreational fishing gear will be hand-tended during the surveys by dedicated anglers, who would monitor the line while it is in the water. Several monitoring and mitigation measures are designed to standardize sea turtle handling and reporting procedures in response to an entanglement (Section 3.3). Notably, these measures would improve response and potential survival of released live animals if an entanglement or interaction with gear were to occur.

While there is a risk of sea turtle entanglement, particularly for leatherbacks in trap and pot gear and all sea turtle sin angling-type gear, this BA considers the likelihood of entanglement to be **discountable** given expected limited frequency and duration of Project-related fisheries surveys and the application of mitigation measures such as ropeless gear for all pot surveys, pre-deployment monitoring, short soak times, and handling protocols. Because of this, gear utilization as part of Project-related fisheries monitoring surveys **may affect, but it is not likely to adversely affect** ESA-listed sea turtles.

6.7.2.3 Marine Fish

Stationary pots such as the commercial pots included under the Proposed Action (Section 3.1.6.2) that are baited pose are unlikely to pose a risk to Atlantic and shortnose sturgeon; fish traps and pots were not recorded as potential sources for capture of Atlantic sturgeon in the Northeast Fisheries Observer Program data (Dunton et al. 2015). There is no evidence to suggest that sturgeon are susceptible to entanglement in ropes and line associated with stationary trap and pot fishing gear. Giant manta rays are at risk of entanglement in fishing gear, driven largely by incidental capture in driftnet and purse seine fisheries (Croll et al. 2016; Lawson et al. 2017). While the species become entangled in lines associated with stationary traps and pots, this risk is highly reduced under the Proposed Action through the use of ropeless gear, which eliminates the use of buoy lines. Atlantic sturgeon prey items, such as mollusks and fish; shortnose sturgeon prey items, such as mollusks and crustaceans; and giant manta ray prey items, such as small fish, may be removed from the marine environment as bycatch in trap gear. However, any bycatch prey items will be returned to the site. Therefore, the trap and pot type surveys will not affect the availability of prey for Atlantic sturgeon, shortnose sturgeon, or giant manta rays in the Project area.

Atlantic sturgeon may be at risk of entanglement in angling-type fishing gear (i.e., hand or hook-and-line), such as that used for the recreational fisheries survey under the Proposed Action. However, all recreational fishing gear will be hand-tended during the surveys by dedicated anglers, who would monitor the line while it is in the water. Similar to that described for sea turtles, several monitoring and mitigation measures are designed to standardize sturgeon handling and reporting procedures in response to an entanglement (Section 3.3). These measures will reduce impact by ensuring the handling of any sturgeon caught in fisheries sampling gear will not cause or exacerbate any direct injury to the animal. Sufficient training and proper technique will also reduce impacts to captured sturgeon by minimizing the time of handling and, therefore, the individual's stress (Bartholomew and Bohnsack 2005; Beardsall et al. 2013). Notably, these measures would improve response and potential survival of released live animals if an entanglement or interaction with gear were to occur.

Giant manta ray are pelagic filter feeders that feed on high concentrations of zooplankton and small fish; their low densities and foraging methods would reduce their potential for entanglement with the Project's recreational fisheries monitoring survey. Further, shortnose sturgeon are not expected to be present in the offshore area and therefore are not expected to encounter any Project-related fishing gear associated with the commercial and recreational monitoring surveys.

Since shortnose sturgeon are not expected to occur in the Lease Area, the species would not be affected by entanglement associated with fisheries monitoring surveys. Therefore, **no effect** is expected for shortnose sturgeon. Entanglement or capture of ESA-listed fish in gear associated with fisheries monitoring surveys is extremely unlikely, and impacts to prey resources are not expected given the short soak times and limited duration of the pot surveys. Thus, exposure of Atlantic sturgeon, and giant manta ray to entanglement in fishing gear around WTGs is unlikely to occur and, thus, **discountable**. Therefore, gear utilization as part of Project-related fisheries monitoring surveys **may affect, but it is not likely to adversely affect** Atlantic sturgeon and giant manta ray.

6.7.3 Entanglement from Altered and Displaced Fishing Activities

Offshore structures and the anticipated reef effect could lead to increased recreational fishing within the Lease Area and result in an increased risk of interaction with fishing gear that may lead to entanglement, ingestion, injury, and death for some ESA-listed species. The reef effect (Section 6.5.5.3) may result in drawing in recreational fishing effort from other areas, and overall interaction between ESA-listed species and fisheries could increase if ESA-species are also drawn to the Lease Areas due to increased prey abundance.

The presence of offshore structures, Project-related vessel traffic, surveys, and maintenance activities could displace commercial and recreational fishing vessels to areas outside the Lease Area. In addition, some potential exists for a shift in gear types from fixed to mobile, or vice versa, due to displacement from the Lease Area. Larger fishing vessels with small-mesh bottom-trawl gear and mid-water trawl gear may be more likely to be displaced from the Lease Area compared to smaller fishing vessels with similar gear types that may be easier to maneuver. However, the majority of recreational fishing activity off Maryland and Delaware occurs inshore, with comparatively lower levels within the Lease Area (COP, Volume II, Section 17.5.1; US Wind 2023). As a result, displacement of recreational fishing activity out of the Lease Area is not expected. Commercial fishing revenue is relatively low within the Lease Area compared to areas farther offshore (COP, Volume II, Section 17.5.1; US Wind 2023). Sea scallop dredging accounts for the greatest percentage of revenue of any gear type in the Lease Area, followed by bottom trawl and pot-type gear (COP, Volume II, Section 17.5.1; US Wind 2023). However, given the low overall use of the Lease Area by commercial fisheries, shift in gear type and displacement of fishing activity is unlikely to result in a measurable change in entanglement risk to ESA-listed species.

While changes in distribution and abundance of species targeted by commercial fisheries could occur during construction due to exposure to increased sediment, noise, and vibration, these effects are anticipated to be short term and localized. Effects are not expected to result in changes in abundance or distribution of target species that would result in changes in patterns of fishing activity. For all fisheries, any changes in fishing location are expected to be limited to moves to geographically adjacent areas given the relatively small footprint of the Project, the distribution of target species, and distance from home ports, all of which limit the potential for significant geographic shifts in distribution of fishing effort.

6.7.3.1 Marine Mammals

An increase in recreational fishing activity within the Lease Area could result in increased indirect risk of interaction with fishing gear that may lead to entanglement, ingestion, injury, or death for some ESA-listed species. If there is an increase in recreational fishing in the Project area, this likely will represent a shift in fishing effort from areas outside the wind farm area to within the wind farm area and an increase in overall recreational fishing effort in the Lease Area. However, entanglement incurred from increased recreational fishing activity in the vicinity of Project infrastructure are not anticipated for ESA-listed marine mammals given the likely gear types and methods that are expected to be utilized by recreational fishers (e.g., hook and line, jigging, etc.). In addition, although forage fish species preyed upon by fin and sei whales may aggregate in the vicinity of offshore infrastructure, direct foraging in close proximity to Project foundations by these fin and sei whales is not anticipated. Prey species for NARWs and sperm whales are not expected to be affected or altered to any measurable degree by the presence of Project infrastructure, so these species would not be expected to forage in direct association with Project infrastructure. Given these foraging and habitat preferences, an increase in recreational fishing activity within the Lease Area is unlikely to result in a measurable increase in entanglement risk for ESA-listed marine mammals.

Project structures could also result in commercial fishing vessel displacement or gear shifts. If fishing vessels are displaced due to the presence of Project infrastructure or other Project-related activities, it is assumed that fishing would resume in areas adjacent to the Lease Area. If a shift in commercial fishing from mobile gear to fixed gear occurs, there would be a potential increase in the number of vertical lines in the water column, resulting in an increased risk of marine mammal interactions with fishing gear. However, any shifts in commercial fishing effort and gear types remain highly speculative at best and the potential impact on ESA-listed marine mammals from these changes remains uncertain.

Given their foraging strategies and habitat preferences that would not cause aggregation or attraction to WTGs, entanglement in fishing gear around project infrastructure is not expected and **discountable** for ESA-listed marine mammals. Therefore, potential entanglement due to altered and displaced fishing activity **may affect, but it is not likely to adversely affect** ESA-listed marine mammals.

6.7.3.2 Sea Turtles

As discussed earlier, 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. If there is an increase in recreational fishing in the Project area, this likely will represent a shift in fishing effort from areas outside the wind farm area to within the wind farm area and an increase in overall effort. Project 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 (e.g., trolling) to fixed gear (e.g., 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. Due to their foraging strategies, leatherback and loggerhead sea turtles are more likely to be exposed to recreational fishing lines in the pelagic Project area than Kemp's ridley and green sea turtles. Kemp's ridley sea turtles may forage on the hard substrate associated with scour protection and may be exposed to any recreational fishing gear that reaches the benthic environment. Furthermore, Kemp's ridley sea turtles can be found in the Project area in high densities during warmer months (June through September; Duke mapper data; https://seamap.env.duke.edu/models/mapper/NUWC_EC). Green sea turtles, which forage on benthic vegetation that does not occur in the Action Area, are less likely to be exposed to recreational fishing lines around Project structures and therefore have less of a chance of entanglement.

Because of their foraging strategies that would not cause aggregation or attraction to WTGs, exposure of green sea turtles to entanglement in fishing gear around project infrastructure is not expected and **discountable**. Therefore, potential entanglement due to altered and displaced fishing activity **may affect, but it is not likely to adversely affect** green sea turtles.

Based on available information, entanglement due to an increased presence of recreational fishing around the WTGs is possible and cannot be discounted for Kemp's ridley, leatherback or loggerhead sea turtles. Therefore, the potential entanglement due to altered and displaced fishing activity **may affect, likely to adversely affect** Kemp's ridley, leatherback and loggerhead sea turtles.

6.7.3.3 Marine Fish

As discussed earlier, the presence of structures during operations could concentrate recreational fishing around foundations and alter the existing distribution and gear type of commercial fisheries. Increased recreational fishing poses a secondary entanglement risk for ESA-listed fish species. The same mechanisms related to entanglement risk that are discussed in Sections 6.7.1 and 6.7.2 apply to entanglement related to altered and displaced fishing activity and are not repeated here.

Entanglement would pose a low risk to Atlantic sturgeon and giant manta ray due to their relatively low occurrences in the Project area and expected minimal direct use of or foraging at the foundations. Since shortnose sturgeon are not expected to occur in the Lease Area, the species would not be affected by altered and displaced fishing activity. Therefore, **no effect** is expected for shortnose sturgeon. Due to their benthic foraging strategy, Atlantic sturgeon have a reduced chance of being exposed to recreational fishing lines in the pelagic Project Area. Giant manta ray are pelagic filter feeders that feed on high concentrations of zooplankton and small fish. Their low densities and foraging methods would reduce their potential for entanglement within WTG area. Thus, exposure of Atlantic sturgeon and giant manta ray to entanglement in fishing gear around WTGs is unlikely to occur and, thus, **discountable**. Therefore, entanglement due to altered and displaced fishing activities **may affect, but it is not likely to adversely affect** Atlantic sturgeon and giant manta ray.

6.8 Air Emissions (C, O&M, D)

Once each phase of the Project is operational, the WTGs and OSSs would not be expected to generate any measurable air pollutant emissions. However, vessels and equipment used in the construction, O&M, and decommissioning for each phase of the Project would generate emissions that could affect air quality within the marine component of the Action Area. Most emissions would occur during Project construction within and near the Lease Area and Offshore Export Cable Route and would be temporary in duration. Emissions would primarily be generated by Project vessels and the installation equipment on board Project vessels. Additional emissions related to the Project could occur at nearby ports used to transport material and personnel to and from the Lease Area.

During O&M, operation of Project vessels for all 3 phases would result in long-term increases in air emissions related to the Proposed Action. However, air emissions from O&M activities would generally be lower than emissions generated during construction activities and are not expected to have a significant effect on regional air quality. Air emissions during decommissioning are expected to be similar or less than emissions estimated for construction activities. US Wind has proposed measures to avoid and minimize air emissions effects. Operation of WTG installation equipment during Project construction would result in short-term increases in air emissions during construction of the Proposed Action.

At this time, there is no information on the effects of air quality on ESA-listed marine mammal and sea turtle species that may occur in the marine component of the Action Area. Marine mammal and sea turtle exposures to air pollutant emissions during Project construction and O&M are anticipated to be temporary and short term. Given that vessel exhausts are located high above the water surface and most vessel activity will occur in the open ocean where exhaust will be dispersed by wind, the likelihood of individual animals being repeatedly exposed to high concentrations of airborne pollutants from Project vessels and equipment is extremely low, and changes in concentration at the water surface level are expected to be so small that they cannot be meaningfully measured. The types of activities and vessels needed for construction and decommissioning (e.g., driving and removing piles, laying and removing cable) are similar; therefore, effects to air quality from decommissioning are assumed to be similar to those of construction, such that the air quality effects throughout the lifespan of the Project are still likely to be so small that they cannot be meaningfully measured.

On this basis, it is reasonable to conclude that any effects to ESA-listed marine mammals and sea turtles from air emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are **insignificant**. Air emissions resulting from the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed marine mammals and sea turtles. Atlantic sturgeon, shortnose sturgeon, and giant manta rays would not be exposed to airborne emissions, therefore this IPF would have **no effect** on ESA-listed fish.

6.9 Lighting (C, O&M, D)

The Proposed Action would introduce mobile and stationary artificial light sources to the Action Area that would persist from dusk to dawn. Vessels and offshore structures would have deck and safety lighting, producing artificial light during the construction, O&M, and decommissioning for all 3 phases.

Lights would be required on vessels and heavy equipment during construction, though only a limited area around Project-related vessels would be lit relative to the surrounding unlit open ocean areas. The WTGs and OSSs would be lighted and marked in accordance with FAA and BOEM guidelines to aid safe navigation within the Project area. Animals could be exposed to artificial lighting from dredges operating at night during installation of the inshore export cables, but this would be limited to species likely to be present around this activity (Sections 6.3.9 and 6.5.3), and a limited area around the activity in an otherwise lit, working waterfront.

Artificial light has been shown to alter the invertebrate epifauna and fish community composition and abundance in proximity to human-made structures (Davies et al. 2015; McConnell et al. 2010; Nightingale et al. 2006). Artificial lighting may disrupt the diel migration (vertical distribution) of some prey species, including zooplankton, which may secondarily influence marine mammal distribution patterns (Orr et al. 2013). Observations at offshore oil rigs showed dolphin species foraging near the surface and staying for longer periods of time around platforms that were lit (Cremer et al. 2009). 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 (Section 5.1.1.4.2). Artificial light in coastal environments is an established stressor for juvenile sea turtles, which use light to aid in navigation and dispersal and can become disoriented when exposed to artificial lighting sources, but the significance of artificial light in offshore environments is less clear (Gless et al. 2008). Finfish impacts due to artificial light are highly species dependent and can either cause attraction or avoidance (Orr et al. 2013).

Collectively, these findings suggest the potential for effects on ESA-listed marine mammal, sea turtle, and fish species as a result of artificial lighting is low. Permanent light sources associated with nearshore or overwater structures may pose the greatest risk to ESA-listed species. While effects would be limited to the area exposed to operational lights, the effects would persist over the lifetime of the Project. Orr et al. (2013) indicated lights on WTG flash intermittently for navigation or safety purposes and do not present a continuous light source. Limpus (2006) suggested intermittent flashing lights with a very short "on" pulse and long "off" interval are non-disruptive to sea turtle behavior, irrespective of the color. Similarly, navigation and anchor lights on top of vessel masts are unlikely to adversely affect sea turtles (Limpus 2006). Additionally, any effects to nesting or emerging sea turtles from lights would be addressed in consultation with the USFWS. Atlantic and shortnose sturgeon are demersal species and unlikely to encounter the minimal lighting generated by the Proposed Action. Additionally, giant manta rays are primarily pelagic and would not be exposed to persistent nearshore lighting associated with the Project.

Orr et al. (2013) summarized available research on potential operational lighting effects from offshore wind energy facilities and concluded the effects on marine mammal, sea turtle, and fish distribution, behavior, and habitat use were unknown but likely negligible when recommended design and operating practices are implemented. Specifically, using low-intensity, shielded, directional lighting on structures; activating work lights only when needed; and using red navigation lights with low strobe frequency would reduce the amount of detectable light reaching the water surface to negligible levels.

As primarily benthic-dwelling species, Atlantic and shortnose sturgeon would not be exposed to lighting associated with the Proposed Action. Therefore, **no effect** is expected for Atlantic and shortnose sturgeon. Based on the available information, effects of lighting from vessels and offshore structures on ESA-listed marine mammals and sea turtles, and giant manta rays leading to changes in behavior and alterations in prey distribution would be too small to be meaningfully measured or detected and, therefore, **insignificant**. Given the small scale of effects, lighting associated with the Proposed Action **may affect, but is not likely to adversely affect** ESA-listed marine mammals, ESA-listed sea turtles, and giant manta ray.

6.10 Unexpected and Accidental Events (C, O&M, D)

This section considers the "low probability events" identified by BOEM in Section 2.3 of the Draft EIS (BOEM 2023b). These events are unexpected, but possible, outcomes of the Proposed Action, and include allisions (the strike of a moving vessel against a stationary object) between vessels and WTGs or OSSs, WTG failure due to weather events, and accidental spills.

6.10.1 Vessel Allisions

Shipping traffic is increasing worldwide, as is development of offshore wind energy. An allision between a vessel and Project infrastructure (i.e., WTG, OSS, or Met Tower foundations) could result in failure or destruction of the structure with the potential for release of chemicals and debris. Additionally, the vessel involved in the allision could be damaged or destroyed, also posing a risk of release of chemicals and debris that could endanger ESA-listed species. There are several measures in place to ensure such an event is extremely unlikely to occur, including the following:

- Corrective maintenance activities to mitigate for unanticipated equipment wear or malfunctions. US Wind anticipates housing spare parts for key Project components at an O&M Facility to initiate repairs expeditiously.
- Inclusion of Project components on nautical charts would limit the likelihood of a vessel operator being unaware of the Project components while navigating in the area.
- Compliance with lighting and marking required by the USCG, which is designed to allow for detection of the Project components by vessels in the area.
- Spacing of Project foundations to allow for safe navigation through the Project area.
- Adherence to NOAA vessel speed restrictions.

Because of these measures, a vessel striking a WTG, OSS, or Met Tower foundation is extremely unlikely to occur. The NSRA for the Project (COP, Volume II, Appendix K1; US Wind 2023) reached a similar conclusion and determined it is highly unlikely that a vessel will strike a foundation. In the unlikely event such a strike occurs, foundation collapse is highly unlikely, even considering the largest/heaviest vessels that could transit the Project area. Additionally, there are no documented allisions between vessels and structures associated with offshore wind farms, and these events are anticipated to be extremely rare. Therefore, impacts to ESA-listed species are extremely unlikely to occur and **discountable**, and effects from vessel allisions with Project infrastructure **may affect, but are not likely to adversely affect** ESA-listed marine mammals, sea turtles, and fish.

6.10.2 WTG Failure

Extratropical storms, including nor'easters, are common in the Project area from October to April. These storms bring high winds and heavy precipitation, which can lead to severe flooding and storm surge. Hurricanes that travel along the U.S. East Coast could affect the Project area with high winds and severe flooding. The Project area experiences return intervals of 15 to 20 years for hurricanes with wind speeds equal to or in excess of 64 knots (33 m/s); the estimated return interval for hurricanes with wind speeds equal to or in excess of 96 knots (49 m/s) is 44 to 68 years (US Wind 2023). The return rate of hurricanes may become more frequent than the historical record and the future probability of a major hurricane will likely be higher than the historical record of these events due to climate change.

While there are numerous geologic faults within Maryland, none are known or suspected to be active. Since 1758, the majority of the recorded 70 earthquakes occurring within Maryland have been minor (less than or equal to magnitude 4: non-damaging but felt) (Maryland Geological Survey 2022). Fault rupture is considered unlikely because no active or potentially active faults have been identified within or near the Project (US Wind 2023).

The engineering specifications of the WTGs and their ability to sufficiently withstand weather events is independently evaluated by a certified verification agent when reviewing the FDR and FIR according to international standards such as International Electrotechnical Commission 61400-1 and 61400-3, which include withstanding hurricane-level events. One of these standards calls for the structure to be able to withstand a 50-year return interval event. An additional standard also includes withstanding 3-second gusts of a 500-year return interval event, which would correspond to Category 5 hurricane windspeeds.

In rare cases, WTGs experience failure due to mechanical issues or weather events. WTGs are designed with safeguards to reduce the potential for failures related to wind events; however, occasional failures do occur. In the event of a catastrophic failure, turbine blades or other components of the structure come apart. While highly unlikely, structural failure of a WTG (i.e., loss of a blade or tower collapse) would result in temporary hazards to navigation for all vessels. This also poses a potential risk of injury from flying debris; however, the area of impact would be extremely small relative to available habitat, and injury to an ESA-listed species from flying debris is extremely unlikely to occur and **discountable**. Therefore, WTG failure under the Proposed Action **may affect, but it is not likely to adversely affect** ESA-listed marine mammals, sea turtles, and fish. Catastrophic failure of a WTG may also result in the release of contaminants, which is considered in the next section.

6.10.3 Accidental Spills, Pollution, and Marine Debris

Effects of Proposed Action include inadvertent risk of releases from refueling vessels, spills from routine maintenance activities, and any more significant spills as a result of a catastrophic event (which could include spills or releases from the WTG or OSS structures). Per the Oil Spill Response Plan submitted with the COP (Appendix A-1, US Wind 2023) the estimated oil types onboard each of the WTGs include oil, grease and synthetic ester dielectric fluids with total volumes of approximately 1,390 gallons (5,260.5 liters). US Wind has not achieved the final design specifications for the OSS. Oil volumes are based upon industry expert estimates for a notional 400 MW OSS, which may include diesel oil, synthetic ester oil, marine diesel oil, hydraulic oil and motor oils with total volumes of approximately 84,972 gallons (321,649 liters).

Exposure to aquatic contaminants or inhalation of fumes from oil spills can result in mortality or sublethal effects on the affected individual’s fitness, including adrenal effects, hematological effects, liver effects, lung disease, poor body condition, skin lesions, and several other health affects attributed to oil exposure (Mohr et al. 2008; Sullivan et al. 2019; Takeshita et al. 2017). However, catastrophic failure of WTGs is rare, and all vessels would be certified by the Project to conform to vessel protocols designed to minimize risk of fuel spills and leaks. US Wind would be expected to comply with USCG and BSEE regulations relating to prevention and control of oil spills.

Onshore releases could occur from construction equipment, HDD activities, or severe weather causing flooding and coastal erosion. All waste generated onshore shall comply with applicable state and federal regulations, including the Resource Conservation and Recovery Act and the Department of Transportation Hazardous Materials regulations.

Maintenance on WTGs is expected to further reduce the risk of accidental spills to such low levels that risk of any spill affecting an ESA-listed species is considered discountable. In the unexpected event of such a failure, US Wind will implement its Oil Spill Response Plan (COP Volume I, Appendix A; US Wind 2023) to contain the spill and mitigate any potential impacts. Based on the above information, impacts to ESA-listed species from contaminant releases due to unexpected events is **discountable** and, therefore, **may affect, but are not likely to adversely affect** ESA-listed marine mammals, sea turtles, and fish.

7 Summary of Effects Determinations and Conclusion

Table 7-1 summarizes the effects determinations for ESA-listed marine mammals, sea turtles, and fish species considered in this BA. Note this table is the same as the table presented in Section 6.2. The following three effects determinations were made:

1. A **may affect, not likely to adversely affect** determination was made when the Project stressors were determined to be **insignificant** or **discountable**.
   a. **Insignificant:** Effects relate to the size or severity of the effect and include effects that are undetectable, not measurable, or so minor they cannot be meaningfully evaluated. Insignificant is the appropriate effects conclusion when plausible effects are going to happen but will not rise to the level of constituting an adverse effect.
   b. **Discountable:** Effects 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 would be an adverse effect if it affected an ESA-listed species), but it is extremely unlikely to occur (NMFS and USFWS 1998).[7]
2. If the Project could result in beneficial effects on ESA-listed species (e.g., 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.
3. A **may affect, likely to adversely affect** determination was also 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.

[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."

Table 7-1. Effects determinations by stressor and species for effects from the Proposed Action

Stressor		Marine Mammals				Sea Turtles				Marine Fish		
		Fin Whale	North Atlantic Right Whale	Sei Whale	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic Ocean DPS)	Kemp's Ridley Sea Turtle	Atlantic Sturgeon	Shortnose Sturgeon	Giant Manta Ray
Underwater Noise	HRG surveys	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Vessel noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Cable installation noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Dredging during installation of the inshore export cable e	NE	NE	NE	NE	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NE
	WTG operations	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Effects on prey	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Decommissioning	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Offshore Impact Pile Driving	LAA	LAA	LAA	NLAA	LAA	LAA	LAA	LAA	NLAA	NLAA	NLAA
	Inshore Impact Pile Driving	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Foundation Relief Drilling	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Seabed Preparation	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Vessel Strike Risk	NLAA	NLAA	NLAA	NLAA	LAA	LAA	LAA	LAA	LAA	LAA	NLAA
Habitat Disturbance	Temporary Seafloor Disturbances	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE
	Turbidity	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Dredging during Installation of the Inshore Export Cable	NE	NE	NE	NE	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NE
	Permanent Seafloor Habitat Loss	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Behavioral Changes Due to the Presence of Structures	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA

	Stressor	Marine Mammals				Sea Turtles				Marine Fish		
		Fin Whale	North Atlantic Right Whale	Sei Whale	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic Ocean DPS)	Kemp's Ridley Sea Turtle	Atlantic Sturgeon	Shortnose Sturgeon	Giant Manta Ray
	Changes in Oceanographic and Hydrologic Conditions Due to the Presence of Structures	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	Reef Effect	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
	EMF and Cable Heat	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Entrainment during Installation of the Inshore Export Cable	NE	NE	NE	NE	LAA	NE	NLAA	LAA	LAA	NLAA	NE
Entanglement and Entrainment	Secondary entanglement from derelict fishing gear	NLAA	NLAA	NLAA	NLAA	NLAA	LAA	LAA	NLAA	NLAA	NE	NLAA
Entanglement and Entrainment	Entanglement from fisheries monitoring surveys: stationary gear	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
Entanglement and Entrainment	Entanglement from altered and displaced fishing activities	NLAA	NLAA	NLAA	NLAA	NLAA	LAA	LAA	LAA	NLAA	NE	NLAA
	Air Emissions	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE
	Lighting	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NLAA
	Vessel Collisions/Allisions	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Unexpected and	WTG Failure	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Unexpected and	Accidental Spills, Pollution, and Marine Debris	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Overall Effects Determination	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**

-- = not applicable for resource; DPS = distinct population segment; EMF = electromagnetic field; HRG = high-resolution geophysical; LAA = likely to adversely affect; NE = no effect; NLAA = not likely to adversely affect; OSS = Offshore substation; WTG = Wind Turbine Generator

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Appendices

Appendix A: Fisheries Resource Monitoring Program

Appendix B: Marine Mammal Monitoring Program

Appendix C: Near Real-Time Whale Buoy Monitoring Program

Appendix D: Results from Multi-Species Pile Driving Calculator Tool for O&M Facility