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Ocean Wind 1 Offshore Wind Farm Final Environmental Impact Statement

May 2023

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Office of Renewable Energy Programs

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ENVIRONMENTAL IMPACT STATEMENT FOR THE OCEAN WIND 1 OFFSHORE WIND FARM

DRAFT ( ) FINAL (X)

Lead Agency:	U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs
Cooperating Federal Agencies:	National Oceanic and Atmospheric Administration, National Marine Fisheries Service U.S. Department of Defense U.S. Department of Defense, U.S. Army Corps of Engineers U.S. Department of Homeland Security, U.S. Coast Guard U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement U.S. Environmental Protection Agency U.S. Department of the Interior, National Park Service U.S. Department of the Interior, U.S. Fish and Wildlife Service
Cooperating State Agencies:	New Jersey Department of Environmental Protection New York State Department of State New Jersey Board of Public Utilities
Contact Person:	Lisa Landers National Environmental Policy Act Coordinator Office of Renewable Energy Programs, Environment Branch for Renewable Energy Bureau of Ocean Energy Management Office (703) 787-1520 lisa.landers@boem.gov
Area:	Area of Renewable Energy Lease Number OCS-A 0498

Abstract:

This Final Environmental Impact Statement (EIS) assesses the reasonably foreseeable impacts on physical, biological, socioeconomic, and cultural resources that could result from the construction and installation, operations and maintenance, and conceptual decommissioning of the Ocean Wind 1 Offshore Wind Farm (Project) proposed by Ocean Wind LLC (Ocean Wind), in its Construction and Operations Plan (COP). The proposed Project described in the COP and this Final EIS would be approximately 1,100 megawatts in scale and sited 15 miles (13 nautical miles) southeast of Atlantic City, New Jersey, within the area of Renewable Energy Lease Number OCS-A 0498 (Lease Area). The Project would serve demand for renewable energy in New Jersey. This Final EIS was prepared in accordance with the requirements of the National Environmental Policy Act (42 United States Code 4321–4370f) and implementing regulations of the Council on Environmental Quality and the Department of the Interior. This Final EIS will inform the Bureau of Ocean Energy Management's decision on whether to approve, approve with modifications, or disapprove the Project's COP.

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S. Executive Summary

S.1. Introduction

This Final Environmental Impact Statement (EIS) assesses the reasonably foreseeable impacts on physical, biological, socioeconomic, and cultural resources that could result from the construction and installation, operations and maintenance (O&M), and conceptual decommissioning of a commercial-scale offshore wind energy facility and transmission cable to shore known as the Ocean Wind 1 Offshore Wind Farm (Project). The Bureau of Ocean Energy Management (BOEM) has prepared the Final EIS under the National Environmental Policy Act (NEPA) (42 U.S. Code [USC] 4321–4370f). This Final EIS will inform BOEM's decision on whether to approve, approve with modifications, or disapprove the Project's Construction and Operations Plan (COP).

Cooperating agencies may rely on this EIS to support their decision-making. In conjunction with submitting its COP, Ocean Wind LLC (Ocean Wind, the Applicant) applied to the National Marine Fisheries Service (NMFS) for an incidental take authorization under the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 USC 1361 et seq.), for incidental take of marine mammals during Project construction. NMFS needs to render a decision regarding the request for authorization due to NMFS' responsibilities under the MMPA (16 USC 1371 (a)(5)(A) and its implementing regulations. NMFS intends to adopt the Final EIS if, after independent review and analysis, NMFS determines the Final EIS to be sufficient to support its separate proposed action and decision to issue the authorization, if appropriate. The U.S. Army Corps of Engineers (USACE) similarly intends to adopt the EIS to meet its responsibilities under Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899 (RHA).

S.2. Purpose and Need for the Proposed Action

In Executive Order 14008, *Tackling the Climate Crisis at Home and Abroad*, issued January 27, 2021, President Biden stated that it is the policy of the United States "to organize and deploy the full capacity of its agencies to combat the climate crisis to implement a Government-wide approach that reduces climate pollution in every sector of the economy; increases resilience to the impacts of climate change; protects public health; conserves our lands, waters, and biodiversity; delivers environmental justice; and spurs well-paying union jobs and economic growth, especially through innovation, commercialization, and deployment of clean energy technologies and infrastructure."

Through a competitive leasing process under 30 Code of Federal Regulations (CFR) 585.211, Ocean Wind was awarded commercial Renewable Energy Lease OCS-A 0498 covering an area offshore New Jersey (Lease Area). Under the terms of the lease, Ocean Wind has the exclusive right to submit a COP for activities within the Lease Area, and it has submitted a COP to BOEM proposing the construction and installation, O&M, and conceptual decommissioning of an approximately 1,100-megawatt (MW) offshore wind energy facility in the Lease Area in accordance with BOEM's COP regulations under 30 CFR 585.626, et seq. (Figure S-1).

Based on BOEM's authority under the Outer Continental Shelf Lands Act (OCSLA) to authorize renewable energy activities on the Outer Continental Shelf (OCS), and Executive Order 14008; the shared goals of the federal agencies to deploy 30 GW of offshore wind energy capacity in the United States by

2030, while protecting biodiversity and promoting ocean co-use[1]; and in consideration of the goals of the Applicant, the purpose of BOEM's action is to determine whether to approve, approve with modifications, or disapprove Ocean Wind's COP. BOEM will make this determination after weighing the factors in Subsection 8(p)(4) of the OCSLA that are applicable to plan decisions and in consideration of the above goals. BOEM's action is needed to fulfill its duties under the lease, which require BOEM to make a decision on the lessee's plans to construct and operate a commercial-scale offshore wind energy facility within the Lease Area (the Proposed Action).

In addition, the National Oceanic and Atmospheric Administration's (NOAA) NMFS received a request for authorization to take marine mammals incidental to construction activities related to the Project, which NMFS may authorize under the MMPA. NMFS's issuance of an MMPA incidental take authorization is a major federal action and, in relation to BOEM's action, is considered a connected action (40 CFR 1501.9(e)(1)). The purpose of the NMFS action—which is a direct outcome of Ocean Wind's request for authorization to take marine mammals incidental to specified activities associated with the Project (e.g., pile driving)—is to evaluate Ocean Wind's request under requirements of the MMPA (16 USC 1371(a)(5)(A)) and its implementing regulations administered by NMFS and to decide whether to issue the authorization. NMFS needs to render a decision regarding the request for authorization due to NMFS' responsibilities under the MMPA (16 USC 1371(a)(5)(A)) and its implementing regulations. NMFS intends to adopt the Final EIS if, after independent review and analysis, NMFS determines the Final EIS to be sufficient to support its separate proposed action and decision to issue the authorization, if appropriate.

The USACE Philadelphia District anticipates requests for authorization of a permit action to be undertaken through authority delegated to the District Engineer by 33 CFR 325.8, pursuant to Section 10 of the RHA (33 USC 403) and Section 404 of the CWA (33 USC 1344). In addition, USACE anticipates that a "Section 408 permission" will be required pursuant to Section 14 of the RHA (33 USC 408) for any proposed alterations that have the potential to alter, occupy, or use any federally authorized civil works projects. USACE considers issuance of permits under these three delegated authorities a major federal action connected to BOEM's action (40 CFR 1501.9(e)(1)). The need for the Project as provided by the Applicant in Ocean Wind's COP and reviewed by USACE for NEPA purposes is to provide a commercially viable offshore wind energy project within the Lease Area to meet New Jersey's need for clean energy. The basic Project purpose, as determined by USACE for Section 404(b)(1) guidelines evaluation, is offshore wind energy generation. The overall Project purpose for Section 404(b)(1) guidelines evaluation, as determined by USACE, is the construction and operation of a commercial-scale offshore wind energy project for renewable energy generation and distribution to the New Jersey energy grids.

The purpose of USACE Section 408 action as determined by Engineer Circular 1165-2-220 is to evaluate the Applicant's request and determine whether the proposed alterations are injurious to the public interest or impair the usefulness of the USACE project. The USACE Section 408 permission is needed to ensure that congressionally authorized projects continue to provide their intended benefits to the public. USACE intends to adopt BOEM's EIS to support its decision on any permits and permissions requested under Section 10 of the RHA, Section 404 of the CWA, and Section 14 of the RHA. USACE would adopt the EIS under 40 CFR 1506.3 if, after its independent review of the document, it concludes that the EIS satisfies USACE's comments and recommendations. Based on its participation as a cooperating agency and its consideration of the final EIS, USACE would issue a Record of Decision (ROD) to formally document its decision on the Proposed Action.

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[1] Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs | The White House: https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/.

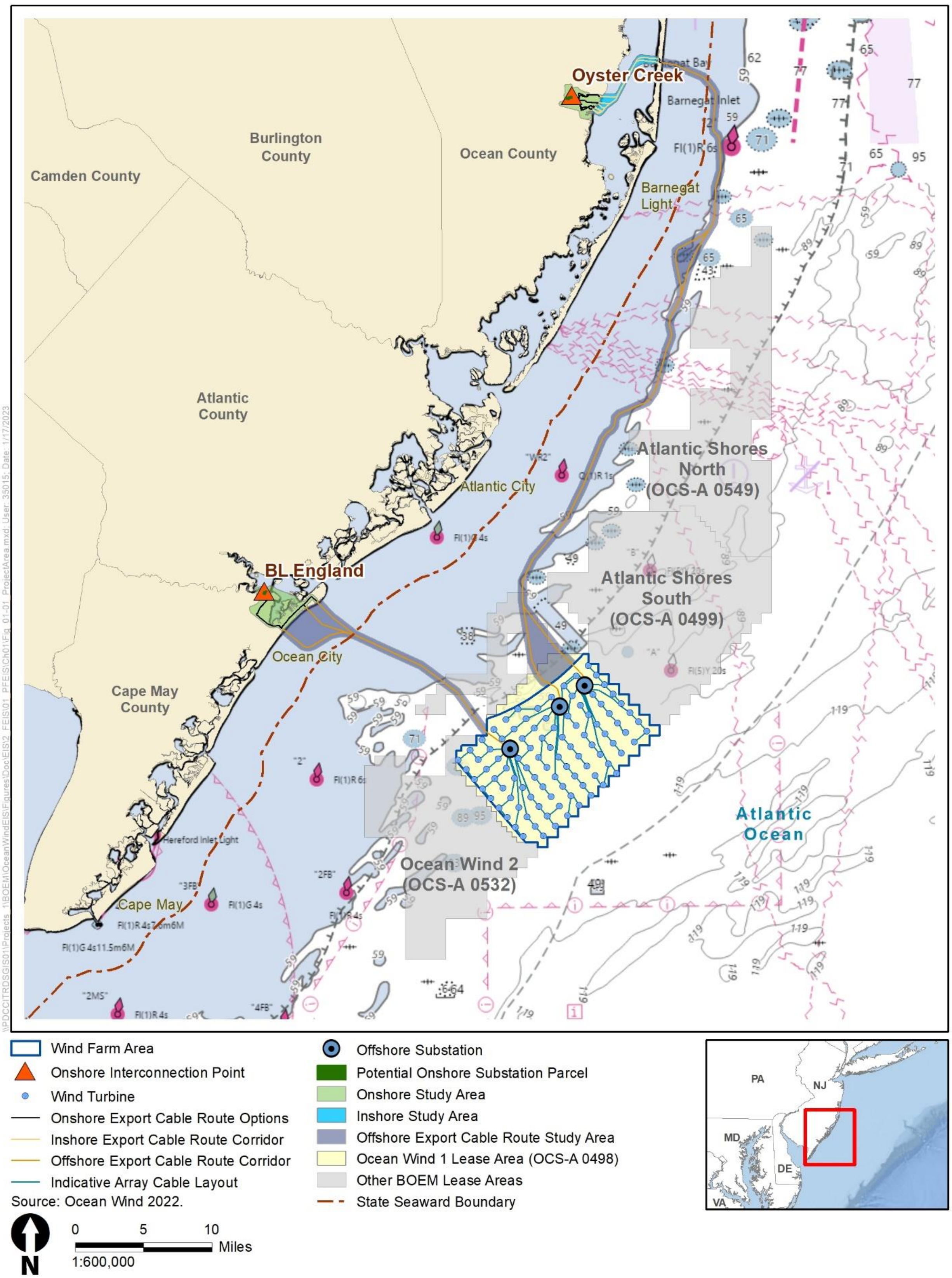

Figure S-1 Ocean Wind 1 Project

S.3. Public Involvement

On March 30, 2021, BOEM issued a Notice of Intent (NOI) to prepare an EIS, initiating a 30-day public scoping period from March 30 to April 29, 2021 (86 *Federal Register* 16630). The NOI solicited public input on the significant resources and issues, impact-producing factors, reasonable alternatives, and potential mitigation measures to analyze in the EIS. BOEM also used the NEPA scoping process to initiate the Section 106 consultation process under the National Historic Preservation Act (54 USC 300101 et seq.), as permitted by 36 CFR 800.2(d)(3), and sought public comment and input through the NOI regarding the identification of historic properties or potential effects on historic properties from activities associated with approval of the Ocean Wind 1 COP. BOEM held three virtual public scoping meetings on April 13, April 15, and April 20, 2021, to present information on the Project and NEPA process, answer questions from meeting attendees, and to solicit public comments. Scoping comments were received through Regulations.gov on docket number BOEM-2021-0024, via email to a BOEM representative, and through oral testimony at each of the three public scoping meetings. BOEM received total of 381 comment submissions from federal and state agencies, local governments, non-governmental organizations, and the general public during the scoping period. The topics most referenced in the scoping comments included commercial fisheries and for-hire recreational fishing; finfish, invertebrates, and essential fish habitat; marine mammals; birds; air quality and climate change; recreation and tourism; employment and job creation; scenic and visual resources; purpose and need; alternatives; cumulative impacts; and mitigation and monitoring. BOEM considered all scoping comments while preparing this Final EIS.

On June 24, 2022, BOEM issued a Notice of Availability of the Draft EIS, initiating a 45-day public comment period from June 24 to August 8, 2022 (87 *Federal Register* 37883). BOEM held three virtual public hearings on July 14, July 20, and July 26, 2022. On August 5, 2022, the comment period was extended by 15 days to conclude on August 23, 2022 (87 *Federal Register* 48038). Public comments were received through Regulations.gov on docket number BOEM-2022-0021, via email and mail to a BOEM representative, and through oral testimony at each of the three public hearings. BOEM received a total of 1,389 comment submissions from federal and state agencies, local governments, non-governmental organizations, and the general public during the comment period. BOEM assessed and considered all the comments received in preparation of the Final EIS. See Appendix A for additional information on public involvement.

S.4. Alternatives

BOEM considered a reasonable range of alternatives during the EIS development process that emerged from scoping, interagency coordination, and internal BOEM deliberations. The Final EIS evaluates the No Action Alternative and five action alternatives (two of which have sub-alternatives). The action alternatives are not mutually exclusive; BOEM may select a combination of alternatives that meet the purpose and need of the proposed Project. The alternatives are as follows:

- No Action Alternative
- Alternative A—Proposed Action
- Alternative B—No Surface Occupancy at Select Locations to Reduce Visual Impacts
  - Alternative B-1—No Surface Occupancy at Select Locations to Reduce Visual Impacts (Smaller Turbine Model)
  - Alternative B-2—No Surface Occupancy at Select Locations to Reduce Visual Impacts (Larger Turbine Model)
- Alternative C—Wind Turbine Layout Modification to Establish a Buffer Between Ocean Wind 1 and Atlantic Shores South

  - Alternative C-1—No Surface Occupancy to Establish a Buffer with Turbine Relocation
  - Alternative C-2—No Surface Occupancy to Establish a Buffer with Turbine Layout Compression
- Alternative D—Sand Ridge and Trough Avoidance
- Alternative E—Submerged Aquatic Vegetation Avoidance

Alternatives considered but dismissed from detailed analysis and the rationale for their dismissal are described in Section 2.1.7 and Appendix C.

S.4.1 No Action Alternative

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and conceptual decommissioning would not occur; and no additional permits or authorizations for the Project would be required. Any potential environmental and socioeconomic impacts, including benefits, associated with the Project as described under the Proposed Action would not occur. The current resource condition, trends, and impacts from ongoing activities under the No Action Alternative serves as the existing baseline against which the direct and indirect impacts of all action alternatives are evaluated.

Over the life of the proposed Project, other reasonably foreseeable future potentially impact-producing offshore wind and non-offshore wind activities would likely be implemented, which would cause changes to the existing baseline conditions even in the absence of the Proposed Action. The continuation of all other existing and reasonably foreseeable future activities described in Appendix F (*Planned Activities Scenario*) without the Proposed Action serves as the baseline for the evaluation of cumulative impacts of all alternatives.

S.4.2 Alternative A—Proposed Action

The Proposed Action would construct, operate, maintain, and decommission an approximately 1,100-MW wind energy facility on the OCS offshore New Jersey, approximately 15 miles southeast of Atlantic City, within the range of design parameters described in Volume I of the Ocean Wind 1 COP (Ocean Wind 2023) and summarized in Table S-1 and Appendix E, *Project Design Envelope and Maximum-Case Scenario*, subject to applicable mitigation measures. Refer to Volume I of the Ocean Wind 1 COP (Ocean Wind 2023) for additional details on Project design.

Table S-1. Summary of Project Design Envelope Parameters

Project Parameter Details
General (Layout and Project Size)
• Up to 98 WTGs • Project anticipated to be in service in late 2024 or early 2025
Foundations
• Monopile foundations with transition piece, or one-piece monopile/transition piece, where the transition piece is incorporated into the monopile • Foundation piles would be installed using a pile-driving hammer • Scour protection around all foundations

Project Parameter Details
Wind Turbine Generators
• Rotor diameter up to 788 feet (240 meters) • Hub height up to 512 feet (156 meters) above MLLW • Upper blade tip height up to 906 feet (276 meters) above MLLW • Lowest blade tip height 70.8 feet (22 meters) above MLLW
Inter-Array Cables
• Target burial depth of 4 to 6 feet (1.2 to 1.8 meters) depending on site conditions, navigation risk, and third-party requirement (final burial depth dependent on Cable Burial Risk Assessment and coordination with agencies) • Cables could be up to 170 kV (alternating current) • Preliminary layout available; however, final layout pending • Maximum total cable length is 190 miles (approximately 300 kilometers) • Cable lay, installation, and burial: Activities may involve use of a jetting tool (jet ROV or jet sled), vertical injection, leveling, mechanical cutting, plowing (with or without jet-assistance), pre-trenching, controlled-flow excavation
Offshore Export Cables
• Up to three maximum 275 kV alternating current export cables • Target burial depth of 4 to 6 feet (1.2 to 1.8 meters) depending on site conditions, navigation risk, and third-party requirements (final burial depth dependent on burial risk assessment and coordination with agencies) • Two export cable route corridors, Oyster Creek and BL England • Maximum total cable length is 143 miles (230 kilometers) for Oyster Creek and 32 miles (51 kilometers) for BL England • Cable lay, installation, and burial: Activities may involve use of a jetting tool (jet ROV or jet sled), vertical injection, leveling, mechanical cutting, plowing (with or without jet-assistance), pre-trenching, backhoe dredger, controlled-flow excavation
Offshore Substations
• Up to three OSS • Total structure height up to 296 feet (90 meters) above MLLW • Maximum length and width of topside structure 295 feet (90 meters; with ancillary facilities) • OSS installed atop a modular support frame and monopile substructure or atop a piled jacket foundation substructure • Foundation piles to be installed using a pile-driving hammer • Scour protection installed at foundation locations where required
Landfall for the Offshore Export Cable
• Open cut or trenchless (e.g., HDD, direct pipe, or auger bore) installation at landfall • Up to six cable ducts for landfall, if installed by trenchless technology • A reception pit (may be subsea pit, not yet finalized) would be required to be constructed at the exit end of the bore • Construction reception pit: excavator barge, land excavator mounted to a barge, sheet piling from barge used for intertidal cofferdams, swamp excavators

Project Parameter Details
Offshore Substations Interconnector Cable
• Maximum 275 kV alternating current cables • Target burial depth of 4 to 6 feet (1.2 to 1.8 meters) depending on conditions (final burial depth dependent on burial risk assessment and coordination with agencies) • Potential layout available; however, final layout pending • Maximum total cable length is 19 miles (approximately 30 kilometers) • Cable lay, installation, and burial: Activities may involve use of a jetting tool, vertical injection, pre-trenching, scar plow, trenching (including leveling, mechanical cutting), plowing, controlled-flow excavation
Onshore Export Cable
• Connect with offshore cables at TJB and carry electricity to the onshore substation • Would be buried at a target burial depth of 4 feet (1.2 meters) (this represents a target burial depth rather than a minimum or maximum) • Could require up to a 50-foot (15-meter) wide construction corridor and up to a 30-foot (9-meter) wide permanent easement for Oyster Creek and BL England cable corridors excluding landfall locations and cable splice locations to accommodate space for splice vaults, joint bays, and HDD • Permanent easements are expected to be larger at splice vaults and transition joint bay locations • Up to eight export cables circuits would be required, with each cable circuit comprising up to three single cables. The cables would consist of copper or aluminum conductors wrapped with materials for insulation protection and sealing. • TJBs, splice vaults/grounding link boxes, and fiber optic system, including manholes
Onshore Substations and Interconnector Cable
• Two onshore substations in proximity to existing substations with associated infrastructure • Each onshore substation would require a permanent site (for Oyster Creek interconnection point up to 31.5 acres and for BL England up to 13 acres), including area for the substation equipment and buildings, energy storage, and stormwater management and landscaping • During construction, up to an additional 3 acres would be required for temporary workspace • The main buildings within the substations would be up to 1,017 feet long, 492 feet wide, and 82 feet tall (310 meters long, 150 meters wide, and 25 meters tall) • Secondary buildings may be used to house reactive compensation, transformers, filters, a control room, and a site office. The external electrical equipment may include switchgear, busbars, transformers, high-voltage reactors, SVC/static synchronous compensator, synchronous condensers, harmonic filters, and other auxiliary equipment. Lightning protection would include up to 35 lightning masts at Oyster Creek and up to 25 masts at BL England for a total height up to 98 feet (30 meters). • Maximum height of overhead lines would be 115 feet (35 meters) • Interconnector cable to existing substation

HDD = horizontal directional drilling; kV = kilovolt; MLLW = mean lower low water; OSS = Offshore Substation; ROV = remotely operated vehicle; SVC = static VAR compensator; TJB = Transition Joint Bay; WTG = wind turbine generator

S.4.3 Alternative B—No Surface Occupancy at Select Locations to Reduce Visual Impacts

Under Alternative B, the construction, O&M, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the COP, subject to applicable mitigation measures. However, no surface occupancy would occur at select wind turbine generator (WTG) positions to reduce the visual impacts of the proposed Project. Each of the sub-alternatives below may be individually selected or combined with any or all other alternatives or sub-alternatives, subject to the combination meeting the purpose and need.

- **Alternative B-1:** No Surface Occupancy at Select Locations to Reduce Visual Impacts (Smaller Turbine Model): This alternative would exclude placement of WTGs at up to nine WTG positions that are nearest to coastal communities (positions F01 to K01 and B02 to D02).
- **Alternative B-2:** No Surface Occupancy at Select Locations to Reduce Visual Impacts (Larger Turbine Model): This alternative would exclude placement of WTGs at up to 19 WTG positions that are nearest to coastal communities (positions F01 to K01, A02 to K02, A03, and C03). Selection of this alternative would be contingent on the larger turbine with a 240-meter rotor diameter being commercially available when BOEM issues its ROD as well as its technical and economic feasibility, and consistency with the purpose and need.

S.4.4 Alternative C—Wind Turbine Layout Modification to Establish a Buffer Between Ocean Wind 1 and Atlantic Shores South

Under Alternative C, the construction, O&M, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the Ocean Wind 1 COP, subject to applicable mitigation measures. However, modifications would be made to the wind turbine array layout to create a 0.81-nautical-mile (nm) to 1.08-nm buffer between WTGs in the lease area of OCS-A 0498 (Ocean Wind 1 Lease Area) and WTGs in the lease area of OCS-A 0499 (Atlantic Shores South Lease Area) to reduce impacts on existing ocean uses, such as commercial and recreational fishing and marine (surface and aerial) navigation. Each of the sub-alternatives below may be individually selected or combined with any or all other alternatives or sub-alternatives, subject to the combination meeting the purpose and need.

- **Alternative C-1:** No Surface Occupancy to Establish a Buffer with Turbine Relocation: No surface occupancy along the northeastern boundary of the Ocean Wind 1 Lease Area (A02 to A09) through the exclusion of eight WTG positions, relocation of up to eight WTG positions to the northern portion of the Ocean Wind 1 Lease Area, or some combination of exclusion and relocation of WTG positions, to allow for a 0.81-nm to 1.08-nm buffer between WTGs in the Ocean Wind 1 Lease Area and WTGs in the Atlantic Shores South Lease Area.
- **Alternative C-2:** No Surface Occupancy to Establish a Buffer with Turbine Layout Compression: No surface occupancy along the northeastern boundary of the Ocean Wind 1 Lease Area to allow for an 0.81-nm to 1.08-nm buffer between WTGs in the Ocean Wind 1 Lease Area and WTGs in the Atlantic Shores South Lease Area. However, under Alternative C-2, the wind turbine array layout would be compressed to allow for a full build of up to 98 WTGs. Ocean Wind 1's turbine array row spacing would be reduced from 1 nm between rows to no less than 0.92 nm between rows.

S.4.5 Alternative D—Sand Ridge and Trough Avoidance

Under Alternative D, the construction, O&M, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the Ocean Wind 1 COP, subject to applicable mitigation measures. However, modifications would be made to the wind turbine array layout to minimize impacts on sand ridge and trough features in the northeastern corner of the Lease Area. This alternative would result in the exclusion of up to 15 WTG positions in the sand ridge and trough area that include A07 to E07, A08 to E08, and A09 to E09. Selection of this alternative with the exclusion of more than nine WTGs would be contingent on the larger turbine with a 240-meter rotor diameter being commercially available when BOEM issues its ROD as well as its technical and economic feasibility, and consistency with the purpose and need.

S.4.6 Alternative E—Submerged Aquatic Vegetation Avoidance

Under Alternative E, the construction, operation, maintenance, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the Ocean Wind 1 COP, subject to applicable mitigation measures. However, the Oyster Creek export cable route traversing Island Beach State Park would be limited to the export cable route option developed to minimize impacts on submerged aquatic vegetation in Barnegat Bay. The alternative may be combined with any or all other alternatives or sub-alternatives, subject to the combination meeting the purpose and need. The submerged aquatic vegetation avoidance export cable route option would make landfall within an auxiliary parking lot of Swimming Area 2 in Island Beach State Park, continue north within parking lots, then northwest under Shore Road before entering Barnegat Bay. Upon entering Barnegat Bay, the export cable route would continue within a previously dredged channel and then reconnect to the Oyster Creek export cable route in Barnegat Bay.

S.5. Environmental Impacts

This Final EIS uses a four-level classification scheme to characterize the potential beneficial impacts and adverse impacts of alternatives as either **negligible**, **minor**, **moderate**, or **major**. Resource-specific adverse and beneficial impact level definitions are presented in each Chapter 3 resource section.

BOEM analyzes the impacts of past and ongoing activities in the absence of the Project as the No Action Alternative. The No Action Alternative serves as the existing baseline against which all action alternatives are evaluated. BOEM also separately analyzes cumulative impacts of the No Action Alternative, which considers all other ongoing and reasonably foreseeable future activities described in Appendix F, *Planned Activities Scenario*. In this analysis, the cumulative impacts of the No Action Alternative serve as the baseline against which the cumulative impacts of all action alternatives are evaluated. Table S-2 summarizes the impacts of each alternative and the cumulative impacts of each alternative; refer to the Chapter 3 resource sections for additional analysis supporting these impact determinations. Under the No Action Alternative, the environmental and socioeconomic impacts and benefits of the action alternatives would not occur.

NEPA implementing regulations (40 CFR 1502.16) require that an EIS evaluate the potential unavoidable adverse impacts associated with a proposed action. Adverse impacts that can be reduced by mitigation measures but not eliminated are considered unavoidable. The same regulations also require that an EIS review the potential impacts of irreversible or irretrievable commitments of resources resulting from implementation of a proposed action. Irreversible commitments occur when the primary or secondary impacts from the use of a resource either destroy the resource or preclude it from other uses. Irretrievable commitments occur when a resource is consumed to the extent that it cannot recover or be replaced.

Appendix L, *Other Impacts*, describes potential unavoidable adverse impacts. Most potential unavoidable adverse impacts associated with the Proposed Action would occur during the construction phase, and would be temporary. Appendix L also describes irreversible and irretrievable commitment of resources by resource area. The most notable such commitments could include effects on habitat or individual members of protected species, as well as potential loss of use of commercial fishing areas.

Table S-2 Summary and Comparison of Impacts Among Alternatives with No Mitigation Measures

Resource	No Action Alternative	Alternative A Proposed Action	Alternative B (B-1/B-2)[1] Reduce Visual Impacts	Alternative C (C-1/C-2)[1] Buffer Between Lease Areas	Alternative D Sand Ridge and Trough Avoidance	Alternative E Submerged Aquatic Vegetation Avoidance
3.4 Air Quality						
Alternative Impacts	Moderate	Minor to moderate; minor beneficial	Minor to moderate; minor beneficial	Minor to moderate; minor beneficial	Minor to moderate; minor beneficial	Minor to moderate; minor beneficial
Cumulative Impacts	Moderate; minor to moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial
3.5 Bats						
Alternative Impacts	Negligible to minor	Negligible to minor	Negligible to minor	Negligible to minor	Negligible to minor	Negligible to minor
Cumulative Impacts	Negligible to minor	Negligible to minor	Negligible to minor	Negligible to minor	Negligible to minor	Negligible to minor
3.6 Benthic Resources						
Alternative Impacts	Negligible to moderate	Negligible to moderate; moderate beneficial	Negligible to minor; moderate beneficial	Negligible to minor; moderate beneficial	Negligible to minor; moderate beneficial	Negligible to minor; moderate beneficial
Cumulative Impacts	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial
3.7 Birds						
Alternative Impacts	Minor	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial
Cumulative Impacts	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial	Moderate; moderate beneficial

Resource	No Action Alternative	Alternative A Proposed Action	Alternative B (B-1/B-2)[1] Reduce Visual Impacts	Alternative C (C-1/C-2)[1] Buffer Between Lease Areas	Alternative D Sand Ridge and Trough Avoidance	Alternative E Submerged Aquatic Vegetation Avoidance
3.8 Coastal Habitats						
Alternative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Cumulative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
3.9 Commercial Fisheries and For-Hire Recreational Fishing						
Alternative Impacts	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial
Cumulative Impacts	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial	Minor to major on commercial fisheries and minor to moderate on for-hire recreational fishing depending on the fishery or fishing operation; minor to moderate beneficial
3.10 Cultural Resources						
Alternative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Resource	No Action Alternative	Alternative A Proposed Action	Alternative B (B-1/B-2)[1] Reduce Visual Impacts	Alternative C (C-1/C-2)[1] Buffer Between Lease Areas	Alternative D Sand Ridge and Trough Avoidance	Alternative E Submerged Aquatic Vegetation Avoidance
Cumulative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
3.11 Demographics, Employment, and Economics						
Alternative Impacts	Minor; minor beneficial	Minor; moderate beneficial	Minor; moderate beneficial	Minor; moderate beneficial	Minor; moderate beneficial	Minor; moderate beneficial
Cumulative Impacts	Minor; moderate beneficial	Minor; moderate beneficial	Minor; moderate beneficial	Minor; moderate beneficial	Minor; moderate beneficial	Minor; moderate beneficial
3.12 Environmental Justice						
Alternative Impacts	Minor to moderate; minor beneficial	Moderate	Moderate	Moderate	Moderate	Moderate
Cumulative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
3.13 Finfish, Invertebrates, and Essential Fish Habitat						
Alternative Impacts	Moderate	Negligible to moderate	Negligible to moderate	Negligible to moderate	Negligible to moderate	Negligible to moderate
Cumulative Impacts	Moderate	Negligible to moderate	Negligible to moderate	Negligible to moderate	Negligible to moderate	Negligible to moderate
3.14 Land Use and Coastal Infrastructure						
Alternative Impacts	Negligible; minor beneficial	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial
Cumulative Impacts	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial	Minor; minor beneficial
3.15 Marine Mammals						
Alternative Impacts	Odontocetes and pinnipeds: minor to moderate	Odontocetes and pinnipeds: minor; minor beneficial	Odontocetes and pinnipeds: minor; minor beneficial	Odontocetes and pinnipeds: minor; minor beneficial	Odontocetes and pinnipeds: minor; minor beneficial	Odontocetes and pinnipeds: minor; minor beneficial
	Other Mysticetes: minor to moderate	Other Mysticetes: moderate	Other Mysticetes: moderate	Other Mysticetes: moderate	Other Mysticetes: moderate	Other Mysticetes: moderate

Resource	No Action Alternative	Alternative A Proposed Action	Alternative B (B-1/B-2)[1] Reduce Visual Impacts	Alternative C (C-1/C-2)[1] Buffer Between Lease Areas	Alternative D Sand Ridge and Trough Avoidance	Alternative E Submerged Aquatic Vegetation Avoidance
	NARW: moderate to major[2]	NARW: moderate to major[2]	NARW: moderate to major[2]	NARW: moderate to major[2]	NARW: moderate to major[2]	NARW: moderate to major[2]
Cumulative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	NARW: moderate to major[2]	NARW: moderate to major[2]	NARW: moderate to major[2]	NARW: moderate to major[2]	NARW: moderate to major[2]	NARW: moderate to major[2]
3.16 Navigation and Vessel Traffic						
Alternative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Cumulative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
3.17 Other Uses						
Alternative Impacts	Marine Mineral Extraction: negligible	Marine Mineral Extraction: negligible	Marine Mineral Extraction: negligible	Marine Mineral Extraction: negligible	Marine Mineral Extraction: negligible	Marine Mineral Extraction: negligible
	Military and National Security Uses: negligible	Military and National Security: minor for most but moderate for search and rescue activities	Military and National Security: minor for most but moderate for search and rescue activities	Military and National Security: minor for most but moderate for search and rescue activities	Military and National Security: minor for most but moderate for search and rescue activities	Military and National Security Uses: minor, but moderate for search and rescue activities
	Aviation and Air Traffic: negligible	Aviation and Air Traffic: minor	Aviation and Air Traffic: minor	Aviation and Air Traffic: minor	Aviation and Air Traffic: minor	Aviation and Air Traffic: minor
	Cables and Pipelines: negligible	Cables and Pipelines: negligible	Cables and Pipelines: negligible	Cables and Pipelines: negligible	Cables and Pipelines: negligible	Cables and Pipelines: negligible
	Radar Systems: negligible	Radar: minor	Radar: minor	Radar: minor	Radar: minor	Radar: minor
	Scientific Research and Surveys: moderate	Scientific Research and Surveys: major	Scientific Research and Surveys: major	Scientific Research and Surveys: major	Scientific Research and Surveys: major	Scientific Research and Surveys: major

Resource	No Action Alternative	Alternative A Proposed Action	Alternative B (B-1/B-2)[1] Reduce Visual Impacts	Alternative C (C-1/C-2)[1] Buffer Between Lease Areas	Alternative D Sand Ridge and Trough Avoidance	Alternative E Submerged Aquatic Vegetation Avoidance
Cumulative Impacts	Marine Mineral Extraction: negligible to minor	Marine Mineral Extraction: negligible to minor	Marine Mineral Extraction: negligible to minor	Marine Mineral Extraction: negligible to minor	Marine Mineral Extraction: negligible to minor	Marine Mineral Extraction: negligible to minor
	Military and National Security: minor for most but moderate for search and rescue activities	Military and National Security Uses: negligible to minor for most but moderate for search and rescue activities	Military and National Security Uses: negligible to minor for most but moderate for search and rescue activities	Military and National Security Uses: minor for most but moderate for search and rescue activities	Military and National Security Uses: negligible to minor for most but moderate for search and rescue activities	Military and National Security Uses: negligible to minor for most but moderate for search and rescue activities
	Aviation and Air Traffic: negligible to minor	Aviation and Air Traffic: negligible to minor	Aviation and Air Traffic: negligible to minor	Aviation and Air Traffic: negligible to minor	Aviation and Air Traffic: negligible to minor	Aviation and Air Traffic: negligible to minor
	Cables and Pipelines: negligible to minor	Cables and Pipelines: negligible to minor	Cables and Pipelines: negligible to minor	Cables and Pipelines: negligible to minor	Cables and Pipelines: negligible to minor	Cables and Pipelines: negligible to minor
	Radar Systems: moderate	Radar Systems: moderate	Radar Systems: moderate	Radar Systems: moderate	Radar Systems: moderate	Radar Systems: moderate
	Scientific Research and Surveys: major	Scientific Research and Surveys: major	Scientific Research and Surveys: major	Scientific Research and Surveys: major	Scientific Research and Surveys: major	Scientific Research and Surveys: major
3.18 Recreation and Tourism						
Alternative Impacts	Negligible	Moderate; minor beneficial	Moderate; minor beneficial	Moderate; minor beneficial	Moderate; minor beneficial	Moderate; minor beneficial
Cumulative Impacts	Moderate; minor beneficial	Moderate; minor beneficial	Moderate; minor beneficial	Moderate; minor beneficial	Moderate; minor beneficial	Moderate; minor beneficial

Resource	No Action Alternative	Alternative A Proposed Action	Alternative B (B-1/B-2)[1] Reduce Visual Impacts	Alternative C (C-1/C-2)[1] Buffer Between Lease Areas	Alternative D Sand Ridge and Trough Avoidance	Alternative E Submerged Aquatic Vegetation Avoidance
3.19 Sea Turtles						
Alternative Impacts	Minor	Negligible to minor; minor beneficial	Negligible to minor; minor beneficial	Negligible to minor; minor beneficial	Negligible to minor; minor beneficial	Negligible to minor; minor beneficial
Cumulative Impacts	Minor	Minor	Minor	Minor	Minor	Minor
3.20 Scenic and Visual Resources						
Alternative Impacts	Minor to moderate	Negligible to major	Negligible to major	Negligible to major	Negligible to major	Negligible to major
Cumulative Impacts	Major	Major	Major	Major	Major	Major
3.21 Water Quality						
Alternative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Cumulative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
3.22 Wetlands						
Alternative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Cumulative Impacts	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Impact rating colors are as follows: orange = major; yellow = moderate; green = minor; light green = negligible. All impact levels are assumed to be adverse unless otherwise specified as beneficial. Where impacts are presented as multiple levels, the color representing the most adverse level of impact has been applied.

[1] Impacts are the same under Alternatives B-1 and B-2 and Alternatives C-1 and C-2 unless otherwise noted in the table.

[2] Impacts were assessed as moderate to major for the No Action Alternative and action alternatives for North Atlantic right whale (NARW) because impacts on individual NARWs could have severe population-level effects and compromise the viability of the species due to their low population numbers and continued state of decline.

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ABBREVIATIONS AND ACRONYMS

Abbreviation	Definition
°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	microgram per liter
µPa	micropascal
µPa-m	micropascal meter
$µPa^2$	micropascal squared
$µPa^2s$	micropascal squared second
AAQS	ambient air quality standards
ACHP	Advisory Council on Historic Preservation
ADLS	Aircraft Detection Lighting System
AFB	Air Force Base
AIS	Automatic Identification System
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMSL	above mean sea level
APE	area of potential effects
APM	Applicant-proposed measure
ARSR-4	Air Route Surveillance Radar-4
ASMFC	Atlantic States Marine Fisheries Commission
ASR-9	Airport Surveillance Radar-9
AWEA	American Wind Energy Association
BA	Biological Assessment
BIA	biologically important area
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BPU	Board of Public Utilities
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CBRA	Cable Burial Risk Assessment
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
CO_2	carbon dioxide
COBRA	CO-Benefits Risk Assessment
COP	Construction and Operations Plan
CWA	Clean Water Act
DASR	Digital Airport Surveillance Radar
dB	decibel
dBA	A-weighted decibel
dB_{RMS}	root-mean-square decibels
dB re 1 µPa	decibel relative to 1 micropascal

Abbreviation	Definition
DNA	deoxyribonucleic acid
DO	dissolved oxygen
DOD	Department of Defense
DPS	distinct population segment
EBS	Ecological Baseline Studies
EC	Earth curvature
EFH	essential fish habitat
EIS	Environmental Impact Statement
EMF	electromagnetic field
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FMP	Fishery Management Plan
FOV	field of view
FTE	full-time equivalent
FWRAM	Full Waveform Range-dependent Acoustic Model
G&G	geophysical and geotechnical
GDP	gross domestic product
GHG	greenhouse gas
GW	gigawatt
HABS	Historic American Buildings Survey
HAP	hazardous air pollutant
HAPC	habitat area of particular concern
HDD	horizontal directional drilling
HFC	high-frequency cetaceans
HRG	high-resolution geophysical
HUC	hydrologic unit code
HVAC	high-voltage alternating current
HVDC	high-voltage direct current
Hz	Hertz
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IPF	impact-producing factor
IWG	Interagency Working Group
kJ	kilojoule
km^2	square kilometer
KOP	Key Observation Point
kV	kilovolt
Lease Area	area of Renewable Energy Lease Number OCS-A 0498
LFC	low-frequency cetaceans
LME	Large Marine Ecosystem
m/s	meter per second

Abbreviation	Definition
m^2	square meter
MAFMC	Mid-Atlantic Fishery Management Council
MEC	munitions and explosives of concern
MFC	mid-frequency cetaceans
mg/L	milligram per liter
MLLW	mean lower low water
MMPA	Marine Mammal Protection Act
MONM	Marine Operation Noise Model
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NABCI	North American Bird Conservation Initiative
NARW	North Atlantic right whale
NEAMAP	Northeast Area Monitoring and Assessment Program
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NJDEP	New Jersey Department of Environmental Protection
nm	nautical mile
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_X	nitrogen oxides
NRHP	National Register of Historic Places
NSRA	Navigation Safety Risk Assessment
NWI	National Wetlands Inventory
NYSDOS	New York State Department of State
O&M	operations and maintenance
Ocean Wind	Ocean Wind LLC
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OPAREA	operating area
OREC	Offshore Wind Renewable Energy Certificate
Ørsted	Ørsted Wind Power North America, LLC
OSS	Offshore Substation(s)
PATON	private aid to navigation
PCB	polychlorinated biphenyls
PDE	Project Design Envelope
PM_{10}	particulate matter smaller than 10 microns in diameter

Abbreviation	Definition
$PM_{2.5}$	particulate matter smaller than 2.5 microns in diameter
Project	Ocean Wind 1 Offshore Wind Farm
PTS	permanent threshold shift
Q	quarter
RAL	radar-activated light
RHA	Rivers and Harbors Act of 1899
RMS	root mean square
ROD	Record of Decision
RODA	Responsible Offshore Development Alliance
RSZ	rotor-swept zone
SAP	Site Assessment Plan
SAR	search and rescue
SAV	submerged aquatic vegetation
SC-GHG	social cost of greenhouse gases
screening criteria	Bureau of Ocean Energy Management’s screening criteria
SEL	sound exposure level
SGCN	Species of Greatest Conservation Need
SHPO	State Historic Preservation Officer
SLIA	seascape, open ocean, and landscape impact assessment
SLVIA	seascape, landscape, and visual impact assessment
SO_2	sulfur dioxide
SPL	sound pressure level
SPL_{peak}	peak sound pressure level
SPL_{RMS}	root-mean-square sound pressure level
STSSN	Sea Turtle Stranding and Salvage Network
SWPPP	stormwater pollution prevention plan
TCP	traditional cultural property
TJB	Transition Joint Bay
TSS	Traffic Separation Scheme
TTS	temporary threshold shift
UME	Unusual Mortality Event
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
VIA	visual impact assessment
VMS	Vessel Monitoring System
VOC	volatile organic compound
WEA	Wind Energy Area
WNS	white-nose syndrome

Abbreviation	Definition
WSR-88D	Weather Surveillance Radar-1988 Doppler
WTG	wind turbine generator

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1. Introduction

This Final Environmental Impact Statement (EIS) assesses the potential biological, socioeconomic, physical, and cultural impacts that could result from the construction, operations and maintenance (O&M), and conceptual decommissioning of the Ocean Wind 1 Offshore Wind Farm (Project) proposed by Ocean Wind LLC (Ocean Wind),[1] in its Construction and Operations Plan (COP).[2] The proposed Project described in the COP and this Final EIS would be approximately 1,100 megawatts (MW) in scale and sited 15 miles (13 nautical miles [nm]) southeast of Atlantic City, New Jersey, within the area of Renewable Energy Lease Number OCS-A 0498 (Lease Area). The Project is designed to serve demand for renewable energy in New Jersey. This Final EIS will inform the Bureau of Ocean Energy Management (BOEM) in deciding whether to approve, approve with modifications, or disapprove the COP (30 Code of Federal Regulations [CFR] 585.628).

This Final EIS was prepared following the requirements of the National Environmental Policy Act (NEPA) (42 United States Code [USC] 4321 et seq.) and implementing regulations (40 CFR 1500–1508). The Council on Environmental Quality's (CEQ) current regulations contain a presumptive time limit of 2 years for completing EISs, and a presumptive page limit of 150 pages or fewer or 300 pages for proposals of unusual scope or complexity. BOEM has followed those limits in preparing this EIS in accordance with the new regulations. Additionally, this Final EIS was prepared consistent with the U.S. Department of the Interior's NEPA regulations (43 CFR 46), longstanding federal judicial and regulatory interpretations, and Administration priorities and policies including Secretary's Order No. 3399 requiring bureaus and offices to not apply any of the provisions of the 2020 changes to CEQ regulations (85 *Federal Register* 43304–43376) "in a manner that would change the application or level of NEPA that would have been applied to a proposed action before the 2020 Rule went into effect." The Ocean Wind 1 COP and all of the volumes and appendices supporting the COP are incorporated into the EIS by reference and are available at: https://www.boem.gov/ocean-wind-1-construction-and-operations-plan.

1.1. Background

In 2009, the U.S. Department of the Interior announced final regulations for the Outer Continental Shelf (OCS) Renewable Energy Program, which was authorized by the Energy Policy Act of 2005. The Energy Policy Act provisions implemented by BOEM provide a framework for issuing renewable energy leases, easements, and rights-of-way for OCS activities (see Section 1.3). BOEM's renewable energy program occurs in four distinct phases: (1) regional planning and analysis, (2) lease issuance, (3) site assessment, and (4) construction and operations. The history of BOEM's planning and leasing activities offshore New Jersey is summarized in Table 1-1.

[1] Ocean Wind LLC was previously owned by Ørsted Wind Power North America, LLC (75 percent ownership) in partnership with Public Service Enterprise Group (25 percent ownership). On January 18, 2023, Ørsted announced that it will acquire Public Service Enterprise Group's 25-percent equity stake, taking full ownership of Ocean Wind 1.

[2] The Ocean Wind 1 COP and appendices are available on BOEM's website: https://www.boem.gov/ocean-wind-1-construction-and-operations-plan.

Table 1-1 History of BOEM Planning and Leasing Offshore New Jersey

Year	Milestone
2011	On April 20, 2011, BOEM published a Call for Information and Nominations for Commercial Leasing for Wind Power on the OCS Offshore New Jersey in the *Federal Register*. The public comment period for the Call closed on June 6, 2011. In response, BOEM received 11 commercial indications of interest. After analyzing AIS data and holding discussions with stakeholders, BOEM removed OCS Blocks Wilmington NJ18– 02 Block 6740 and Block 6790 (A, B, C, D, E, F, G, H, I, J, K, M, N) and Block 6840 (A) to alleviate navigational safety concerns resulting from vessel transits out of the New York Harbor.
2012	On February 3, 2012, BOEM published in the *Federal Register* a Notice of Availability of a final EA and FONSI for commercial wind lease issuance and site assessment activities on the Atlantic OCS offshore New Jersey, Delaware, Maryland, and Virginia.
2014	On July 21, 2014, BOEM published a Proposed Sale Notice requesting public comments on the proposal to auction two leases offshore New Jersey for commercial wind energy development.
2015	On September 23, 2015, BOEM announced that it published a Final Sale Notice, which stated a commercial lease sale would be held November 9, 2015, for the WEA offshore New Jersey. The New Jersey WEA was auctioned as two leases. RES America Developments, Inc. was the winner of Lease Area OCS-A 0498 and US Wind, Inc. was the winner of lease OCS-A 0499.
2016	On April 14, 2016, BOEM received an application to assign 100 percent of the commercial lease OCS-A 0498 to Ocean Wind. BOEM approved the assignment on May 10, 2016.
2017	On February 14, 2017, BOEM received a request to extend the preliminary term[3] for commercial lease OCS-A 0498 from March 1, 2017, to March 1, 2018. BOEM approved the request on March 1, 2017.
2018	On September 15, 2017, Ocean Wind submitted a Site Assessment Plan for commercial wind lease OCS-A 0498, which was subsequently revised on November 10, 2017, January 25, 2018, and February 23, 2018. BOEM approved the Site Assessment Plan on May 17, 2018.
2019	On August 15, 2019, Ocean Wind submitted its COP for the construction, operations, and conceptual decommissioning of the Project within a portion of the Lease Area. Updated versions of the COP were submitted on March 13, 2020, September 24, 2020, March 24, 2021, December 10, 2021, May 27, 2022, October 14, 2022, and April 24, 2023.
2020	On December 8, 2020, Ocean Wind submitted an application to BOEM to assign the portion of lease OCS-A 0498 that is not covered by the COP to Ørsted North America, Inc. BOEM approved the assignment on March 26, 2021. The lease area assigned to Ørsted North America, Inc. now carries the new lease number OCS-A 0532.
2021	On March 30, 2021, BOEM published a Notice of Intent to Prepare an EIS for Ocean Wind's Proposed Wind Energy Facility Offshore New Jersey (86 *Federal Register* 16630).
2022	On June 24, 2022, BOEM published a Notice of Availability of a Draft EIS initiating a 45-day public comment period for the Draft EIS (87 *Federal Register* 37883). On August 3, 2022, BOEM announced a 15-day extension of the public review and comment period and published a notice of the extension on August 5, 2022 (87 *Federal Register* 48038).
2023	On May 26, 2023, BOEM published a Notice of Availability of a Final EIS initiating a minimum 30-day mandatory waiting period, during which BOEM is required to pause before issuing a ROD.

Source: BOEM 2021a, 2021b

[3] Per 30 CFR 585.235(a)(1), each commercial lease will have a preliminary term of 12 months, within which the lessee must submit a Site Assessment Plan or a combined Site Assessment Plan and COP. The preliminary term begins on the effective date of the lease.

AIS = Automatic Identification System; EA = Environmental Assessment; FONSI = Finding of No Significant Impact; ROD = Record of Decision; WEA = Wind Energy Area

1.2. Purpose and Need for the Proposed Action

In Executive Order 14008, *Tackling the Climate Crisis at Home and Abroad*, issued January 27, 2021, President Joseph R. Biden stated that it is the policy of the United States "to organize and deploy the full capacity of its agencies to combat the climate crisis to implement a Government-wide approach that reduces climate pollution in every sector of the economy; increases resilience to the impacts of climate change; protects public health; conserves our lands, waters, and biodiversity; delivers environmental justice; and spurs well-paying union jobs and economic growth, especially through innovation, commercialization, and deployment of clean energy technologies and infrastructure."

Through a competitive leasing process under 30 CFR 585.211, RES America Developments, Inc. was awarded commercial Renewable Energy Lease OCS-A 0498 covering an area offshore New Jersey (the Lease Area). BOEM subsequently approved 100-percent assignment of the lease to Ocean Wind. Under the terms of the lease, Ocean Wind has the exclusive right to submit a COP for activities within the Lease Area, and it has submitted a COP to BOEM proposing the construction and installation, O&M, and conceptual decommissioning of an offshore wind energy facility in the Lease Area (the Ocean Wind 1 Offshore Wind Farm or the Project) in accordance with BOEM's COP regulations under 30 CFR 585.626, et seq. Ocean Wind's goal is to develop a commercial-scale offshore wind energy facility in the Lease Area with up to 98 wind turbine generators (WTG), inter-array cables, up to three Offshore Substations (OSS), two onshore substations, and two transmission cable routes making landfall in Ocean County, New Jersey and Cape May County, New Jersey (Figure 1-1).

The Project would contribute to New Jersey's goal of 11 gigawatts (GW) of offshore wind energy generation by 2040 as outlined in New Jersey Governor's Executive Order No. 307, issued on September 22, 2022. Furthermore, Ocean Wind's stated goal is to construct and operate a commercial-scale offshore wind energy facility in the Lease Area intended to fulfill the New Jersey Board of Public Utilities' (BPU) September 20, 2018, solicitation for 1,100 MW of offshore wind capacity. The 1,100-MW solicitation and a corresponding Offshore Wind Renewable Energy Certificate (OREC) allowance of 4,851,489 MW-hours per year were awarded to Ocean Wind via BPU on June 21, 2019 (BPU Docket No. QO18121289, In the Matter of the Board of Public Utilities Offshore Wind Solicitation for 1,100 MW – Evaluation of the Offshore Wind Applications[4]).

The BPU Order identifies 1,100 MW of offshore wind as the required capacity of the Project and requires as a Term and Condition of the award that the Project be funded through OREC as defined by the New Jersey Offshore Wind Economic Development Act of 2010. For each MW-hour delivered to the transmission grid, the Project will be credited and subsequently compensated for one OREC. Ocean Wind's annual OREC allowance is 4,851,489 MW-hours per year per the 2019 award by BPU. According to the BPU Order, any unmet OREC allowances in a given year may be carried forward to the next year and the total allowance cannot be reduced or increased without mutual consent by BPU and Ocean Wind. Ocean Wind's stated goal is to routinely meet the OREC allowance in order to obtain the maximum possible annual payment from BPU for the Project's operations.

Based on BOEM's authority under the Outer Continental Shelf Lands Act (OCSLA) to authorize renewable energy activities on the OCS, and Executive Order 14008; the shared goals of the federal agencies to deploy 30 GW of offshore wind energy capacity in the United States by 2030, while

[4] BPU's June 21, 2019, Order, Docket No. QO18121289, is available at: https://www.njcleanenergy.com/files/file/6-21-19-8D.PDF.

protecting biodiversity and promoting ocean co-use[5]; and in consideration of Ocean Wind's goals, the purpose of BOEM's action is to determine whether to approve, approve with modifications, or disapprove Ocean Wind's COP. BOEM will make this determination after weighing the factors in subsection 8(p)(4) of the OCSLA that are applicable to plan decisions and in consideration of the above goals. BOEM's action is needed to fulfill its duties under the lease, which require BOEM to make a decision on the lessee's plans to construct and operate a commercial-scale offshore wind energy facility within the Lease Area (the Proposed Action).

[5] Fact Sheet: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs | The White House: https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/.

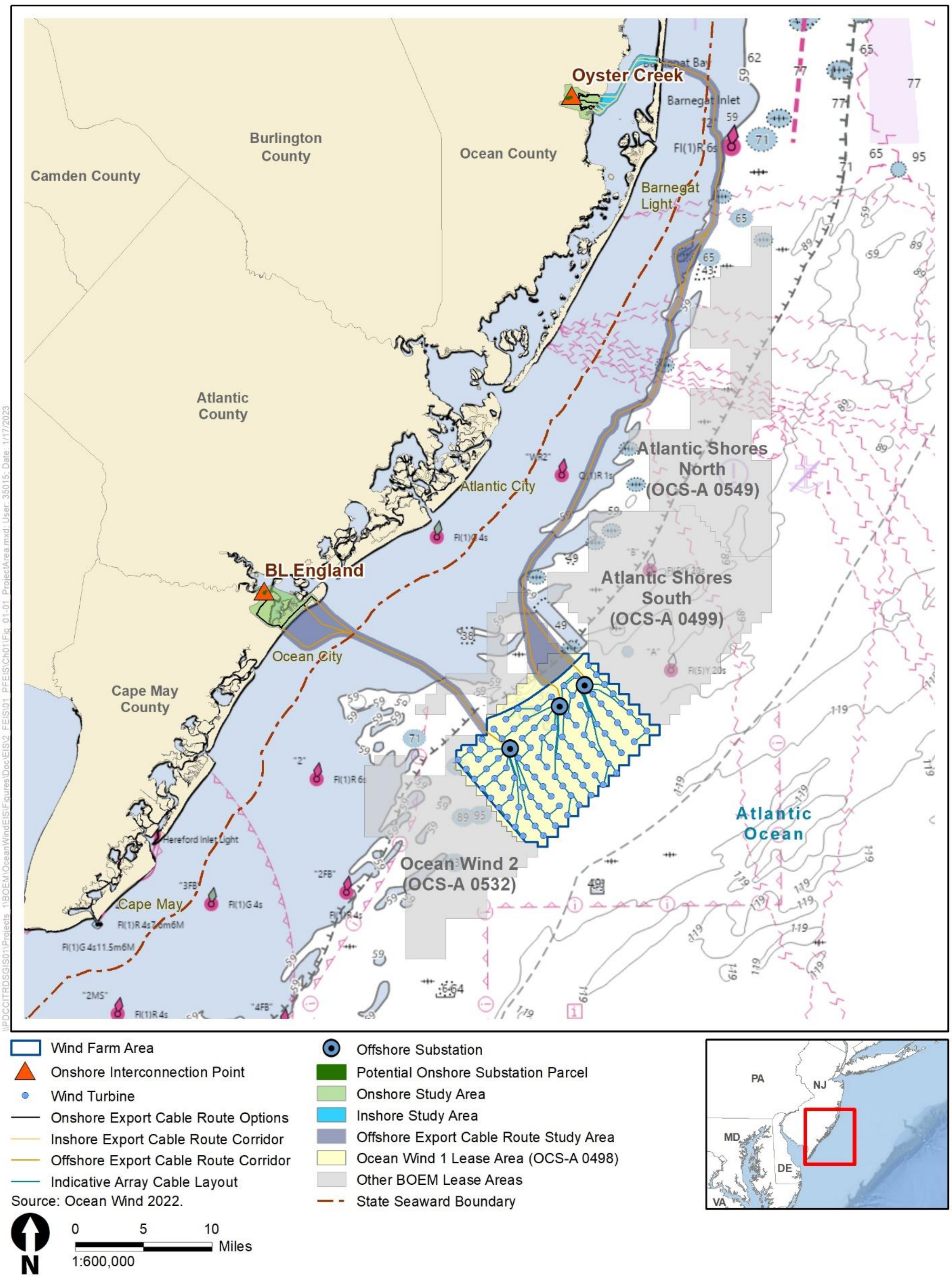


Figure 1-1 Ocean Wind 1 Project Area

In addition, the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) received a request for authorization to take marine mammals incidental to construction activities related to the Project, which NMFS may authorize under the Marine Mammal Protection Act (MMPA). NMFS' issuance of an MMPA incidental take authorization is a major federal action and, in relation to BOEM's action, is considered a connected action (40 CFR 1501.9(e)(1)). The purpose of the NMFS action—which is a direct outcome of Ocean Wind's request for authorization to take marine mammals incidental to specified activities associated with the Project (e.g., pile driving)—is to evaluate Ocean Wind's request under requirements of the MMPA (16 USC 1371(a)(5)(A)) and its implementing regulations administered by NMFS and to decide whether to issue the authorization. NMFS needs to render a decision regarding the request for authorization due to NMFS' responsibilities under the MMPA (16 USC 1371(a)(5)(A)) and its implementing regulations. NMFS intends to adopt the Final EIS if, after independent review and analysis, NMFS determines the Final EIS to be sufficient to support its separate proposed action and decision to issue the authorization, if appropriate.

The U.S. Army Corps of Engineers (USACE) Philadelphia District anticipates requests for authorization of a permit action to be undertaken through authority delegated to the District Engineer by 33 CFR 325.8, pursuant to Section 10 of the Rivers and Harbors Act of 1899 (RHA) (33 USC 403) and Section 404 of the Clean Water Act (CWA) (33 USC 1344). In addition, USACE anticipates that a "Section 408 permission" will be required pursuant to Section 14 of the RHA (33 USC 408) for any proposed alterations that have the potential to alter, occupy, or use any federally authorized civil works projects. USACE considers issuance of permits under these three delegated authorities a major federal action connected to BOEM's action (40 CFR 1501.9(e)(1)). The need for the Project as provided by the Applicant in Ocean Wind's COP and reviewed by USACE for NEPA purposes is to provide a commercially viable offshore wind energy project within the Lease Area to meet New Jersey's need for clean energy. The basic Project purpose, as determined by USACE for Section 404(b)(1) guidelines evaluation, is offshore wind energy generation. The overall Project purpose for Section 404(b)(1) guidelines evaluation, as determined by USACE, is the construction and operation of a commercial-scale offshore wind energy project for renewable energy generation and distribution to the New Jersey energy grids.

The purpose of USACE Section 408 action as determined by Engineer Circular 1165-2-220 is to evaluate the Applicant's request and determine whether the proposed alterations are injurious to the public interest or impair the usefulness of the USACE project. The USACE Section 408 permission is needed to ensure that congressionally authorized projects continue to provide their intended benefits to the public. USACE intends to adopt BOEM's EIS to support its decision on any permits and permissions requested under Section 10 of the RHA, Section 404 of the CWA, and Section 14 of the RHA. USACE would adopt the EIS under 40 CFR 1506.3 if, after its independent review of the document, it concludes that the EIS satisfies USACE's comments and recommendations. Based on its participation as a cooperating agency and its consideration of the final EIS, USACE would issue a Record of Decision (ROD) to formally document its decision on the Proposed Action.

1.3. Regulatory Overview

The Energy Policy Act of 2005, Public Law 109-58, amended the OCSLA (43 USC 1331 et seq.)[6] by adding a new subsection 8(p) that authorizes the Secretary of the Interior to issue leases, easements, and rights-of-way in the OCS for activities that "produce or support production, transportation, or transmission of energy from sources other than oil and gas," which include wind energy projects.

[6] Public Law No. 109-58, § 119 Stat. 594 (2005)

The Secretary of the Interior delegated this authority to the former Minerals Management Service, and later to BOEM. Final regulations implementing the authority for renewable energy leasing under the OCSLA (30 CFR 585) were promulgated on April 22, 2009.[7] These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove Ocean Wind's COP (30 CFR 585.628).

Subsection 8(p)(4) of the OCSLA states: "[t]he Secretary shall ensure that any activity under [subsection 8(p)] is carried out in a manner that provides for –

(A) safety;
(B) protection of the environment;
(C) prevention of waste;
(D) conservation of the natural resources of the outer Continental Shelf;
(E) coordination with relevant Federal agencies;
(F) protection of national security interests of the United States;
(G) protection of correlative rights in the outer Continental Shelf;
(H) a fair return to the United States for any lease, easement, or right-of-way under this subsection;
(I) prevention of interference with reasonable uses (as determined by the Secretary) of the exclusive economic zone, the high seas, and the territorial seas;
(J) consideration of—
  (i) the location of, and any schedule relating to, a lease, easement, or right-of-way for an area of the outer Continental Shelf; and
  (ii) any other use of the sea or seabed, including use for a fishery, a sealane, a potential site of a deepwater port, or navigation;
(K) public notice and comment on any proposal submitted for a lease, easement, or right of-way under this subsection; and
(L) oversight, inspection, research, monitoring, and enforcement relating to a lease, easement, or right-of-way under this subsection."

As stated in M-Opinion 37067, ". . . subsection 8(p)(4) of OCSLA imposes a general duty on the Secretary to act in a manner providing for the subsection's enumerated goals. The subsection does not require the Secretary to ensure that the goals are achieved to a particular degree, and she retains wide discretion to determine the appropriate balance between two or more goals that conflict or are otherwise in tension."[8]

Section 2 of commercial Renewable Energy Lease OCS-A 0498 provides the lessee with an exclusive right to submit a COP to BOEM for approval. Section 3 provides that BOEM will decide whether to approve a COP in accordance with applicable regulations in 30 CFR 585, noting that BOEM retains the right to disapprove a COP based on its determination that the proposed activities would have unacceptable environmental consequences, would conflict with one or more of the requirements set forth in 43 USC 1337(p)(4), or for other reasons provided by BOEM under 30 CFR 585.613(e)(2) or 585.628(f). Section 3 of the lease also provides that BOEM reserves the right to approve a COP with modifications, as well as the right to authorize other uses within the leased area that will not unreasonably interfere with activities described in Addendum A, Description of Leased Area and Lease Activities.

BOEM's evaluation and decision on the COP are also governed by other applicable federal statutes and implementing regulations such as NEPA and the Endangered Species Act (ESA) (16 USC 1531–1544). The analyses in this Final EIS will inform BOEM's decision under 30 CFR 585.628 for the COP that was

[7] Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf, 74 *Federal Register* 19638–19871 (April 29, 2009)
[8] M-Opinion 37067 at page 5, http://doi.gov/sites/doi.gov/files/m-37067.pdf.

initially submitted in August 2019 and later updated with new information on March 13, 2020, September 24, 2020, March 24, 2021, December 10, 2021, May 27, 2022, and October 14, 2022. BOEM is required to coordinate with federal agencies and state and local governments and ensure that renewable energy development occurs in a safe and environmentally responsible manner. In addition, BOEM's authority to approve activities under the OCSLA only extends to approval of activities on the OCS. Appendix A outlines the federal, state, regional, and local permits and authorizations that are required for the Project and the status of each permit and authorization. Appendix A also provides a description of BOEM's consultation efforts during development of the Final EIS.

1.4. Relevant Existing NEPA and Consulting Documents

The following documents were utilized to inform the preparation of this Final EIS and are incorporated in their entirety by reference.

- *Final Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf, OCS EIS/EA MMS 2007-046* (MMS 2007)—This Programmatic EIS was developed by the Minerals Management Service to support establishment of a program that provides for efficient and orderly development of alternative energy projects on the federal OCS, as well as the alternate use of offshore facilities for other energy- and marine-related activities. The four alternatives considered in the Final Programmatic EIS are: (1) the proposed action (i.e., the establishment of the Alternative Energy and Alternate Use Program on the OCS through rulemaking); (2) a case-by-case alternative (i.e., the Minerals Management Service would consider individual project proposals for alternative energy or alternate use on a case-by-case basis but would not issue formal regulations); (3) a no action alternative (i.e., the Minerals Management Service would not approve leases, easements, or rights-of-way for any alternative energy facility on the federal OCS or alternate use of existing offshore facilities); and (4) a preferred alternative (i.e., a combination of the proposed action and the case-by-case alternative). The document examined the potential environmental consequences of each of these alternatives and was used to establish initial measures to mitigate environmental consequences.
- *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia Final Environmental Assessment,* OCS EIS/EA BOEM 2012-003 (BOEM 2012)—BOEM prepared this Environmental Assessment to consider the environmental impacts of issuing renewable energy leases and authorizing site characterization activities needed to develop specific project proposals on those leases in identified Wind Energy Areas (WEA) on the OCS offshore New Jersey, Delaware, Maryland, and Virginia. BOEM used this Environmental Assessment to inform decisions to issue leases in the refined WEAs and to subsequently approve Site Assessment Plans (SAP) on those leases.
- *Ocean Wind 1 Offshore Wind Farm Biological Assessment for the United States Fish and Wildlife Service* (BOEM 2022a)—BOEM prepared this document pursuant to Section 7 of the ESA to evaluate potential effects of the Proposed Action on ESA-listed species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS).
- *Ocean Wind 1 Offshore Wind Farm Biological Assessment for National Marine Fisheries Service* (BOEM 2022b)—BOEM prepared this document pursuant to Section 7 of the ESA to evaluate potential effects of the Proposed Action on ESA-listed species under the jurisdiction of NMFS.
- *Ocean Wind 1 Offshore Wind Farm Essential Fish Habitat Assessment for National Marine Fisheries Service* (BOEM 2022c)—BOEM prepared this document pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) to evaluate the potential effects of the Proposed Action on essential fish habitat (EFH) and EFH species under the jurisdiction of NMFS.

- *Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement* (BOEM 2021c)—BOEM prepared this document for the Vineyard Wind Offshore Wind Energy Project COP submitted by Vineyard Wind LLC. The Final EIS analyzes the potential environmental impacts of the COP (the proposed action) and alternatives to the proposed action.
- *South Fork Wind Farm and South Fork Export Cable Project Final Environmental Impact Statement* (BOEM 2021d)—BOEM prepared this document for the COP submitted by South Fork Wind, LLC. The Final EIS analyzes the potential environmental impacts of the COP (the proposed action) and alternatives to the proposed action.

Additional environmental studies conducted to support planning for offshore wind energy development are available on BOEM's website: https://www.boem.gov/renewable-energy-research-completed-studies.

1.5. Methodology for Assessing the Project Design Envelope

Ocean Wind proposes using a Project Design Envelope (PDE) concept. This concept allows Ocean Wind to define and bracket proposed Project characteristics for environmental review and permitting while maintaining a reasonable degree of flexibility for selection and purchase of Project components such as WTGs, foundations, submarine cables, and OSS.

This Final EIS assesses the impacts of the PDE that is described in the Ocean Wind COP and presented in Appendix E by using the "maximum-case scenario" process. The maximum-case scenario is composed of each design parameter or combination of parameters that would result in the greatest impact for each physical, biological, and socioeconomic resource. This Final EIS evaluates potential impacts of the Proposed Action and each action alternative using the maximum-case scenario to assess the design parameters or combination of parameters for each environmental resource.[9] This Final EIS considers the interrelationship between aspects of the PDE rather than simply viewing each design parameter independently. Certain resources may have multiple maximum-case scenarios, and the most impactful design parameters may not be the same for all resources. Appendix E explains the PDE approach in more detail and presents a detailed table outlining the design parameters with the highest potential for impacts by resource area. Through consultation with its own engineers and outside industry experts, BOEM verified that the maximum-case scenario analyzed in the Final EIS could reasonably occur.

1.6. Methodology for Assessing Impacts

This Final EIS also assesses past, present (ongoing), and reasonably foreseeable future (planned) actions that could occur during the life of the Project. Ongoing and planned actions occurring within the geographic analysis areas include (1) other offshore wind energy development activities; (2) undersea transmission lines, gas pipelines, and other submarine cables (e.g., telecommunications); (3) tidal energy projects; (4) marine minerals use and ocean-dredged material disposal; (5) military use; (6) marine transportation (commercial, recreational, and research-related); (7) fisheries use, management, and monitoring surveys; (8) global climate change; (9) oil and gas activities; and (10) onshore development activities. Appendix F (*Planned Activities Scenario*) describes the actions that BOEM has identified as potentially contributing to the existing baseline, and the actions potentially contributing to cumulative impacts when combined with impacts from the alternatives over the specified spatial and temporal scales. The geographic analysis area was determined for each resource analyzed in this Final EIS. A description of how the spatial boundaries were determined and a corresponding figure are provided at the beginning of each resource section in Chapter 3.

[9] BOEM's draft guidance on the use of design envelopes in a COP is available at: https://www.boem.gov/sites/default/files/renewable-energy-program/Draft-Design-Envelope-Guidance.pdf.

1.6.1 Past and Ongoing Activities and Trends (Existing Baseline)

Each resource-specific environmental consequences section in Chapter 3 of this Final EIS includes a description of the baseline conditions of the affected environment. The existing baseline considers past and present activities in the geographic analysis area, including those related to offshore wind projects with an approved COP (e.g., Vineyard Wind 1 and South Fork) and approved past and ongoing site assessment surveys, as well as other non-wind activities (e.g., Navy military training, existing vessel traffic, climate change). The existing condition of resources as influenced by past and ongoing activities and trends represents the existing baseline condition for impact analysis. Other factors currently affecting the resource, including climate change, are also acknowledged for that resource and are included in the impact-level conclusion.

1.6.2 Planned Activities

It is reasonable to predict that future activities may occur over time and that, cumulatively, those activities would affect the existing baseline conditions discussed in Section 1.6.1. Cumulative impacts are analyzed and concluded separately in each resource-specific environmental consequences section in Chapter 3 of this Final EIS. The existing baseline condition as influenced by future planned activities evaluated in Appendix F (*Planned Activities Scenario*) and the Proposed Action represent the sum of the cumulative impacts expected if the Project is approved. The impacts of future planned offshore wind projects are predicted using information from and assumptions based on COPs submitted to BOEM that are currently undergoing independent review.

2. Alternatives

This chapter (1) describes the alternatives carried forward for detailed analysis in this Final EIS, including the Proposed Action, No Action, and other action alternatives; (2) describes the non-routine activities and low-probability events that could occur during construction, O&M, and decommissioning of the proposed Project; and (3) presents a summary and comparison of impacts among alternatives and resource affected.

Identification of Preferred Alternative: The CEQ NEPA regulations require the identification of a preferred alternative in the Final EIS. BOEM has identified Alternative A in combination with Alternative E as the Preferred Alternative. Alternative E narrows the export cable route options in the PDE and cannot be implemented independently. The Preferred Alternative is depicted on Figure 2-2, Figure 2-3, Figure 2-6, and Figure 2-12. The Preferred Alternative is identified to let the public know which alternative BOEM, as the lead agency, is leaning toward before an alternative is selected for action when a ROD is issued. No final agency action is being taken by the identification of the Preferred Alternative and BOEM is not obligated to select the Preferred Alternative.

2.1. Alternatives Analyzed in Detail

BOEM considered a reasonable range of alternatives during the EIS development process that emerged from scoping, interagency coordination, and internal BOEM deliberations. Alternatives were reviewed using BOEM's screening criteria ("screening criteria"), presented in Appendix C, *Additional Analysis for Alternatives Dismissed*. Alternatives that met the screening criteria (i.e., were found to be infeasible or did not meet the purpose and need) were dismissed from detailed analysis in this Final EIS. Alternatives considered but dismissed from detailed analysis and the rationale for their dismissal are described in Section 2.1.7 and Appendix C. The alternatives carried forward for detailed analysis in this Final EIS are summarized in Table 2-1 below and described in detail in Sections 2.1.1 through 2.1.6. The alternatives listed in Table 2-1 are not mutually exclusive. BOEM may "mix and match" multiple listed Final EIS alternatives to result in a preferred alternative that will be identified in the Final EIS provided that (1) the design parameters are compatible; and (2) the preferred alternative still meets the purpose and need.

Although BOEM's authority under the OCSLA only extends to the activities on the OCS, alternatives related to addressing nearshore and onshore elements as well as offshore elements of the Proposed Action are analyzed in the EIS. BOEM's regulations (30 CFR 585.620) require that the COP describes all planned facilities that the lessee would construct and use for the Project, including onshore and support facilities and all anticipated Project easements. As a result, those federal, state, and local agencies with jurisdiction over nearshore and onshore impacts are able to adopt, at their discretion, those portions of BOEM's EIS that support their own permitting decisions.

NMFS and USACE are serving as cooperating agencies. NMFS intends to adopt the Final EIS if, after independent review and analysis, NMFS determines the Final EIS to be sufficient to support its separate proposed action and decision to issue the authorization, if appropriate. USACE similarly intends to adopt the EIS if it is determined to be sufficient after independent review to meet its responsibilities under Section 404 of the CWA and Section 10 of the RHA. Under the Proposed Action and other action alternatives, NMFS' action alternative is to issue the requested Letter of Authorization to the Applicant to authorize incidental take for the activities specified in its application and that are being analyzed by BOEM in the reasonable range of alternatives described here. USACE is required to analyze alternatives to the proposed Project that are reasonable and practicable pursuant to NEPA and the CWA 404(b)(1) Guidelines. The range of alternatives analyzed in the Final EIS, including cable route options within the

PDE and alternatives considered but dismissed, represents a reasonable range of alternatives for this analysis.

BOEM decided to use the NEPA substitution process for National Historic Preservation Act (NHPA) Section 106 purposes, pursuant to 36 CFR 800.8(c), during its review of the Project. Section 106 of the NHPA regulations, "Protection of Historic Properties" (36 CFR 800), provides for use of the NEPA substitution process to fulfill a federal agency's NHPA Section 106 review obligations in lieu of the procedures set forth in 36 CFR 800.3 through 800.6. Draft avoidance, minimization, and mitigation measures to resolve adverse effects on historic properties are presented in Appendix H, *Mitigation and Monitoring*. Ongoing consultation with consulting parties and government-to-government consultation with tribal nations may result in additional measures or changes to these measures.

Table 2-1 Alternatives Considered for Analysis

Alternative	Description
No Action Alternative	Under the No Action Alternative, BOEM would not approve the COP; the Project construction and installation, O&M, and conceptual decommissioning would not occur; and no additional permits or authorizations for the Project would be required.[1] Any potential environmental and socioeconomic impacts, including benefits, associated with the Project as described under the Proposed Action would not occur. The current resource condition, trends, and effects from ongoing activities under the No Action Alternative serve as the baseline against which all action alternatives are evaluated. Over the life of the proposed Project, other reasonably foreseeable future impact-producing offshore wind and non-offshore wind activities are expected to occur, which would cause changes to the existing baseline conditions even in the absence of the Proposed Action. The continuation of all other existing and reasonably foreseeable future activities described in Appendix F (*Planned Activities Scenario*) without the Proposed Action serves as the baseline for the evaluation of cumulative impacts.
Alternative A: Proposed Action (Preferred Alternative)	Under Alternative A, the construction, O&M, and conceptual decommissioning of an 1,100-MW wind energy facility consisting of up to 98 WTGs, up to three alternating-current OSS, inter-array cables linking the individual WTGs to the OSS, and substation interconnector cables linking the substations to each other would be developed in the Lease Area, approximately 13 nm southeast of Atlantic City, New Jersey. Up to three offshore export cables (installed within two export cable route corridors) that connect to onshore export cable systems and two onshore substations with connections to the existing electrical grid in New Jersey at BL England and Oyster Creek would also be developed. The BL England export cable route corridor would landfall in Ocean City, New Jersey, and the Oyster Creek export cable route corridor would landfall in Lacey Township, New Jersey. Development of the wind energy facility would occur within the range of design parameters outlined in the COP (Ocean Wind 2023), subject to applicable mitigation measures.
Alternative B: No Surface Occupancy at Select Locations to Reduce Visual Impacts	Under Alternative B, the construction, O&M, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the COP, subject to applicable mitigation measures. However, no surface occupancy would occur at select WTG positions to reduce the visual impacts of the proposed Project. Each of the sub-alternatives below may be individually selected or combined with any or all other alternatives or sub-alternatives, subject to the combination meeting the purpose and need.

[1] Under the No Action Alternative, impacts on marine mammals incidental to construction activities would not occur. Therefore, NMFS would not issue the requested authorization under the MMPA to the Applicant.

Alternative	Description
	• **Alternative B-1:** No Surface Occupancy at Select Locations to Reduce Visual Impacts (Smaller Turbine Model): This alternative would exclude placement of WTGs at up to nine[2] WTG positions that are nearest to coastal communities (positions F01 to K01 and B02 to D02). The final number of WTG positions excluded in the Final EIS may be fewer than nine to ensure consistency with an 1,100-MW nameplate capacity and annual OREC allowance to fulfill Ocean Wind's contractual obligations with BPU. • **Alternative B-2:** No Surface Occupancy at Select Locations to Reduce Visual Impacts (Larger Turbine Model): This alternative would exclude placement of WTGs at up to 19 WTG positions that are nearest to coastal communities (positions F01 to K01, A02 to K02, A03, and C03). Selection of this alternative would be contingent on the larger turbine with a 240-meter rotor diameter being commercially available when BOEM issues its ROD as well as technical and economic feasibility and consistency with the purpose and need. The final number of WTG positions excluded in the Final EIS may be fewer than 19 to ensure consistency with an 1,100-MW nameplate capacity and annual OREC allowance to fulfill Ocean Wind's contractual obligations with BPU.

[2] The PDE parameters for WTGs outlined in the COP include a rotor diameter up to 240 meters. Current and near-term commercially available WTGs likely used for this Project range from a 12.4-MW WTG (smaller turbine model) to a 14.7-MW WTG (larger turbine model). Calculations using these turbine nameplate capacities and the Project nameplate capacity (1,100 MW) were used to develop alternatives (i.e., 1,100 MW divided by 12.4 MW equals 89 WTGs; therefore, a maximum of nine WTGs could be removed). The calculated WTG number represents the maximum number prior to applying a capacity factor. Capacity factor is the average power output divided by the maximum power capability for a given time period. Capacity factor plays a role in estimating the expected annual energy production, and for the Project would most likely vary between 45 percent and 63 percent. Ocean Wind has selected the GE Haliade-X 12-MW WTG; however, the environmental review analyzes the PDE as it is presented in the COP.

Alternative	Description
Alternative C: Wind Turbine Layout Modification to Establish a Buffer Between Ocean Wind 1 and Atlantic Shores South	Under Alternative C, the construction, O&M, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the Ocean Wind 1 COP, subject to applicable mitigation measures. However, modifications would be made to the wind turbine array layout to create a 0.81-nm to 1.08-nm buffer[3] between WTGs in the lease area of OCS-A 0498 (Ocean Wind 1 Lease Area) and WTGs in the lease area of OCS-A 0499 (Atlantic Shores South Lease Area) to reduce impacts on existing ocean uses, such as commercial and recreational fishing and marine (surface and aerial) navigation. Each of the sub-alternatives below may be individually selected or combined with any or all other alternatives or sub-alternatives, subject to the combination meeting the purpose and need. • **Alternative C-1:** No Surface Occupancy to Establish a Buffer with Turbine Relocation: No surface occupancy along the northeastern boundary of the Ocean Wind 1 Lease Area (A02 to A09) through the exclusion of eight WTG positions, relocation of up to eight WTG positions to the northern portion of the Ocean Wind 1 Lease Area, or some combination of exclusion and relocation of WTG positions, to allow for a 0.81-nm to 1.08-nm buffer between WTGs in the Ocean Wind 1 Lease Area and WTGs in the Atlantic Shores South Lease Area. • **Alternative C-2:** No Surface Occupancy to Establish a Buffer with Turbine Layout Compression: No surface occupancy along the northeastern boundary of the Ocean Wind 1 Lease Area to allow for a 0.81-nm to 1.088-nm buffer between WTGs in the Ocean Wind 1 Lease Area and WTGs in the Atlantic Shores South Lease Area. However, under Alternative C-2, the wind turbine array layout would be compressed to allow for a full build of up to 98 WTGs. Ocean Wind 1's turbine array row spacing would be reduced from 1 nm between rows to no less than 0.99 nm between rows.
Alternative D: Sand Ridge and Trough Avoidance	Under Alternative D, the construction, O&M, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the Ocean Wind 1 COP, subject to applicable mitigation measures. However, modifications would be made to the wind turbine array layout to minimize impacts on sand ridge and trough features in the northeastern corner of the Lease Area. This alternative would result in the exclusion of up to 15 WTG positions in the sand ridge and trough area that include A07 to E07, A08 to E08, and A09 to E09. The identification of individual WTGs for exclusion, should the number excluded be fewer than 15, would be coordinated with NMFS. Selection of this alternative with the exclusion of more than nine WTGs would be contingent on the larger turbine with a 240-meter rotor diameter being commercially available when BOEM issues its ROD as well as its technical and economic feasibility, and consistency with the purpose and need. The final number of WTG positions considered for exclusion in the Final EIS may be reduced to fewer than nine to fifteen to ensure consistency with an-1,100 MW nameplate capacity and annual OREC allowance to fulfill Ocean Wind's contractual obligations with BPU.

[3] Buffer distance would range between 0.81 nm and 1.08 nm; however, distance between individual WTGs may be greater than 1.08 nm.

Alternative	Description
Alternative E: Submerged Aquatic Vegetation Avoidance (Preferred Alternative)	Under Alternative E, the construction, operation, maintenance, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the Ocean Wind 1 COP, subject to applicable mitigation measures. However, the Oyster Creek export cable route traversing Island Beach State Park would be limited to the option developed to minimize impacts on submerged aquatic vegetation in Barnegat Bay. The submerged aquatic vegetation avoidance export cable route option would make landfall within an auxiliary parking lot of Swimming Area 2 in Island Beach State Park, continue north within parking lots, then northwest under Shore Road before entering Barnegat Bay. Upon entering Barnegat Bay, the export cable route would continue within a previously dredged channel and then reconnect to the Oyster Creek export cable route in Barnegat Bay. This alternative would narrow the design envelope so that the Applicant could only select the northernmost export cable route; the northernmost export cable route would not function independently but is intended to be combined with another alternative or sub-alternative, subject to the combination meeting the purpose and need.

2.1.1 No Action Alternative

Under the No Action Alternative, BOEM would not approve the COP. Project construction and installation, O&M, and decommissioning would not occur, and no additional permits or authorizations for the Project would be required.[4] Any potential environmental and socioeconomic impacts, including benefits, associated with the Project as described under the Proposed Action would not occur. The current resource condition and effects from ongoing activities under the No Action Alternative serve as the existing baseline against which all direct and indirect impacts from alternatives are evaluated.

Over the life of the proposed Project, other reasonably foreseeable future potentially impact-producing offshore wind and non-offshore wind activities would likely be implemented, which would cause changes to the existing baseline conditions even in the absence of the Proposed Action. The continuation of all other existing and reasonably foreseeable future activities described in Appendix F (*Planned Activities Scenario*) without the Proposed Action serves as the future baseline for the evaluation of cumulative impacts.

2.1.2 Alternative A—Proposed Action (Preferred Alternative)

The Proposed Action is to construct, operate, maintain, and decommission an approximately 1,100-MW wind energy facility consisting of up to 98 WTGs, up to three OSS, inter-array cables linking the individual WTGs to the OSS, and substation interconnector cables linking the substations to each other in the Lease Area, approximately 13 nm southeast of Atlantic City, New Jersey (Figure 1-1). Up to three offshore export cables (installed within two export cable route corridors) that connect to onshore export cable systems and two onshore substations with connections to the existing electrical grid in New Jersey at BL England and Oyster Creek would also be developed. The BL England export cable route corridor would landfall in Ocean City, New Jersey, and the Oyster Creek export cable route corridor would landfall in Lacey Township, New Jersey. Development of the wind energy facility would occur within the range of design parameters described in Volume I of the Ocean Wind 1 COP (Ocean Wind 2023) and summarized in Appendix E, *Project Design Envelope and Maximum-Case Scenario*. The expected annual energy production of the Proposed Action is 4,851,489 MW-hours per year or 100 percent of Ocean

[4] Under the No Action Alternative, impacts on marine mammals incidental to construction activities would not occur. Therefore, NMFS would not issue the requested authorization under the MMPA to the Applicant.

Wind's annual OREC allowance per the 2019 award by BPU. A description of construction and installation, O&M, and decommissioning activities to be undertaken for the Proposed Action is included in Sections 2.1.2.1 through 2.1.2.4 below. Refer to Volume I of the Ocean Wind 1 COP (Ocean Wind 2023) for additional details on Project design.

2.1.2.1. Committed Mitigation and Monitoring

Ocean Wind has committed to measures as part of its Project to avoid or minimize impacts on physical, biological, socioeconomic, and cultural resources (summarized in COP Volume II, Table 1.1-2; Ocean Wind 2023). These measures are described in Appendix H, *Mitigation and Monitoring*, and are incorporated as part of the Proposed Action. Consultations under Section 7 of the ESA and the MSA as well as the submission for and issuance of other necessary permits and authorizations under applicable statutes, including the MMPA and Coastal Zone Management Act, may result in additional measures or changes to these measures.

As part of the Proposed Action, Ocean Wind has committed to conducting several pre-, during, and post-construction monitoring surveys. Ocean Wind is voluntarily conducting pre-construction surveys under existing permits. A list of these surveys is provided below along with the Project phase during which the monitoring would occur. A description of the survey activities is provided in the respective resource sections in Chapter 3.

Table 2-2 Monitoring Surveys

Monitoring Survey	Project Phase	Chapter 3 Resource Section
Fisheries Monitoring Plan	Pre-construction, Construction, and Operation	Commercial Fisheries and For-Hire Recreational Fishing
Benthic Monitoring Plan	Pre-construction, Construction, and Operation	Benthic Resources
Protected Species Mitigation and Monitoring Plan: Marine Mammals, Sea Turtles, and ESA-listed Fish	Pre-construction, Construction, and Operation	Finfish, Invertebrates, and EFH; Marine Mammals; Sea Turtles
Avian and Bat Post-Construction Monitoring Framework	Operation	Bats; Birds
Submerged Aquatic Vegetation Monitoring Plan	Pre-construction, Construction, and Operation	Benthic Resources

2.1.2.2. Construction and Installation

The Proposed Action would include the construction and installation of both onshore and offshore facilities. Construction and installation would begin in 2023 and be completed in 2025. Ocean Wind anticipates initiating land-based construction before beginning the offshore components. An indicative Project schedule is included in COP Volume I, Chapter 4, Figure 4.5-1 (Ocean Wind 2023) and summarized below. Timeframes are identified by the 3-month quarter (Q) of that respective year.

Onshore Export Cables and Onshore Substations — Q3 of 2023 to Q1 of 2025

Landfall Cable Installation — Q4 of 2023 to Q4 of 2024

Offshore Export Cable Installation — Q2 of 2024 to Q1 of 2025

Offshore Foundations (WTG and OSS) — Q2 of 2024 to Q4 of 2024

Inter-array Cable Installation	Q3 of 2024 to Q2 of 2025
WTG and OSS Installation and Commissioning	Q3 of 2024 to Q4 of 2025

2.1.2.2.1 Site Preparation Activities

Site preparation activities are necessary during construction. Site preparation includes activities such as high-resolution geophysical (HRG) surveys, geotechnical surveys, and unexploded ordnance (UXO)/munitions and explosives of concern (MEC) risk mitigation. HRG surveys are anticipated to support the construction of WTG and OSS foundations and installation of export, inter-array, and OSS interconnector cables.

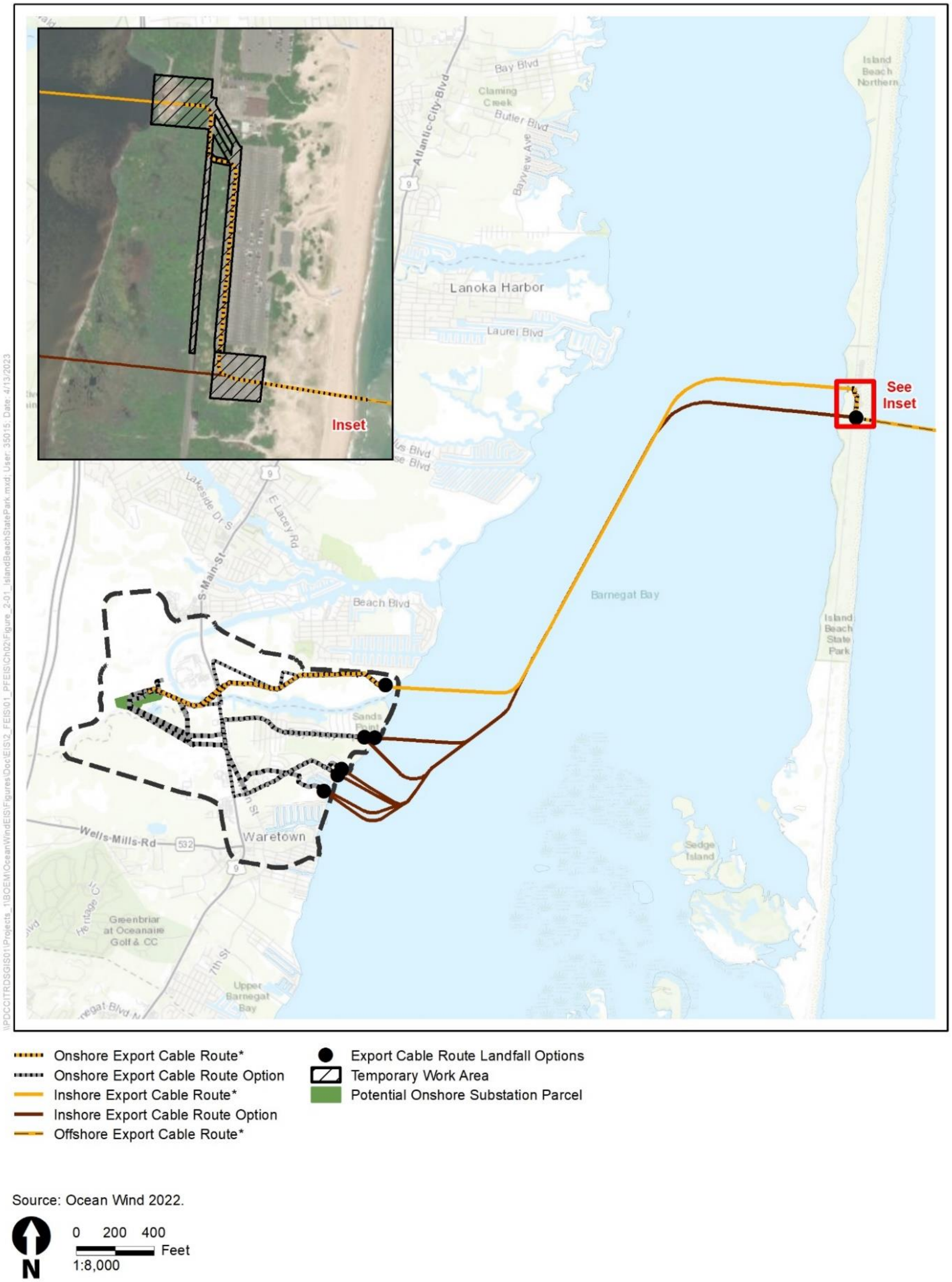
HRG surveys would occur as part of site preparation activities before and during construction and would also occur intermittently after construction. Surveys would include equipment operating at less than 180 kilohertz and consist of multibeam depth sounding, seafloor imaging, and shallow- and medium-penetration sub-bottom profiling within the Project area. Potential equipment used during HRG surveys would be side-scan sonar, multibeam echosounders, magnetometers and gradiometers, parametric sub-bottom profilers, compressed high-intensity radiated pulses sub-bottom profilers, boomers, or sparkers. Although survey plans would not be completed until construction contracting commences, Ocean Wind assumes that HRG surveys would be conducted 24 hours a day with an assumed average daily distance of 43.5 miles (70 kilometers). A maximum of three vessels would work concurrently within a 24-hour period with an assumed transit speed of 4 knots (2.1 meters per second [m/s]). Throughout the 5-year period for which MMPA Incidental Take Authorization regulations would be promulgated, the HRG surveys would be a total of 624 days.

Avoidance is the preferred approach to UXO/MEC mitigation; however, for instances where avoidance is not possible, confirmed UXO/MEC may be removed through in-situ disposal or physical relocation. In-situ disposal of UXO/MEC would be done with low-order (deflagration) or high-order (detonation) methods or by cutting the UXO/MEC to extract the explosive components. Although the exact number and type of UXO in the Project area are not yet know, it is currently assumed that up to 10 UXOs may need to be detonated in place. If necessary, these detonations would occur on up to 10 different days (i.e., one detonation would occur per day) (Ocean Wind 2023).

2.1.2.2.2 Onshore Activities and Facilities

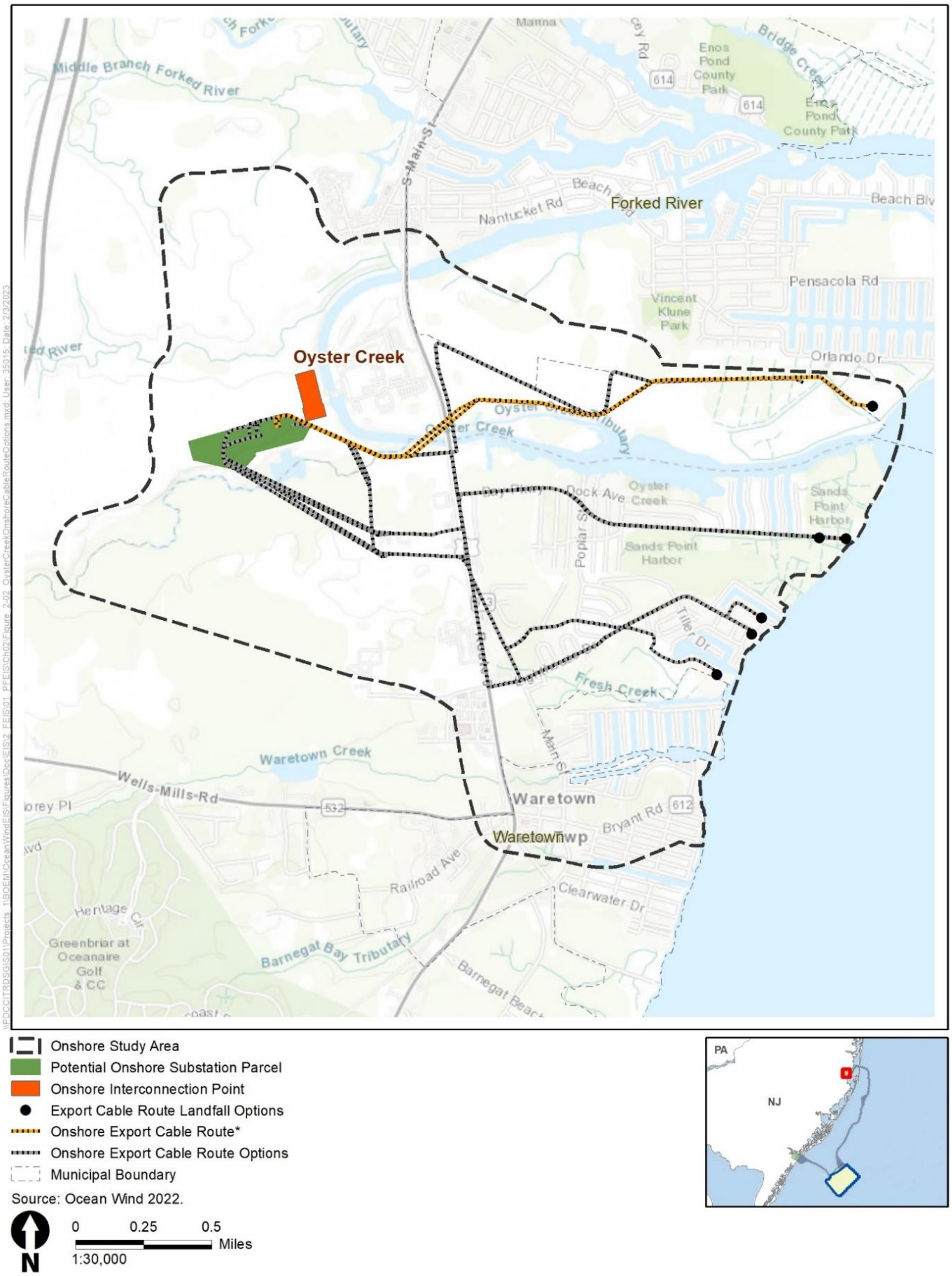
Proposed onshore Project elements include the landfall site, the Transition Joint Bay (TJB) that connects the offshore export cable to the onshore export cable, the onshore export cable route(s) to the onshore substation, and the connection from the onshore substation to the existing grid (these elements collectively compose the Onshore Project area). Appendix E, *Project Design Envelope and Maximum-Case Scenario*, describes the PDE for onshore activities and facilities and COP Volume I provides additional details on construction and installation methods (Ocean Wind 2023). These onshore elements of the Proposed Action are included in BOEM’s analysis in the EIS to support the analysis of a complete Project; however, BOEM’s authority under the OCSLA only extends to the activities on the OCS.

The proposed Project includes two interconnection points with the PJM electric transmission system: Oyster Creek and BL England. To reach the onshore substation at Oyster Creek, the offshore export cables would first cross Island Beach State Park using one of two routes as shown on Figure 2-1 before making landfall and following the onshore cable route as shown on Figure 2-2. To reach the onshore substation at BL England, the offshore export cables would make landfall at the designated locations in Ocean City and follow the onshore cable routes as shown on Figure 2-3. Critical structures and equipment at onshore substations would be elevated to 3 feet above the current 100-year base flood elevation, consistent with Federal Emergency Management Agency design recommendations, to account for tidal surge and sea level rise as a result of climate change. The PDE also includes additional landfall and onshore export cable route options to reach the onshore substation at Oyster Creek and additional landfall and onshore export cable route options to reach the onshore substation at BL England to allow for route refinement and optimization. The PDE includes all proposed onshore options, which will be analyzed collectively as part of the Proposed Action in the Final EIS. Ocean Wind has identified its preferred onshore routes on Figure 2-1 and Figure 2-2 for Oyster Creek and Figure 2-3 for BL England, but it may elect to obtain permits for and construct any of the depicted onshore routes. The transition of the export cables from offshore to onshore would occur at a TJB onshore and be accomplished by using open cut (i.e., trenching) or trenchless methods (bore or horizontal directional drilling [HDD]). The TJBs would be buried below grade and accessible via a manhole cover. The TJBs would be protected from erosion caused by storm events through stabilization of the area using imported fill topped with concrete mattresses.



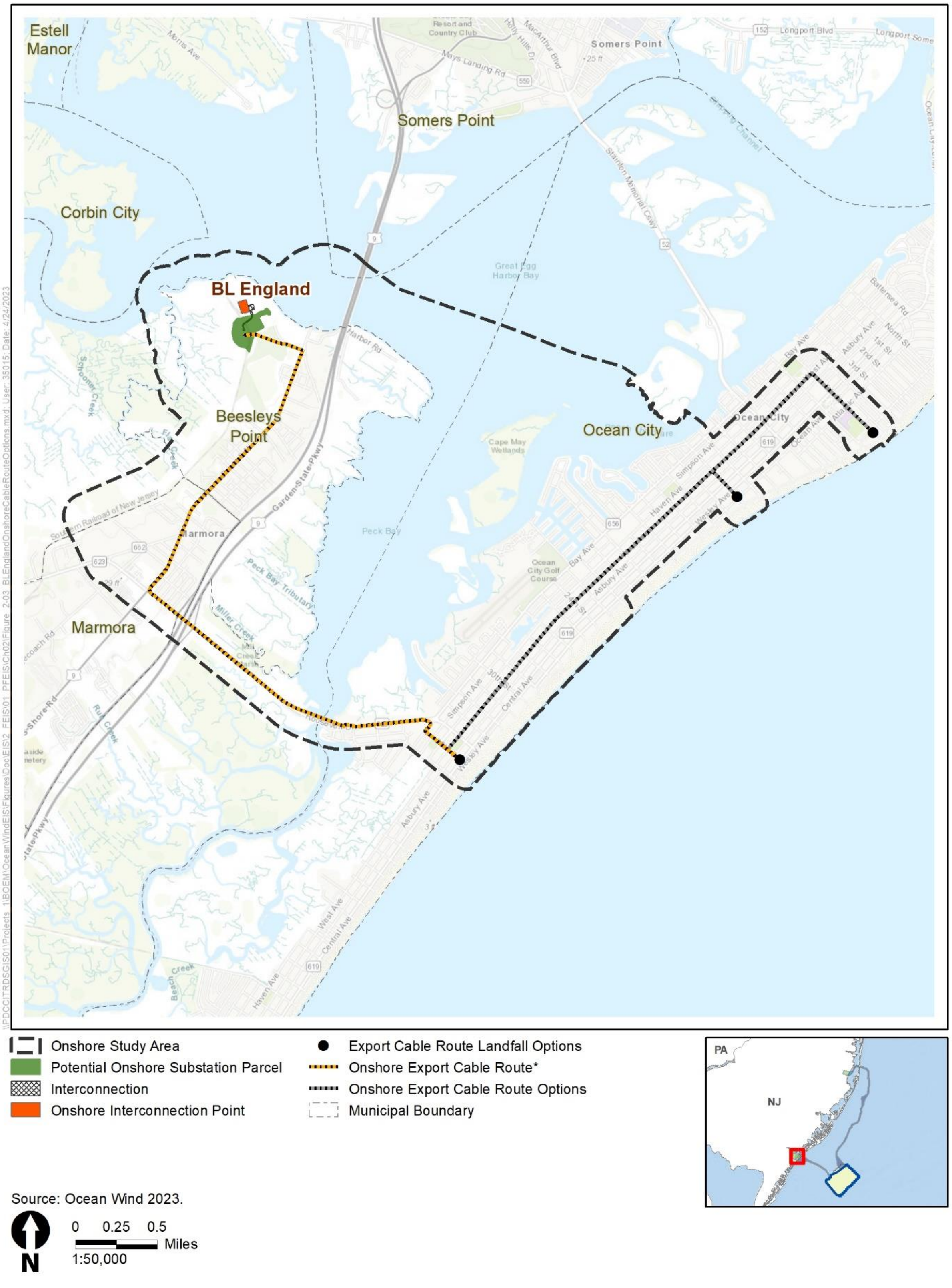
* Asterisks within the figure legend identify the cable routes for which Ocean Wind has submitted permit applications.

Figure 2-1 Oyster Creek Export Cable Route Options at Island Beach State Park



* Asterisks within the figure legend identify the cable routes for which Ocean Wind has submitted permit applications.

Figure 2-2 Onshore Cable Route Options to Oyster Creek Substation (Preferred Alternative)



* Asterisks within the figure legend identify the cable routes for which Ocean Wind has submitted permit applications.

Figure 2-3 Onshore Cable Route Options to BL England Substation (Preferred Alternative)

Onshore export cables would be buried and housed within a single duct bank buried along the onshore export cable route. The planned duct bank would be encased in concrete with a target burial depth of 4 feet. The duct bank would include six conduits for the power cables, two conduits for fiber optic communications cables, and two conduits for ground continuity conductors. Installation of onshore export cable would require up to a 50-foot (15-meter) wide construction corridor and up to a 30-foot (9-meter) wide permanent easement for the Oyster Creek and BL England cable corridors excluding landfall locations and cable splice locations. Permanent easements are expected to be larger at splice vaults and TJB locations. The Oyster Creek onshore cable route options that cross Route 9 and Oyster Creek would be installed using trenchless technology.

The proposed onshore export cable routes would terminate at the Oyster Creek and BL England substation sites. The proposed Oyster Creek substation is sited on the former Oyster Creek nuclear plant in Lacey Township, which was retired and is in the decommissioning phase. It would occupy up to 31.5 acres (127,476 square meters [m^2]). The proposed BL England substation is sited on the site of a former coal, oil, and diesel plant in Upper Township that was retired in phases between 2014 and 2019. It would occupy up to 13 acres (52,609 m^2). For both proposed substations, either an overhead connection or an underground transmission line with an overhead tie-line may be used from the onshore substation to an interconnection point at an existing nearby facility.

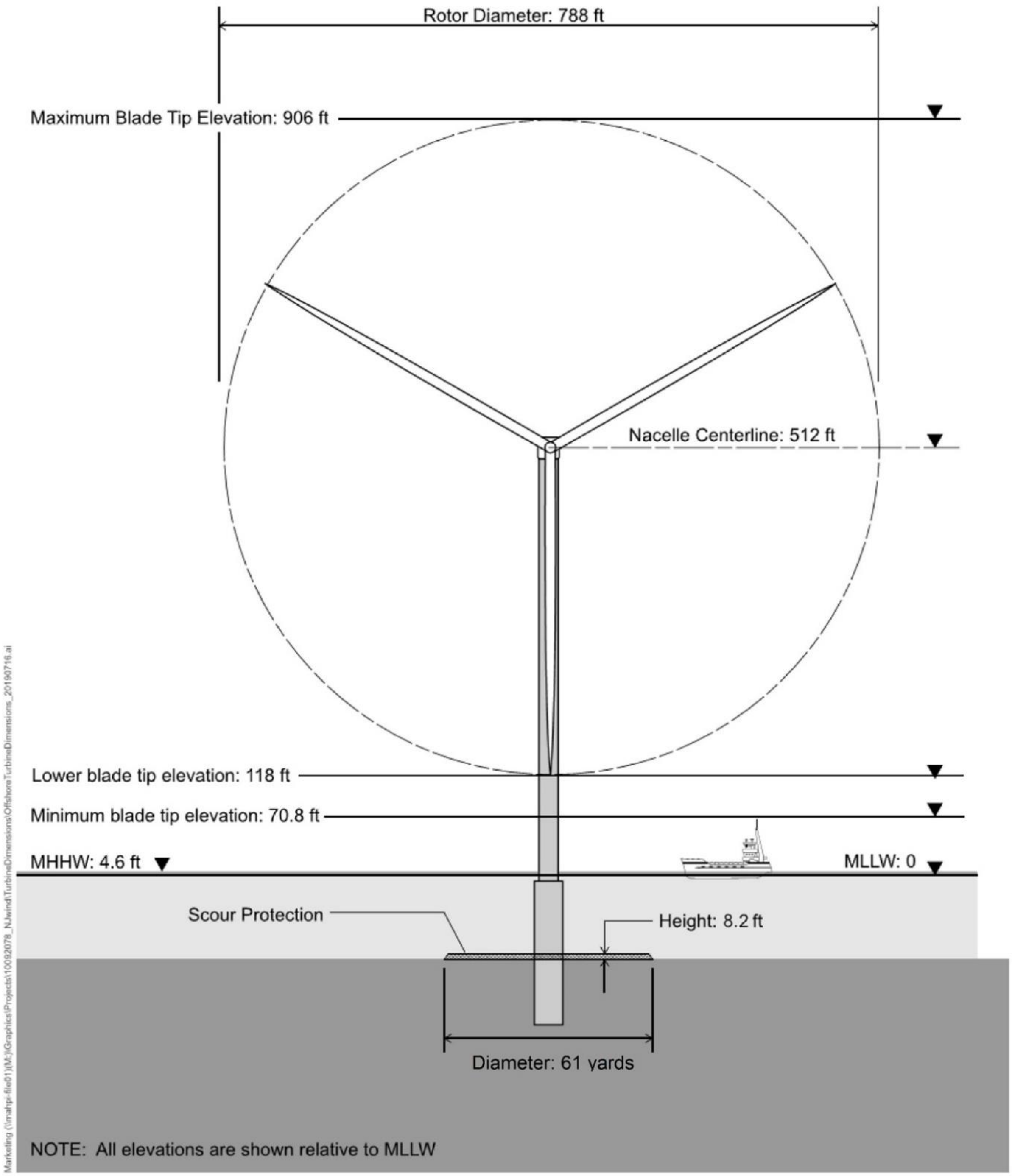
2.1.2.2.3 Offshore and Nearshore Activities and Facilities

Proposed offshore Project components include WTGs and their foundations, OSS and their foundations, scour protection for foundations, inter-array and substation interconnection cables, and offshore export cables (these elements collectively compose the Offshore Project area). Infrastructure and equipment for environmental monitoring, asset monitoring, and communication systems are also proposed. The proposed offshore Project elements are on the OCS as defined in the OCSLA, with the exception that a portion of the export cables would be within state waters (Figure 1-1). Appendix E, *Project Design Envelope and Maximum-Case Scenario*, describes the PDE for offshore activities and facilities and COP Volume I provides additional details on construction and installation methods (Ocean Wind 2023).

Ocean Wind proposes the installation of up to 98 WTGs extending up to 906 feet (276 meters) above mean lower low water (MLLW) with a spacing of 1 nm by 0.8 nm between WTGs in a southeast-northwest orientation within the 68,450-acre (277-square-kilometer [km^2]) Wind Farm Area.[5] Refer to Figure 2-4 for a schematic drawing of the maximum WTG design parameters. Ocean Wind would mount the WTGs on monopile foundations (Figure 2-5). A monopile foundation typically consists of a single steel tubular section, consisting of sections of rolled steel plate welded together. A transition piece is fitted over the monopile and secured via bolts or grout. OSS would be placed on either monopile or piled jacket foundations. Piled jacket foundations are formed of a steel lattice construction, composed of tubular steel members and welded joints, and secured to the seabed by hollow steel pin piles attached to each of the jacket feet. Renderings of the WTGs and indicative figures of the OSS monopile and piled jacket foundations are included in COP Volume I, Section 6.1.1 (Ocean Wind 2023). The WTG foundations would have a maximum seabed penetration of 164 feet (50 meters). Where required, scour protection would be placed around foundations to stabilize the seabed near the foundations as well as the foundations themselves. The scour protection would be a maximum of 8.2 feet (2.5 meters) in height,

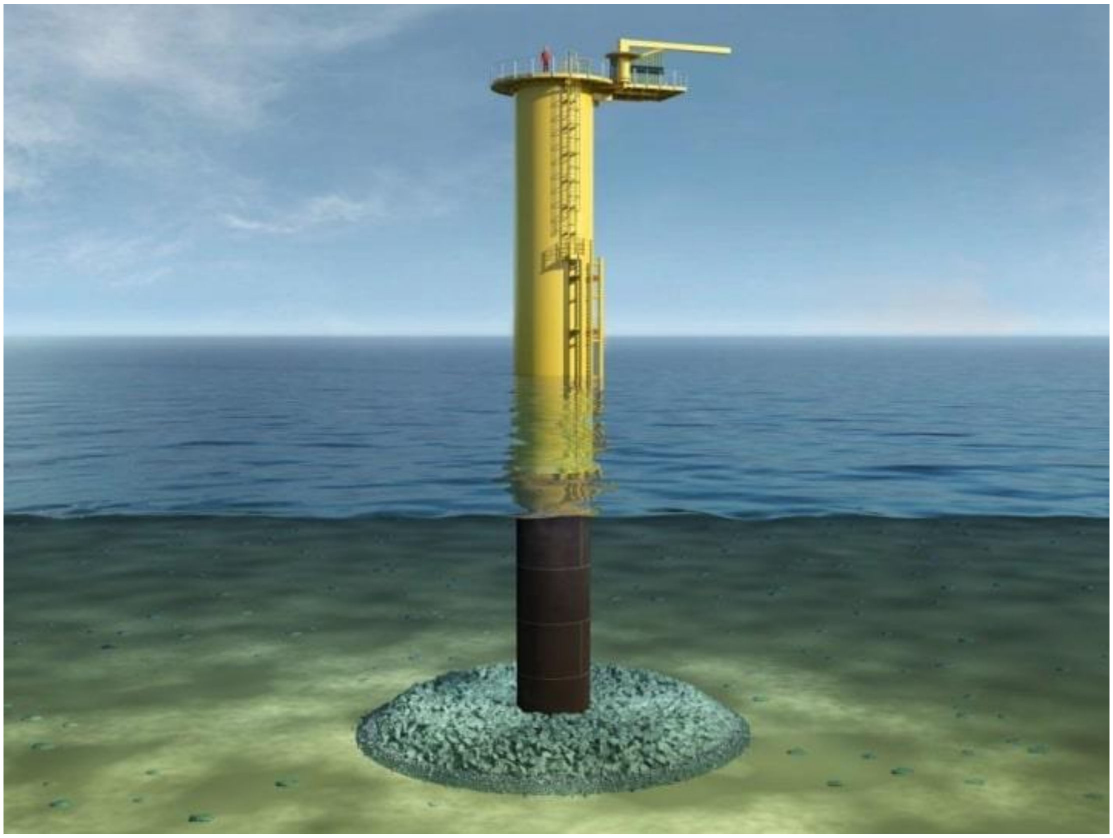
[5] Subsequent to publication of the Draft EIS, Ocean Wind submitted an updated COP incorporating an array layout compression scenario analyzed under Alternative C-2, Wind Turbine Layout Modification to Establish a Buffer Between Ocean Wind 1 and Atlantic Shores South. This array layout compression scenario, depicted on Figure 2-6 of the Draft EIS, modifies the WTG array layout by compressing the WTG array layout to create a 0.81-nm buffer. Ocean Wind 1 and Atlantic Shores South, in coordination with the U.S. Coast Guard, developed this mutually agreeable scenario, which was documented in a joint letter signed by Ocean Wind and Atlantic Shores Offshore Wind on July 21, 2022.

would extend away from the foundation as far as 73 feet (22.3 meters). Each WTG would contain approximately 1,585 gallons (6,000 liters) of transformer oil and 146 gallons (553 liters) of general oil (for hydraulics and gearboxes). Use of other chemicals would include diesel fuel, coolants/refrigerants, grease, paints, and sulfur hexafluoride. COP Volume I, Section 8.1 provides additional details related to proposed chemicals and their anticipated volumes (Ocean Wind 2023).



Source: Ocean Wind 2023.
MHHW = mean higher high water; MLLW = mean lower low water

Figure 2-4 Wind Turbine Schematic (Maximum Design Parameter)



Source: Ocean Wind 2023.

Figure 2-5 Monopile Foundation Type

Ocean Wind proposes to install foundations and WTGs using up to two jack-up vessels, as well as necessary support vessels and barges as listed in COP Volume I, Table 6.1.2-1 (Ocean Wind 2023). After the seabed has been prepared for foundations, Ocean Wind would begin pile driving until the target embedment depth is met. Installation of monopile and piled jacket foundations are similar, although piled jacket foundations would require more seabed preparation for each of the jacket feet.

Ocean Wind proposes to construct up to three OSS to collect the electricity generated by the offshore turbines. OSS help stabilize and maximize the voltage of power generated offshore, reduce potential electrical losses, and transmit energy to shore. OSS are generally installed in two phases: first the foundation substructure would be installed in a similar method to that described above, then the topside structure would be installed on the foundation structure. More information on installation can be found in COP Volume I, Section 6.1.2 (Ocean Wind 2023). Each substation is expected to require two primary vessels, which may include jack-up vessels, jack-up barges, sheerleg barges, or Heavy-Lift Vessels, as well as necessary support vessels and barges as listed in COP Volume I, Table 6.1.2-2 (Ocean Wind 2023). OSS would consist of a topside structure with one or more decks on either a monopile or piled jacket foundation. Inter-array cables would transfer electrical energy generated by the WTGs to the OSS. OSS would include step-up transformers and other electrical equipment needed to connect the 66-kilovolt (kV) inter-array cables to the 275-kV or 220-kV offshore export cables. Substations would be connected to one another via substation interconnector cables. Up to two interconnector cables with a maximum voltage of 275 kV would be buried beneath the seabed.

The WTGs and OSS would be lit and marked in accordance with Federal Aviation Administration (FAA) and United States Coast Guard (USCG) lighting standards and consistent with BOEM best practices. Ocean Wind proposes to implement an Aircraft Detection Lighting System (ADLS) to automatically activate lights when aircraft approach. Ocean Wind would paint WTGs no lighter than radar-activated light (RAL) 9010 Pure White and no darker than RAL 7035 Light Grey. Additionally, the lower sections of each structure would be marked with high-visibility yellow paint from the water line to an approximate height of at least 50 feet (15 meters), consistent with International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) guidance.

Ocean Wind proposes several cable installation methods for the inter-array and substation interconnector cables. Site preparation activities for cable laying would include boulder and sand wave clearance and pre-lay grapnel runs. A combination of displacement plow, subsea grab, or back hoe dredger may be used to clear boulders. For dense boulder fields, a displacement plow would most likely be used. A displacement plow is a Y-shaped tool composed of a boulder board attached to a plow. The plow is pulled along the seabed and scrapes the seabed surface, pushing boulders out of the cable corridor. The plow is lightly ballasted to clear the corridor of boulders but not create a deep depression in the seabed. A displacement plow cannot be used in areas where slopes are steep. Multiple passes may be required dependent on the burial tool selected and seabed conditions. Where there are steep slopes, large obstructions occur, or boulder density is low, a subsea grab may be used. In shallower waters, a backhoe dredger may be used. Following boulder clearance, a series of grapnels would be towed along the final cable route to locate and clear remaining obstructions, such as abandoned cables, fishing gear, and marine debris, prior to cable installation (i.e., a pre-lay grapnel run). A pre-lay grapnel run would be undertaken usually no more than 2 weeks before installation of the cable along a particular route length.

Sand waves (i.e., mobile sediment features on the seabed that resemble sand dunes) may be cleared prior to cable installation. Cables must be buried at a depth beneath the level where natural sand wave movement would not uncover them. Also, the natural slope of the sand waves can pose a hazard for installation tools that require a relatively level surface to operate effectively. Sand wave clearance may be needed where cable exposure is predicted over the lifetime of the Project due to seabed mobility or where slopes are greater than approximately 10 degrees (17.6 percent). Sand wave clearance would be accomplished using traditional dredging methods (e.g., trailing suction hopper dredging), controlled-flow excavation, or a sand wave removal plow to side cast material. Multiple passes may be required. Where there is a time gap between sand wave clearing and installation, the area may start to infill and pre-sweeping may be required to remove partial infill prior to cable installation.

Inter-array and substation interconnection cables would be laid and buried up to 2 weeks post-lay using a jetting tool if seabed conditions allow. Alternatively, the inter-array cables may be installed by using a tool towed behind the installation vessel to simultaneously open the seabed and lay the cable, or by laying the cable and following with a tool to embed the cable. Possible installation methods for these options include jetting, vertical injection, control flow excavation, trenching, and plowing. The inter-array and substation interconnector cables have a target burial depth of 4 to 6 feet (1.2 to 1.8 meters) below the stable seabed.

Two offshore export cable route corridors are proposed by Ocean Wind in the COP: Oyster Creek and BL England (Ocean Wind 2023). Up to two offshore export cables would be buried under the seabed within the Oyster Creek export cable route corridor to make landfall and deliver electrical power to the Oyster Creek substation. The offshore export cable route corridor to Oyster Creek would begin within the Wind Farm Area and proceed northwest to the Atlantic Ocean side of Island Beach State Park. At Island Beach State Park, Ocean Wind proposes two options. In the first option, the cable route would directly cross the barrier island using an HDD installation to cross the Swimming Area 2 Beach. HDD entry pits would be in an auxiliary parking lot of Swimming Area 2. The inshore export cable route corridor to Oyster Creek would exit the bay side of the Island Beach State Park and cross Barnegat Bay southwest to make landfall near Oyster Creek in either Lacey or Ocean Township. In the second option, the route would diverge and continue north within parking lots, then northwest under Shore Road before entering Barnegat Bay. Upon entering Barnegat Bay, the export cable route would continue within a previously dredged channel and then reconnect to the Oyster Creek export cable route in Barnegat Bay. Offshore export cables would be installed up to the TJB using open cut (i.e., trenching) or trenchless methods (i.e., bore or HDD). The final method would be based on an assessment of topography, bathymetry, accessibility, tidal conditions, geotechnical situation, environmental constraints, and other parameters. Sheet piling would be temporarily installed to support open cut trenches and as intertidal cofferdams for HDD exit pits. Open cut installation entails excavation of a trench using a land-based or barge-mounted excavator, positioning and securing the cable, burial and backfill to restore pre-existing contours, and revegetation. HDD installation involves excavation of an exit pit, drilling and pumping drilling fluid to create a bore and then pulling conduit into the bore. The export cable is then pulled through the installed conduit. The installation process is supported by a marine work platform and support vessels. The landfall at Island Beach State Park would cross Swimming Beach 2. HDD is the preferred option at this location to achieve burial depths of 30 feet or more. The landfall for BL England would cross Ocean City beaches that are included in the USACE beach nourishment program. Based on USACE guidance, the cable must be buried at depths not attainable by open cut or trenching (30 feet or more) and therefore HDD is the preferred option (Ocean Wind 2023). One offshore export cable would be buried under the seabed within the BL England export cable route corridor to make landfall and deliver electrical power to the BL England substation. The BL England offshore export cable route corridor would begin within the Wind Farm Area and proceed west to make landfall in Ocean City, New Jersey. Each offshore export cable would consist of three-core 275-kV alternating current cables.

Dredging may be required in shallow areas in Barnegat Bay to facilitate vessel access for export cable installation west of Island Beach State Park and near the landfall at Lacey or Ocean Township. Ocean Wind also proposes to dredge Barnegat Inlet and the Oyster Creek Channel within the authorized width and depth, if necessary to allow for safe and reliable passage of construction vessels into Barnegat Bay. Barnegat Inlet and the Oyster Creek Channel in Barnegat Bay are part of the Barnegat Inlet Federal Navigation Project, operated and maintained by USACE. Maintenance dredging of Barnet Inlet and the Oyster Creek Channel were previously analyzed by USACE in the *Final Environmental Assessment, National Regional Sediment Management (RSM) Program, WRDA 2016 Section 1122 Beneficial Use Pilot Project: Barnegat Inlet, Ocean County, New Jersey* (USACE 2020a) and the *Final Environmental Assessment, National Regional Sediment Management (RSM) Program, WRDA 2016 Section 1122 Beneficial Use Pilot Project: Oyster Creek Channel, Barnegat Inlet Federal Navigation Project, Ocean County, New Jersey* (USACE 2020b). Ocean Wind has coordinated with USACE Philadelphia District regarding current channel conditions and planned maintenance dredging, as USACE maintains the authorized depths within Barnegat Inlet and the Oyster Creek Channel through regular maintenance dredging. Dredging of approximately 18,000 cubic yards within an 3.7-acrea area would be conducted using a hydraulic cutterhead or closed-clamshell dredging and dredged material would be transferred to an upland disposal facility via a pipeline system, barge, or scow and disposed of in accordance with U.S. Environmental Protection Agency (USEPA) Guidelines, USACE Guidelines, New Jersey Administrative Code 7:7 Appendix G for the Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters, and applicable State Surface Water Quality Standards at New Jersey Administrative Code 7:9B and permit conditions.

Offshore export cables would be installed similarly to the inter-array cables. The installation vessel would transit to and take position at the landfall location and the cable end would be pulled into the preinstalled duct ending in the TJB. The installation vessel would transit the route toward the OSS, installing the cable by simultaneous lay and burial (plow/jetting/cutting) or surface lay and burial by a cable burial vessel (jetting/cutting/control flow excavation). The export cables have a target burial depth of 4 to 6 feet (1.2 to 1.8 meters) below the stable seabed.

Target burial depth is determined based on an assessment of seabed conditions, seabed mobility, and the risk of interaction with external hazards such as fishing gear and vessel anchors, while also considering other factors such as installation beneath maintained navigational channels and decreased thermal conductivity with increased cable burial depth. A Cable Burial Risk Assessment (CBRA) would be developed prior to construction and coordination with agencies would also inform final target burial depth. In the event that cables cannot achieve proper burial depths or where the proposed cables would cross existing infrastructure, Ocean Wind proposes the following protection methods: (1) rock placement, (2) concrete mattress placement, (3) frond mattress placement, (4) rock bags, or (4) seabed spacers. When the cable has been installed, post cable-lay surveys and depth-of-burial surveys would be conducted to determine if the cable has reached the desired depth. The remedial protection measures described above may be required in places where the target burial depth cannot be met. Ten percent of the inter-array, substation interconnector, and export cables would likely require protection.

The construction and installation phase of the proposed Project would make use of both construction and support vessels to complete tasks in the Wind Farm Area. Construction vessels would travel between the Wind Farm Area and the following ports that are expected to be used during construction: Atlantic City, New Jersey as a construction management base; Paulsboro, New Jersey or from Europe directly for foundation fabrication and load out; Norfolk, Virginia or Hope Creek, New Jersey for WTG pre-assembly and load out; and Port Elizabeth, New Jersey or Charleston, South Carolina, or directly from Europe for cable staging. During installation of inter-array and substation interconnection cables, Ocean Wind anticipates a maximum of 20 vessels operating during a typical workday in the Wind Farm Area. For offshore export cable installation, Ocean Wind anticipates a maximum of 26 vessels operating during a typical workday.

Ocean Wind proposes to deploy up to two wave buoys in the Wind Farm Area, up to six floating or bottom-mounted Acoustic Doppler Current Profilers in seabed frames along the export cable routes, and up to one wave buoy or bottom-mounted Acoustic Doppler Current Profilers may be deployed in Barnegat Bay to conduct meteorological and metocean evaluations during construction activities. Meteorological data to be collected and analyzed, including wind speed and direction, wave heights, and current speed and direction, would provide real-time data for vessels operating offshore. After construction, one wave buoy within 500 meters of a WTG would stay in place up to 5 years to support asset management, structural monitoring, and marine transfer operations.

2.1.2.3. Operations and Maintenance

The proposed Project is anticipated to have an operating period of 35 years.[6] Ocean Wind would use an onshore O&M facility in Atlantic City, New Jersey sited at the location of a retired marine terminal. Ørsted Wind Power North America, LLC (Ørsted) plans to rehabilitate this former marina facility near Absecon Inlet to create a port facility off the mid-Atlantic coast that can service potential wind turbine farms. The O&M facility would include offices, control rooms, warehouses, and workshop space. Approximately 500 feet (152 meters) of dockside harbor facilities and associated parking facilities would be added. The City of Atlantic City intends to secure authorization for marina upgrades, namely dredging in the marina and at Absecon Inlet, for the benefit of multiple marina users. Ørsted's rehabilitation of the former marina facility (including office and warehouse construction) and the City of Atlantic City's

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

marina upgrades are being separately reviewed and authorized by USACE (USACE Public Notices NAP-2021-00187-39 and NAP-2021-00573-95, respectively) and state and local agencies. The improvements are not dependent on the Proposed Action being analyzed in this EIS.

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

2.1.2.3.1 Onshore Activities and Facilities

The onshore substations, onshore export cables, and grid connections would include inspections, preventative maintenance, and, as needed, corrective maintenance. Inspections of these facilities would occur as often as weekly. Routine preventive maintenance would occur annually for main servicing, but individual aspects may occur each quarter. Maintenance programs would conform to the equipment manufacturers' warranty requirements.

2.1.2.3.2 Offshore Activities and Facilities

Ocean Wind would conduct inspections of foundations, bathymetry, scour (and associated scour protection, if deployed), and cable burial. Multi-beam echosounder surveys would be conducted during years 1, 4, and 5 post-commissioning, after which an optimal survey frequency would be determined based on initial findings. Sonar, remotely operated vehicles, drones, and divers may be required. Routine maintenance is expected for WTGs, foundations, and OSS. Ocean Wind would conduct annual maintenance of WTGs, including safety surveys, blade maintenance, and painting as needed. OSS would be routinely maintained for preventative maintenance up to 12 times per year. A cable maintenance and monitoring plan would be developed and implemented. Although the offshore export cables, inter-array cables, and OSS interconnector cables typically have no maintenance requirements unless a failure occurs, cable failures may result from anchors and fishing gear. During these low-probability events, cables would be located, unburied, and lifted above sea level for repair or replacement aboard the cable-handling vessel. Upon completion of the repair, the cable would be lowered onto the seabed, assessed to determine its proximity to the original location, and reburied using a jetting tool. Spare parts for key Project components may be housed at the O&M facility so Ocean Wind could initiate repairs expeditiously. Portions of the cables are anticipated to become exposed due to natural sediment transport processes and would require scour protection replenishment or reburial. Ocean Wind would conduct multi-beam echosounder bathymetry survey along the cable routes immediately following installation and at 1 year, 2 to 3 years, and 5 to 8 years post-commissioning, after which survey frequency would depend on prior survey findings. Additional surveys may be conducted after major storm events as otherwise needed (Ocean Wind 2023).

Ocean Wind would need to use vessels, remote sensing equipment, and vehicles during O&M activities described above. The Project would use a variety of vessels to support O&M including crew transfer vessels, service operation vessels, jack-up vessels, and supply vessels. In a year, the Proposed Action would generate a maximum of 908 crew vessel trips, 102 jack-up vessel trips, and 104 supply vessel trips; and a maximum of 2,278 crew transfer vessel trips, or service operations vessel trips (COP Volume I, Section 6.1.3.5, Table 6.1.2-11; Ocean Wind 2023).

2.1.2.4. Decommissioning

Under 30 CFR 585 and commercial Renewable Energy Lease OCS-A 0498, Ocean Wind would be required to remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by the proposed Project. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (30 CFR 285.910(a)). Absent permission from BOEM, Ocean 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. Ocean Wind has submitted a conceptual decommissioning plan as part of the COP, and the final decommissioning application would outline Ocean Wind's process for managing waste and recycling proposed Project components (Volume I, Section 6.3; Ocean Wind 2023). Although the proposed Project is anticipated to have an operational life of 35 years, it is possible that some installations and components may remain fit for continued service after this time. Ocean Wind would have to apply for and be granted an extension if it wanted to operate the proposed Project for more than the 25-year operations term stated in its lease.

BOEM would require Ocean Wind to submit a decommissioning application upon the earliest of the following dates: 2 years before the expiration of the lease, 90 days after completion of the commercial activities on the commercial lease, or 90 days after cancellation, relinquishment, or other termination of the lease (see 30 CFR 285.905). Upon completion of the technical and environmental reviews, BOEM may approve, approve with conditions, or disapprove the lessee's decommissioning application. This process would include an opportunity for public comment and consultation with municipal, state, and federal management agencies. Ocean Wind would need to obtain separate and subsequent approval from BOEM to retire in place any portion of the proposed Project. Approval of such activities would require compliance under NEPA and other federal statutes and implementing regulations.

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

2.1.2.4.1 Onshore Activities and Facilities

At the time of decommissioning, some components of the onshore electrical infrastructure may still have substantial life expectancies. Depending on the needs at the time, the onshore cables installed overhead may either be used for other projects or removed. There are no proposed plans to disrupt streets or onshore public utility rights-of-way by excavating or deconstructing buried onshore facilities and components.

2.1.2.4.2 Offshore Activities and Facilities

For both WTGs and OSS, decommissioning would be a "reverse installation" process, with turbine components or the OSS topside structure removed prior to foundation removal. Ocean Wind would remove monopile foundations by cutting below the seabed level in accordance with standard practices and seabed conditions at the time of demolition. Ocean Wind proposes to leave scour protection placed around the base of the monopile, if used, in place. This request would be made to BOEM through 30 CFR 585.434(a). However, the Bureau of Safety and Environmental Enforcement (BSEE) would most likely require that the scour protection be removed in accordance with 30 CFR 285.902(a). Offshore cables would either be left in place or removed, or a combination of both, depending on regulatory requirements at the time of decommissioning. It is anticipated that the inter-array cables would be removed using controlled-flow excavation or a grapnel to lift the cables from the seabed.

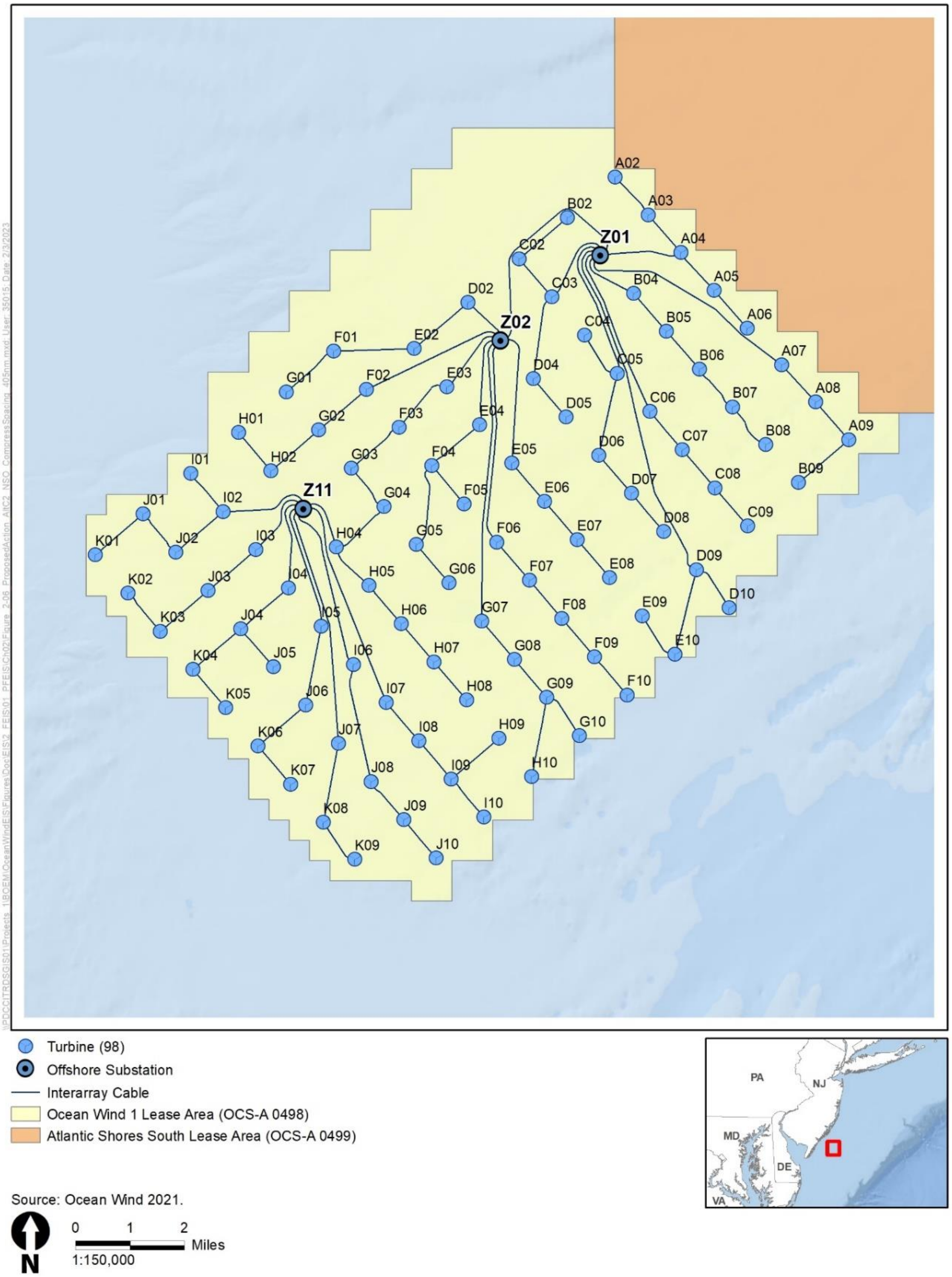


Figure 2-6 Proposed Action[7] (Preferred Alternative)

[7] Ocean Wind's October 2022 COP updated the proposed array layout to a scenario analyzed under Alternative C-2 in the Draft EIS: No Surface Occupancy to Establish a Buffer with Turbine Layout Compression (Compression Layout for 0.81-nm Buffer).

2.1.3 Alternative B—No Surface Occupancy at Select Locations to Reduce Visual Impacts

Alternative B was developed through the scoping process for the Draft EIS in response to public comments concerning the visual impacts of the Project. Under Alternative B, no surface occupancy would occur at select WTG positions to reduce the visual impacts of the proposed Project. The range of design parameters for Project components and activities to be undertaken for construction and installation, O&M, and conceptual decommissioning would be the same as described for the Proposed Action. Alternative B includes two sub-alternatives to account for two different turbine sizes and power-generating capabilities. Each of the below sub-alternatives may be individually selected or combined with any or all other alternatives or sub-alternatives, subject to the combination meeting the purpose and need.

- **Alternative B-1:** No Surface Occupancy at Select Locations to Reduce Visual Impacts (Smaller Turbine Model) (Figure 2-7). This alternative would exclude placement of WTGs at up to nine WTG positions that are nearest to coastal communities (positions F01 to K01 and B02 to D02).
- **Alternative B-2:** No Surface Occupancy at Select Locations to Reduce Visual Impacts (Larger Turbine Model) (Figure 2-8). This alternative would exclude placement of WTGs at up to 19 WTG positions that are nearest to coastal communities (positions F01 to K01, A02 to K02, A03, and C03). Selection of this alternative would be contingent on the larger turbine with a 240-meter rotor diameter being commercially available when BOEM issues its ROD as well as its technical and economic feasibility, and consistency with the purpose and need.

Exclusion of WTG positions would result in reduced expected annual energy production. For example, removal of the maximum number (nine) of WTGs under Alternative B-1 could result in a 14-percent reduction in expected annual energy production as measured in MW-hours per year in comparison to the Proposed Action. Removing fewer than nine WTGs would decrease the reduction in expected annual energy production; however, there would be a corresponding decrease in the ability for Alternative B-1 to reduce the visual impacts of the Project. Any changes to the stated MW-hour allowance in the June 2019 Order would require the consent of both BPU and Ocean Wind. Alternatives B-1 and B-2 would require redesign of the inter-array cables and may require additional site investigation. Collecting and processing the additional survey data could lead to a Project delay of up to 2 years.

2.1.4 Alternative C—Wind Turbine Layout Modification to Establish a Buffer Between Ocean Wind 1 and Atlantic Shores South

During the scoping process for the Draft EIS public comments from USCG, the Responsible Offshore Development Alliance (RODA), and commercial fishermen identified concerns with the different layouts between the Ocean Wind 1 and Atlantic Shores South projects and proximity of the two projects in the adjacent lease areas. BOEM developed Alternative C in coordination with USCG to address the concerns raised during the scoping process. Under Alternative C, modifications would be made to the wind turbine array layout to create a 0.81-nm to 1.08-nm buffer between WTGs in OCS-A 0498 (Ocean Wind 1 Lease Area) and WTGs in OCS-A 0499 (Atlantic Shores South Lease Area). Atlantic Shores South would also need to modify its wind turbine layout in order to create a total buffer distance of between 0.8 nm and 1.1 nm; however, this Final EIS only analyzes the portion of the buffer within the Ocean Wind 1 Lease Area. A buffer would provide a clear visual distinction between the separate projects and provide for sufficient maneuvering space for both surface and aerial (helicopter) navigation. Each of the below sub-alternatives may be individually selected or combined with any or all other alternatives or sub-alternatives, subject to the combination meeting the purpose and need. The range of design parameters for Project components and activities to be undertaken for construction and installation, O&M, and conceptual decommissioning would be the same as described for the Proposed Action.

- **Alternative C-1:** No Surface Occupancy to Establish a Buffer with Turbine Relocation (Figure 2-9). This alternative would result in no surface occupancy along the northeastern boundary of the Ocean Wind 1 Lease Area through the exclusion of eight WTG positions (A02 to A09), relocation of up to eight WTG positions to the northern portion of the Ocean Wind 1 Lease Area, or some combination of exclusion and relocation of WTG positions, to allow for a 0.81-nm to 1.08-nm buffer between WTGs in the Ocean Wind 1 Lease Area and WTGs in the Atlantic Shores South Lease Area.
- **Alternative C-2:** No Surface Occupancy to Establish a Buffer with Turbine Layout Compression (Figure 2-10). This alternative would result in no surface occupancy along the northeastern boundary of the Ocean Wind 1 Lease Area to allow for an 0.81-nm to 1.08-nm buffer (Figure 2-10[8]) between the WTGs in the Ocean Wind 1 Lease Area and the WTGs in the Atlantic Shores South Lease Area. However, under Alternative C-2, the wind turbine array layout would be compressed to allow for a full build of up to 98 WTGs. Ocean Wind 1's turbine array row spacing would be reduced from 1 nm between rows to no less than 0.99 nm between rows.

Exclusion of WTG positions would lead to a reduced expected annual energy production. For example, removal of the eight 12-MW WTGs under Alternative C-1 could result in a 12.5-percent reduction in expected annual energy production as measured in MW-hours per year in comparison to the Proposed Action. Exclusion of fewer than eight WTGs would not allow Alternative C-1 to provide a buffer between WTGs in the Ocean Wind 1 Lease Area and the Atlantic Shores South Lease Area. Compression of the array layout to 0.99-nm by 0.8-nm spacing under Alternative C-2 could result in an 8-percent reduction in expected annual energy production in comparison to the Proposed Action. Any changes to the stated MW-hour allowance in the June 2019 Order would require the consent of both BPU and Ocean Wind.

Alternatives that relocate WTG positions or compress the WTG layout and require redesign of the inter-array cables may require additional site investigation. Collecting and processing the additional survey data could lead to a Project delay of up to 2 years.

[8] Figure 2-10 depicts a compressed array layout with the 1.08-nm (2,000-meter) buffer positioned on the centerline of the shared boundary between the Ocean Wind 1 Lease Area and the Atlantic Shores South Lease Area.

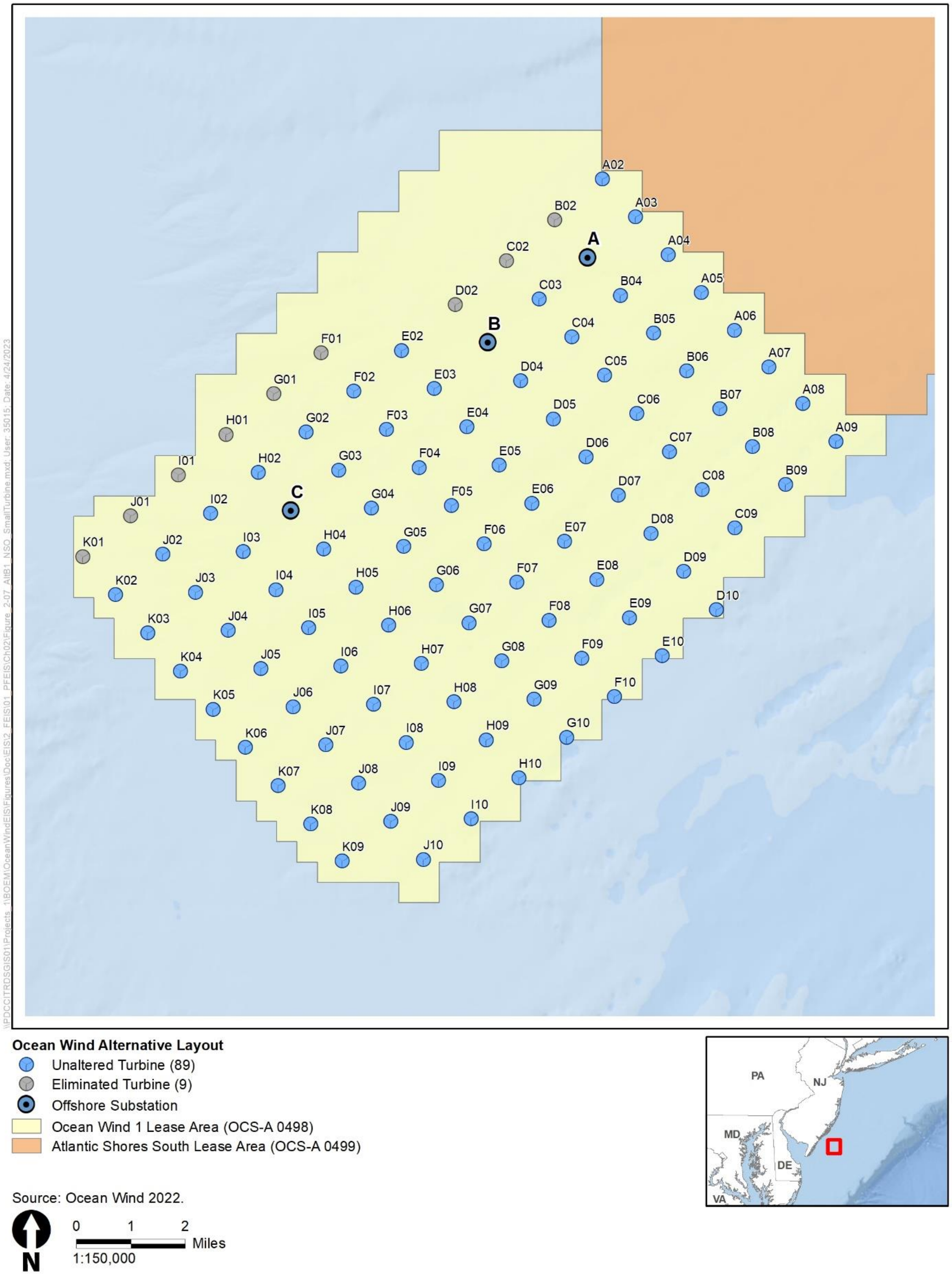


Figure 2-7 Alternative B-1: No Surface Occupancy at Select Locations to Reduce Visual Impacts (Smaller Turbine Model)

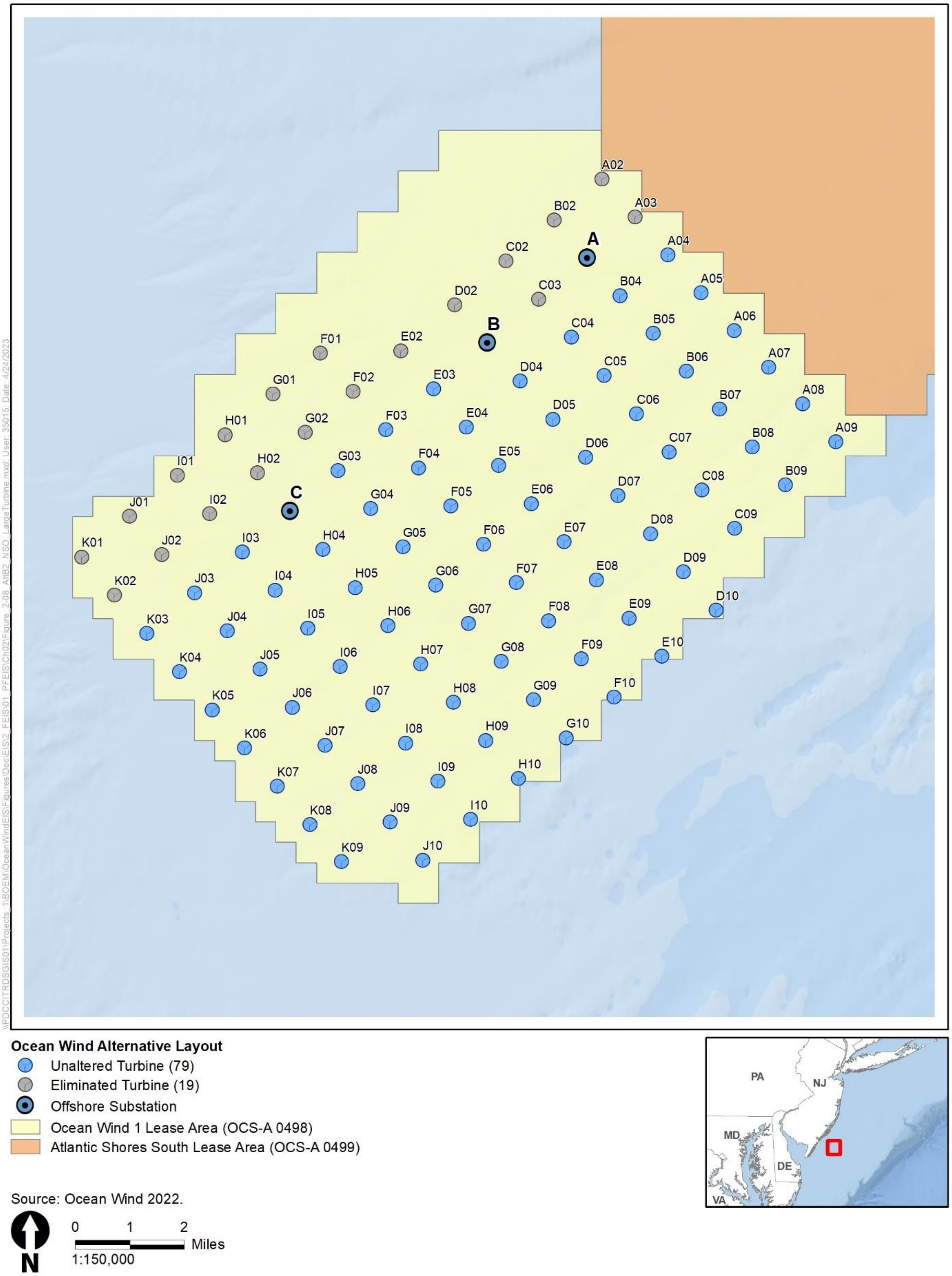


Figure 2-8 Alternative B-2: No Surface Occupancy at Select Locations to Reduce Visual Impacts (Larger Turbine Model)

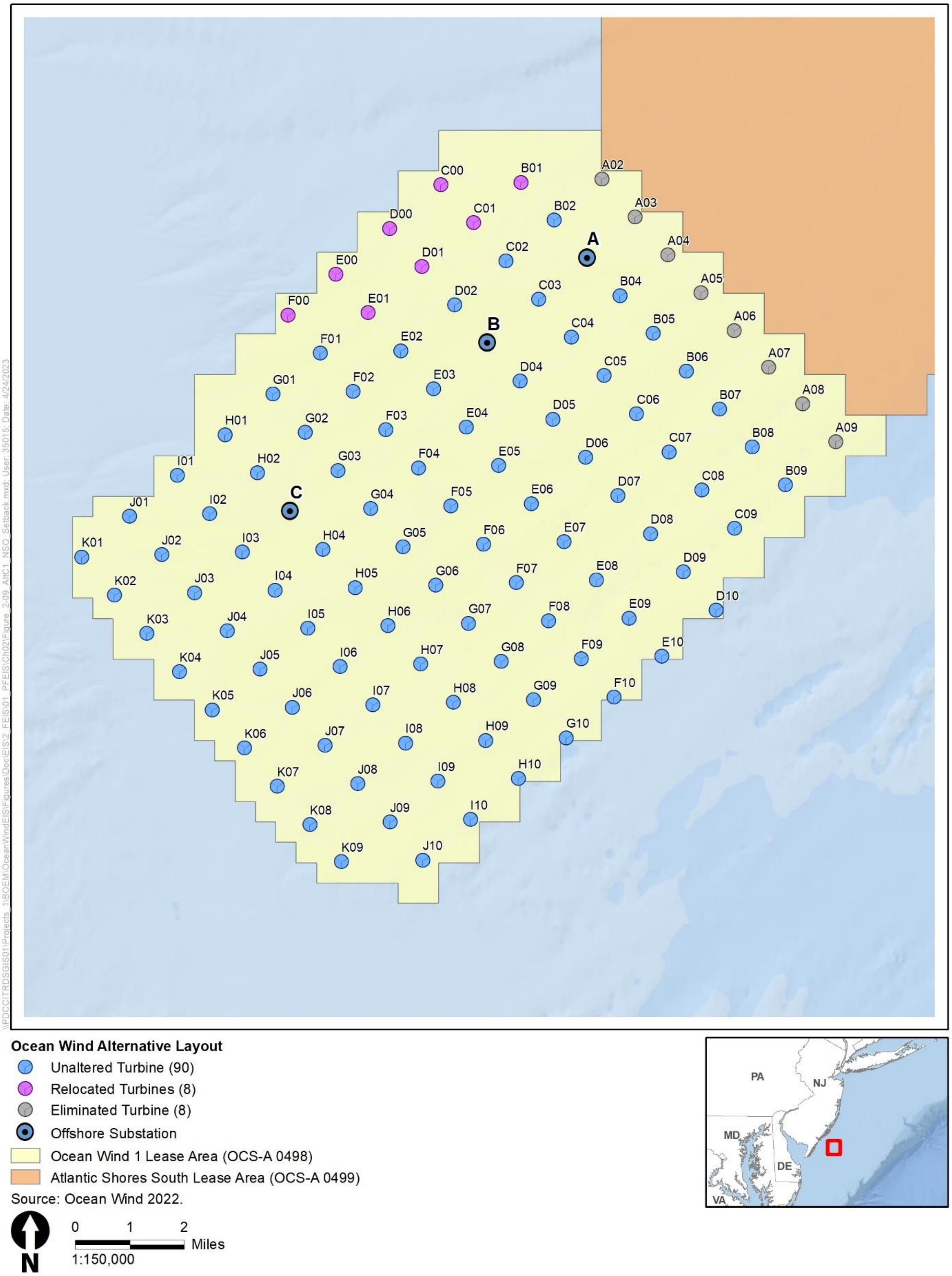


Figure 2-9 Alternative C-1: No Surface Occupancy to Establish a Buffer with Turbine Relocation

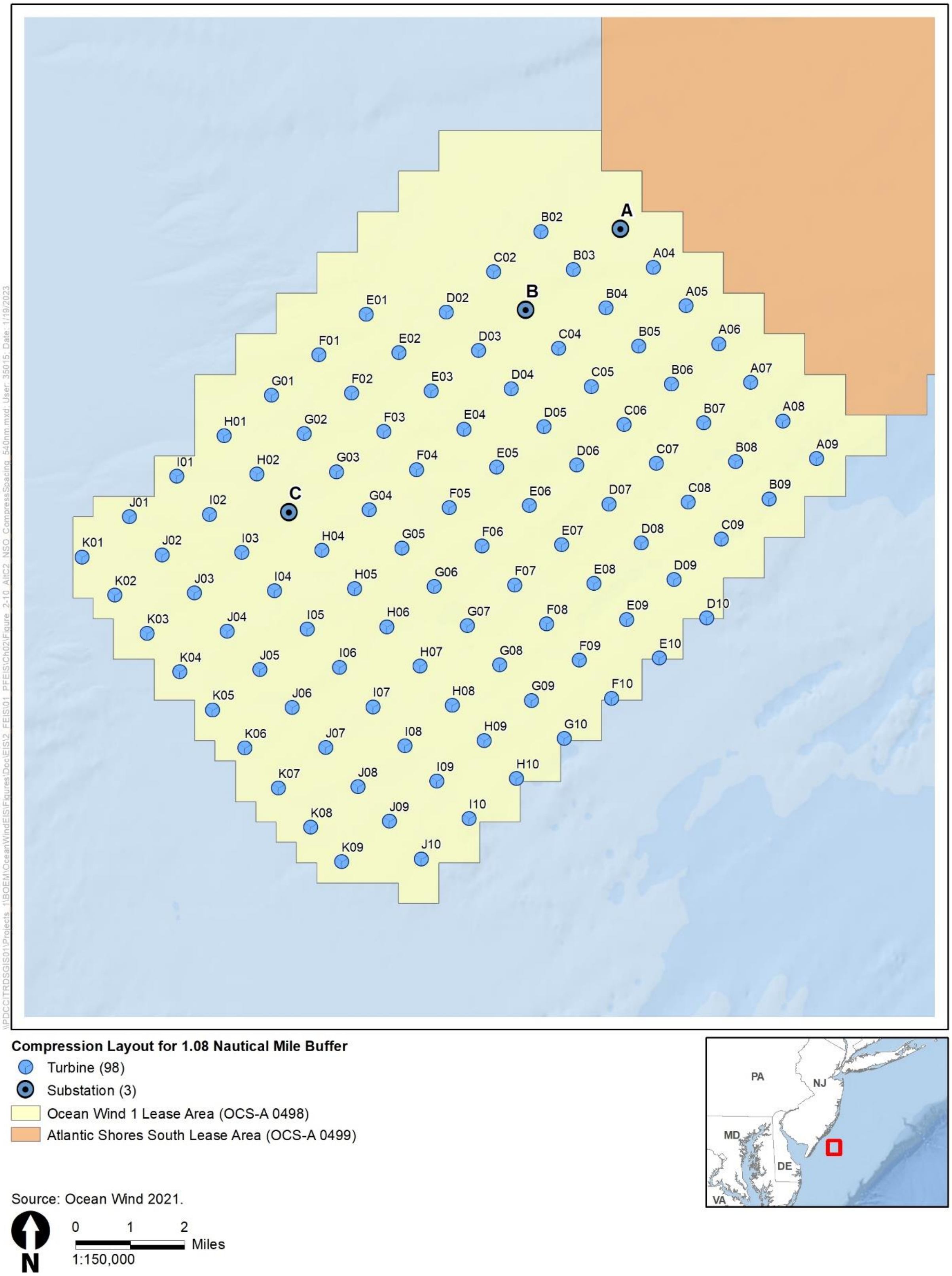


Figure 2-10 Alternative C-2: No Surface Occupancy to Establish a Buffer with Turbine Layout Compression (Compression Layout for Buffer)

2.1.5 Alternative D—Sand Ridge and Trough Avoidance

Under Alternative D (Figure 2-11), the construction, O&M, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the Ocean Wind 1 COP, subject to applicable mitigation measures. However, modifications would be made to the wind turbine array layout to minimize impacts on sand ridge and trough features in the northeastern corner of the Lease Area. This alternative would result in the exclusion of up to 15 WTG positions in the sand ridge and trough area. The identification of individual WTGs for exclusion, should the number excluded be fewer than 15, would be coordinated with NMFS. These physical features are found throughout the OCS in the mid-Atlantic and provide important habitat for several species. Ridge and swale habitat provide complex physical structures that affect the composition and dynamics of ecological communities, with increased structural complexity often leading to greater species diversity, abundance, overall function, and productivity. The sand ridges and troughs are areas of biological significance for migration and spawning of mid-Atlantic fish species, many of which are recreationally targeted in those specific areas. Although the overall artificial reef effect would be decreased by reducing the total number of WTGs in the Lease Area, the biological benefits of preserving natural fish habitat may be beneficial. Selection of this alternative with the exclusion of more than nine WTGs would be contingent on the larger turbine with a 240-meter rotor diameter being commercially available when BOEM issues its ROD as well as its technical and economic feasibility, and consistency with the purpose and need.

Exclusion of WTG positions would lead to a reduced expected annual energy production. For example, removal of 15 12-MW WTGs could result in a 19-percent reduction to expected annual energy production as measured in MW-hours per year in comparison to the Proposed Action. Removing fewer than 15 WTGs would decrease the reduction in expected annual energy production; however, there would be a corresponding decrease in the ability for Alternative D to minimize impacts of the Project on sand ridge and trough features in the northeastern corner of the Lease Area. Any changes to the stated MW-hour allowance in the June 2019 Order would require the consent of both BPU and Ocean Wind. Alternative D would require redesign of the inter-array cables and may require additional site investigation. Collecting and processing the additional survey data could lead to a Project delay of up to 2 years.

2.1.6 Alternative E—Submerged Aquatic Vegetation Avoidance (Preferred Alternative)

Under Alternative E (Figure 2-12), the construction, O&M, and eventual decommissioning of an 1,100-MW wind energy facility on the OCS offshore New Jersey would occur within the range of the design parameters outlined in the Ocean Wind 1 COP, subject to applicable mitigation measures. However, the Oyster Creek export cable route option traveling directly across the barrier island would not be used and the export cable route would be limited to the option developed to minimize impacts on submerged aquatic vegetation (SAV) in Barnegat Bay. The SAV avoidance export cable route option would make landfall within an auxiliary parking lot of Swimming Area 2 in Island Beach State Park and then continue north within parking lots, then northwest under Shore Road before entering Barnegat Bay. Upon entering Barnegat Bay, the export cable route would run west within a previously dredged channel and then reconnect to the Oyster Creek export cable route in Barnegat Bay. This alternative would narrow the design envelope so that the Applicant could only select the northernmost export cable route; the northernmost export cable route would not function independently but is intended to be combined with another alternative or sub-alternative, subject to the combination meeting the purpose and need.

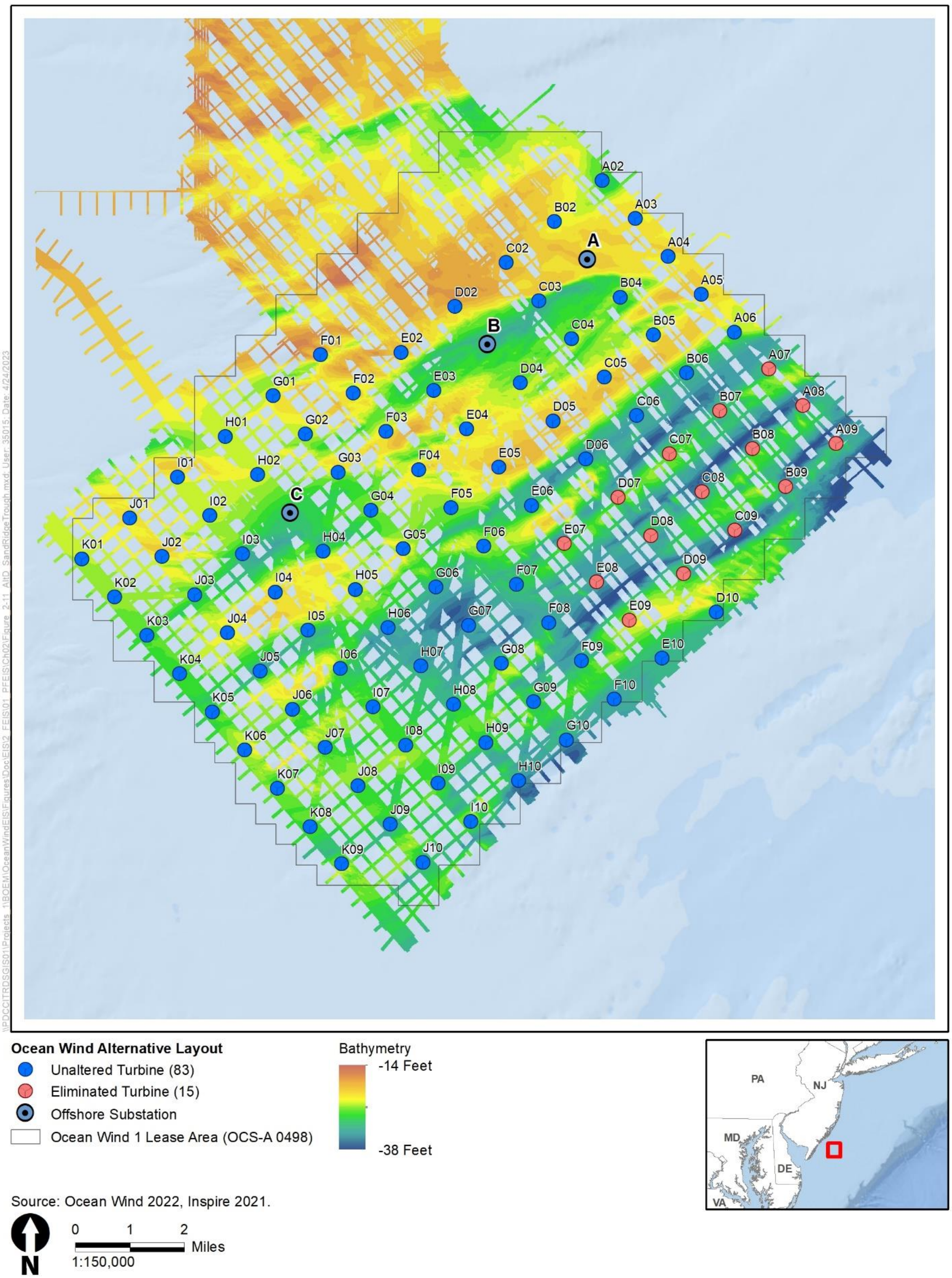


Figure 2-11 Alternative D: Sand Ridge and Trough Avoidance

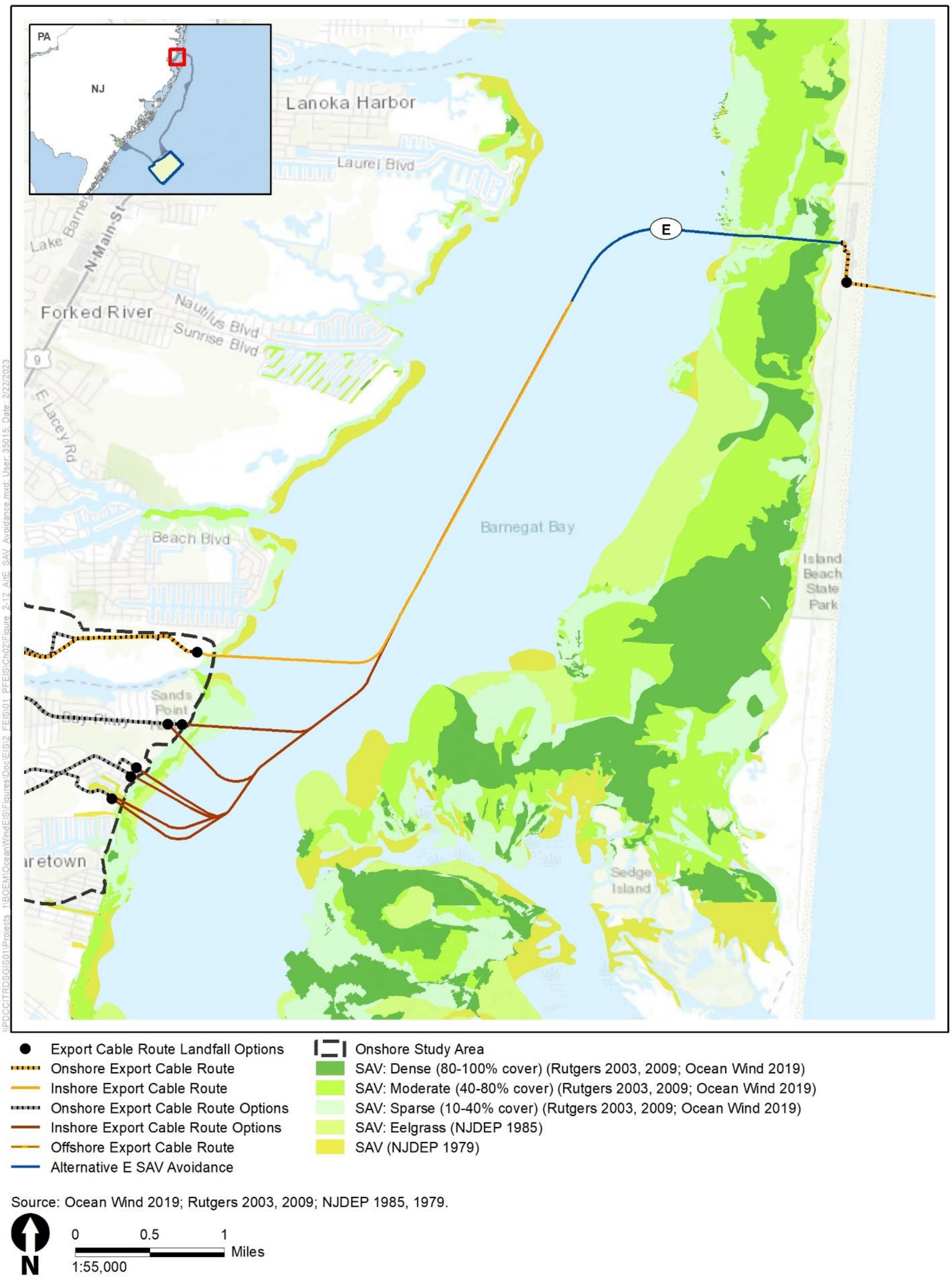


Figure 2-12 Alternative E: SAV Avoidance (Preferred Alternative)

2.1.7 Alternatives Considered but not Analyzed in Detail

Under NEPA, a reasonable range of alternatives framed by the purpose and need must be developed for analysis for any major federal action. The alternatives should be "reasonable," which the Department of the Interior has defined as those that are "technically and economically practical or feasible and meet the purpose and need of the proposed action."[9] There should also be evidence that each alternative would avoid or substantially lessen one or more potential, specific, and significant socioeconomic or environmental effects of the project.[10] Alternatives that could not be implemented if they were chosen (for legal, economic, or technical reasons), or do not resolve the need for action and fulfill the stated purpose in taking action to a large degree, are therefore not considered reasonable.

BOEM considered alternatives to the Proposed Action that were identified through coordination with cooperating and participating agencies and through public comments received during the public scoping period for the EIS. BOEM then evaluated the alternatives and dismissed from further consideration alternatives that did not meet the purpose and need, did not meet the screening criteria, or both. The screening criteria are provided in Appendix C, *Additional Analysis for Alternatives Dismissed*. Additional analysis was necessary to determine the economic and technical feasibility of several possible SAV avoidance alternatives. This analysis, as well as analysis conducted for other dismissed alternatives, is described in Appendix C.

Table 2-3 lists the alternatives and the rationale for their dismissal. These alternatives are presented below with a brief discussion of the reasons for their elimination as prescribed in CEQ regulations at 40 CFR 1502.14(a) and Department of the Interior regulations at 43 CFR 46.420(b–c).

Table 2-3 Alternatives Considered but not Analyzed in Detail

Alternative	Rationale for Dismissal
Wind Farm Location and Generating Capacity	
Alternate locations for the wind energy facility outside the Lease Area (i.e., farther north, farther offshore, or in a different WEA [including in the Hudson South WEA])	Evaluating an alternate location for the wind energy facility outside of the Lease Area would constitute a new Proposed Action and would not meet BOEM's purpose and need to respond to Ocean Wind's proposal and determine whether to approve, approve with modifications, or disapprove the COP to construct, operate and maintain, and decommission a commercial-scale offshore wind energy facility within the Lease Area. BOEM's regulations require BOEM to analyze Ocean Wind's proposal to build a commercial-scale wind energy facility on the Lease Area. BOEM would consider proposals on other existing leases through a separate regulatory process. This alternative would effectively be the same as selecting the No Action alternative.
Project with lower nameplate capacity than 1,100 MW, requiring fewer turbine positions that would be located in specific sections of the Lease Area	An 1,100-MW nameplate capacity is necessary to fulfill the terms of BPU's 2019 Order. BOEM is analyzing several alternatives (B, C, and D) in detail that could require fewer WTG positions or restrict WTGs in specific sections of the Lease Area while still meeting the proposed 1,100-MW nameplate capacity. Moreover, this alternative does not address a specific concern or provide sufficient detail to meaningfully analyze impacts; therefore, this alternative was not carried forward for separate analysis.

[9] 43 CFR 46.420(b). The terms "practical" and "feasible" are not intended to be synonymous (73 *Federal Register* 61331, October 15, 2008).
[10] 43 CFR 46.415(b)

Alternative	Rationale for Dismissal
Phased Development/Pilot Facility/“Go Slow Alternative”	BOEM received comments expressing concern for the reliability of offshore wind power and several commenters suggested building the Project in a phased approach or building a much smaller pilot facility to confirm the benefits and impacts before building out the complete Project as proposed. This alternative would negate Ocean Wind’s ability to fulfill the terms of BPU’s 2019 Order to construct and operate an 1,100-MW commercial-scale wind energy facility within the Lease Area with operations targeted to begin in 2024 and does not address a specific environmental or socioeconomic concern. This alternative would effectively be the same as selecting the No Action alternative.
Wind Turbine Array Layout and Spacing	
Using a 2-nm by 2-nm wind turbine layout to provide safe access for fishing vessels	Commenters suggested that BOEM should analyze an alternative WTG layout with a 2-nm spacing between WTGs. As illustrated on Figure C-1, a 2-nm spacing would only provide for 30 WTG positions with a nameplate capacity of between 360 and 420 MW if a 12-MW or 14-MW WTG is selected, respectively. A WTG layout with 2-nm spacing between WTGs would not provide enough WTG positions in the Wind Farm Area to fulfill BPU’s solicitation award for 1,100 MW of offshore wind. This alternative was not carried forward for detailed analysis because it would negate Ocean Wind’s ability to fulfill the terms of BPU’s 2019 Order and would not meet BOEM’s purpose and need.
Consistent wind turbine spacing and layout across the Ocean Wind 1 and Atlantic Shores South projects	Commenters, including USCG, requested that BOEM consider an alternative that would create a uniform WTG spacing and layout across the adjacent Ocean Wind 1 and Atlantic Shores South projects to minimize impacts on vessel users and search and rescue operations, and to facilitate straight-line routes and consistent marking and lighting for navigation safety. The WTG spacing and layouts presented in the Ocean Wind 1 and Atlantic Shores South COPs were designed to accommodate the predominant vessel traffic patterns in each lease area, and vessel traffic patterns differ within each lease area. A uniform spacing and layout across the two adjacent projects would not align with the predominant vessel traffic patterns established by vessel users; therefore, this alternative was not carried forward for detailed analysis

Alternative	Rationale for Dismissal
2- to 4-nm separation between the Ocean Wind 1 and Atlantic Shores South projects	USCG commented that in the absence of a common spacing and layout between the two projects, setbacks from the shared border are recommended to provide a distinct visual separation and facilitate safe navigation between and across the two adjacent projects. Another commenter recommended that a 2- to 4-nm transit corridor be established between the Ocean Wind 1 and Atlantic Shores South projects to preserve traditional transit paths through the lease areas to access fishing grounds. BOEM evaluated separation distances between the Ocean Wind 1 and Atlantic Shores South projects. As the length traveled along the boundary between the Ocean Wind 1 and Atlantic Shores South projects would be approximately 7 nm and there would be additional paths along the predominant inshore-offshore routes through the array to allow for traffic dispersal, BOEM, through coordination with USCG, determined that an 0.8-nm to 1.08-nm separation between the Ocean Wind 1 and Atlantic Shores South projects was adequate to accommodate inshore-offshore vessel traffic, as well as changes in path or orientation as vessels transit between the two adjacent projects. According to USCG, 0.8 nm to 1.08 nm is also an acceptable distance for its sea and air assets to adjust their path as they move between the two adjacent projects. BOEM, in consultation with USCG, developed Alternative C (Wind Turbine Layout Modification to Establish a Buffer Between Ocean Wind 1 and Atlantic Shores South), which analyzes a 0.81-nm to 1.08-nm buffer with the intent that both the Ocean Wind 1 and Atlantic Shores South projects would implement wind turbine array layout modifications to result in a combined separation distance of 0.8 nm to 1.08 nm. Alternative C analyzes a buffer while maintaining a layout orientation that accommodates the predominant vessel traffic patterns in the Ocean Wind 1 Lease Area. Therefore, this alternative was not carried forward for detailed analysis.
Wind Turbine Technology	
Alternative wind turbine foundations	Commenters suggested that BOEM consider alternatives for WTG foundations that avoid the use of pile driving, such as gravity-based, suction bucket, or floating foundations. During Project development, Ocean Wind considered multiple design alternatives for WTG foundations that were ultimately not selected for inclusion in the PDE for the COP. Alternative foundations considered but not carried forward included monopod suction caisson foundations, suction caisson jacket foundations, gravity-based turbine and OSS foundations, and floating platforms. Ocean Wind determined that these alternative foundation types were not suitable for development of the Project due to local site conditions as well as technical and supply chain considerations (see Table 5.2-1, *Technology Considered for the Project*, in Volume I of the COP for additional information on alternative foundation types considered). Because these foundation types were already reviewed by Ocean Wind and determined not to be suitable as documented in the COP, this alternative was eliminated from detailed analysis.

Alternative	Rationale for Dismissal
Offshore and Onshore Export Cables	
Alternative export cable route with landfall in Sea Isle City	Ocean Wind evaluated an export cable route corridor, extending from the Ocean Wind 1 Offshore Wind Farm to a landfall in Sea Isle City to connect to the BL England interconnection point, as an alternative to the export cable route corridor that would landfall in Ocean City to connect to BL England. The Sea Isle City route corridor was dismissed from detailed analysis because it is a longer offshore export cable route that would extend the construction schedule and result in additional impacts over a longer period of time. Specifically, the offshore export cable route would traverse USACE borrow areas, prime fishing areas, and artificial reef. The longer onshore cable route would have greater impacts on residential areas due to prolonged construction adjacent to residential areas and involve several stream crossings, including a major tributary of Ludlam Bay (intracoastal waterway). The longer onshore corridor would potentially affect additional National Heritage Priority Sites, historic buildings, historic districts, and archaeological grid sites; wetlands; and vernal pool habitat. The Sea Isle City export cable route is expected to result in greater impacts overall compared to the Ocean City landfall, and so the Sea Isle City export cable route was dismissed from detailed analysis.
Alternatives for cable construction methods and protection including burying the cable deeper and remote monitoring of cables	BOEM received comments suggesting alternative methods of cable installation be analyzed that allow for full cable burial to minimize permanent habitat impacts and potential hazardous interactions with fishing gear. The fishing industry requested a minimum burial of 8–10 feet to avoid interactions with fishing gear or, if a shallower depth is permitted, it must be paired with remote monitoring to ensure the cable remains adequately buried. Ocean Wind has proposed a target burial depth of 4 to 6 feet with the final burial depth dependent on the CBRA and coordination with agencies. The target burial depth is determined based on an assessment of seabed conditions integrated from geophysical and geotechnical surveys, seabed mobility, and the risk of interaction with external hazards such as fishing gear and vessel anchors, while also considering other factors such as maintained navigational channels and thermal conductivity. Project impacts associated with cable construction methods and protection are disclosed in Chapter 3 of the Final EIS for relevant affected resources. As applicable, BOEM could also choose to implement additional mitigation measures to further reduce or avoid impacts. Cable burial depth and use of remote monitoring to ensure that cable burial is maintained can be addressed as mitigation in the EIS, if warranted, rather than as an EIS alternative. Therefore, this alternative was not carried forward for detailed analysis.

Alternative	Rationale for Dismissal
Alternative offshore cable routes to reduce impacts on tug-tow traffic routes	A commenter requested that BOEM evaluate different alignments to the Oyster Creek cable corridor to minimize the area that cables occupy within the existing tug-tow traffic route. Various alignments should be evaluated, including crossing perpendicular to the prevailing north-south coastwise tug-tow traffic route, rather than parallel and within it; and shifting the cable corridor to be predominantly west of the traffic route. Submarine cables have been installed in the Atlantic Ocean for over 100 years starting with telegraph cables. There are numerous active and inactive cables along the New Jersey shore and throughout the Mid-Atlantic areas, including in the existing tug and towing traffic routes. There are well-established best management practices and laws that have allowed for the mutual coexistence of submarine cables with vessel operations including current federal and boating laws that require that (1) submarine cables be included on NOAA nautical charts, (2) vessel owners have proper navigational equipment on board, including up-to-date nautical charts, and (3) vessel owners avoid charted hazards, such as submarine cables. A CBRA will be developed and will assess potential hazards such as fishing gear snags on cables; anchored vessel drags onto cable; vessels suffering engine failure anchors onto the cable; vessels inadvertently anchoring onto the cable; foundering vessels sinking onto or damaging cable; dredging activity damaging cable or causing cable(s) to become exposed; military activity damage the cable(s); and recreational activities damage the cable(s). In terms of natural hazards, the following are also assessed: seabed mobility causes cable to become exposed; and seabed obstructions/boulders. As such, a specific alternative to reduce the potential for impacts on tug and tow traffic routes would not address a significant impact from the Project.
Reducing the number of offshore cable routes	One commenter noted that the COP proposes connecting the Project to shore via two distinct cable routes to reduce impacts on the onshore power grid and requested that the EIS explain why the use of multiple cables is needed, develop and analyze alternatives to this approach, and acknowledge that the use of two cable routes greatly increases offshore impacts, including habitat disturbance and modification, as well as safety concerns for fisheries that use bottom-tending mobile gear. As outlined in the COP, Ocean Wind is utilizing available points of interconnection to the onshore grid at Oyster Creek and BL England, and proposes to split the power injection between these two interconnection points. An alternative that reduces the number of offshore export cable routes would not be technically or economically practicable because it would result in a need for extensive upgrades to the onshore power grid, and so this alternative was dismissed from detailed analysis. These factors outweigh any potential future decrease in offshore impacts that may result from having one cable corridor instead of two.

Alternative	Rationale for Dismissal
Shared cable corridor	Commenters recommended that BOEM consider offshore export cable routing alternatives that would have adjacent projects (i.e., Ocean Wind 1 and Atlantic Shores South) use a shared cable corridor. BOEM cannot dictate that a lessee use a shared cable corridor. 30 CFR 585.200(b) states, “A lease issued under this part confers on the lessee the rights to one or more project easements without further competition for the purpose of installing gathering, transmission, and distribution cables; pipelines; and appurtenances on the OCS as necessary for the full enjoyment of the lease.” While BOEM could require a lessee to use a previously existing shared cable corridor established by a BOEM-issued Right-of-Way grant when the use of the shared cable corridor is technically and economically practical and feasible alternative for the project, BOEM cannot limit a lessee’s right to a project easement when such a cable corridor does not exist and there is no way of determining if the use of a future shared cable corridor would be a technically and economically practical and feasible alternative for the project. Therefore, BOEM cannot require Ocean Wind to use a non-existent shared cable corridor for this Project. Furthermore, Ocean Wind 1’s export cables would connect to the power grid via different onshore substations than Atlantic Shores South. Developing a shared export cable corridor would not be technically or economically practicable because the Ocean Wind 1 and Atlantic Shores South projects have distinct interconnection points to the electric power grid.
SAV Avoidance Alternative E-1	NMFS requested that BOEM consider an offshore export cable routing alternative that would avoid impacts on SAV. The Oyster Creek export cable route would make landfall on Island Beach State Park within an auxiliary parking lot of Swimming Area #2 and then follow Shore Road north approximately 2.67 miles before entering Barnegat Bay to reconnect to the Oyster Creek export cable route in Barnegat Bay (refer to Figure C-2 in Appendix C, *Additional Analysis for Alternatives Dismissed*). Alternative E-1 would increase the export cable route by approximately 6.2 miles, which would likely require installation of a reactive compensation station approximately 3 to 5 miles offshore of Island Beach State Park due to energy dissipation and consequent limits in the distance that active power can be carried. An SAV avoidance alternative identified in the COP as the Prior Channel Route Option was developed by Ocean Wind in November 2021. The Prior Channel Route Option was developed following the same premise of Alternative E-1; however, the export cable would not travel as far north on Shore Road prior to entering Barnegat Bay and reconnecting to the export cable route identified under the Proposed Action. Because the Prior Channel Route Option was developed with the same premise as Alternative E-1, would have substantially similar effects on SAV, and would result in fewer resource impacts, the Prior Channel Route is carried forward in the Draft EIS as Alternative E, and Alternative E-1 was not carried forward for separate analysis.

Alternative	Rationale for Dismissal
SAV Avoidance Alternative E-2	NMFS requested that BOEM consider an offshore export cable routing alternative that would avoid impacts on SAV. The Oyster Creek export cable route would make landfall on Island State Beach Park within an auxiliary parking lot of Swimming Area #2 and then follow Central Avenue/Shore Road north approximately 2.7 miles before crossing Barnegat Bay to make landfall within a parking lot at Berkeley Island County Park and would then follow existing roads to the onshore substation. Alternative E-2 would increase the export cable route by approximately 4.3 miles, which would likely require installation of a reactive compensation station approximately 3 to 5 miles offshore of Island Beach State Park due to energy dissipation and consequent limits in the distance that active power can be carried. BOEM's regulations and guidance under 30 CFR 585.626 and 585.627 require the lessee to submit detailed geotechnical and geophysical data and analysis, benthic survey data and analysis, socioeconomic data and analysis, biological data and analysis, and initial cable installation feasibility information as well as MEC and UXO supplemental information. Alternative E-2 identifies significant new route areas (2.8 miles offshore/nearshore and 9.3 miles onshore) for which the lessee has not collected and analyzed the required data. Without the required data and analysis, BOEM cannot confirm that Alternative E-2 is technically feasible. Obtaining the required data would require additional desktop analysis, development of survey plans, survey, lab analysis, and reporting for BOEM to review. Additional survey could result in up to 2 years of Project delays. Alternative E-2 has substantially similar benefits to SAV as Alternative E, which is analyzed in detail in this Final EIS. Alternative E also greatly minimizes impacts on SAV in comparison to the impacts expected from the Proposed Action. Furthermore, Alternative E does not have the same feasibility concerns and resource impacts as Alternative E-2. Additional detail regarding the feasibility concerns and resource impacts associated with Alternative E-2 are provided in Appendix C, *Additional Analysis for Alternatives Dismissed*. Therefore, Alternative E-2 was dismissed from further consideration in the Draft EIS.

Alternative	Rationale for Dismissal
SAV Avoidance Alternative E-3	NMFS and NJDEP requested that BOEM consider an offshore export cable routing alternative that would avoid impacts on SAV. The Oyster Creek export cable route would make landfall in an existing parking lot in Ship Bottom, New Jersey, and then follow Route 72 and U.S. Highway 9 to the onshore substation. BOEM's regulations and guidance under 30 CFR 585.626 and 585.627 require the lessee to submit detailed geotechnical and geophysical data and analysis, benthic survey data and analysis, socioeconomic data and analysis, biological data and analysis, and initial cable installation feasibility information as well as MEC and UXO supplemental information. Alternative E-3 identifies significant new route areas (7.3 miles offshore and 13.7 onshore) for which the lessee has not collected and analyzed the required data. Without the required data and analysis, BOEM cannot confirm that Alternative E-3 is technically feasible. Obtaining the required data would require additional desktop analysis, development of survey plans, survey, lab analysis, and reporting for BOEM to review. Additional survey and analysis could result in up to 2 years of delay, which would result in delays to the anticipated commencement of commercial operations and may result in a determination that Alternative E-3 is not feasible or results in unacceptable unavoidable impacts. Alternative E-3 has substantially similar benefits to SAV as Alternative E, which is analyzed in detail in this Final EIS. Alternative E also greatly minimizes impacts on SAV in comparison to the impacts expected from the Proposed Action. Furthermore, Alternative E does not have the same feasibility concerns and resource impacts as Alternative E-3. Additional detail regarding the feasibility concerns and resource impacts associated with Alternative E-3 are provided in Appendix C, *Additional Analysis for Alternatives Dismissed*. Therefore, Alternative E-3 was dismissed from further consideration in the Draft EIS.

Alternative	Rationale for Dismissal
Onshore Export Cables	
Alternatives to onshore export cable routes	Commenters requested that BOEM consider alternative export cable routes to reduce disturbance to local communities. Suggestions for alternatives included utilizing vacant land across from Oyster Creek Power Plant, running cables under the Forked River or Oyster Creek, or utilizing the Corson’s and Egg Harbor inlets to access the BL England interconnection point. An alternative to utilize the vacant land across from the Oyster Creek Power Plant for the onshore cable route will not be carried forward for separate analysis because it would not be substantially different in design or effects than the analysis of the Proposed Action and other action alternatives. Moreover, there is no evidence that the alternative would avoid or substantially lessen one or more significant socioeconomic or environmental effects of the Project. The Holtec Property route from the landfall location in Lacey Township to the Oyster Creek substation travels west across undeveloped land, taking advantage of previously disturbed areas where possible, before following abandoned roadways associated with the existing confined disposal facility and Holtec property. To minimize potential impacts on wetlands and vegetation, the route would follow existing berms, paths, and trails where practical. This route crosses through the vacant land across from the Oyster Creek Power Plant before following existing roadways, State Route 9, and a private road to the Oyster Creek substation parcel. Ocean Wind reviewed potential export cable routes within the Forked River and the Oyster Creek channel and determined they were not technically feasible or practical options to carry forward for detailed analysis in the PDE. The route within the Forked River was not carried forward because it would require additional regulatory approval to install a cable within the federally maintained navigation channel, and its implementation would have greater environmental impacts than the proposed routes. Additionally, there are design and construction constraints due to the Forked River’s narrow channel and shallow water depths outside the channel. The Oyster Creek route was not carried forward for analysis due to constraints related to cable construction and maintenance, including that very deep cable burial would be required at the channel entrance that is currently dredged. The use of Great Egg Harbor inlet for the export cable route was also evaluated by Ocean Wind. This alternative was not carried forward for the following reasons: sediments in the inlet are dynamic, requiring additional cable protection such as cable mattresses, which would result in additional impacts on natural resources; access to the inlet by other vessels would be restricted during construction, which would result in additional impacts on other marine uses and navigation; and there is an existing USACE borrow area at the mouth of the inlet and USACE does not typically authorize crossing of borrow areas. Additional detail regarding the feasibility concerns associated with the Great Egg Harbor inlet export cable route are provided in Appendix C.

Alternative	Rationale for Dismissal
Alternative maximizing protection of natural resources/locate Project outside known habitat for federal or state-listed species	BOEM received comments to consider a Project alternative that maximizes the protection of natural habitats and minimizes the impact on those habitats and associated flora and fauna, particularly avoiding potential cable landing on Island Beach State Park and other barrier island locations that are prime ecological assets containing populations of several globally rare, federal and state rare, endangered, and threatened animals, plants, and natural communities. Ocean Wind has coordinated with NJDEP to identify the preferred location for a crossing of Island Beach State Park that would minimize impacts on park operations and resources. The proposed export cable would make landfall within an existing auxiliary parking lot for Swimming Area #2, and the main parking lot for Swimming Area #2 would be used for equipment staging. Use of existing parking lots for the cable landfall and equipment staging would minimize impacts on natural habitats and associated flora and fauna. Because impacts on Island Beach State Park have already been reviewed extensively and Ocean Wind is using NJDEP's preferred location for crossing the barrier island, consideration of other alternative cable landing locations within Island Beach State Park is not warranted.
Alternative to minimize impacts on NARW	A commenter requested that BOEM include a range of alternatives to prohibit HRG during seasons when protected species are known to be present in the Project area, in addition to any dynamic restrictions due to the presence of NARW or other endangered species. Additionally, the EIS should include alternatives that require clearance zones for NARW that extend at least 1,000 meters with requirements for HRG survey vessels to use Protected Species Observers and Passive Acoustic Monitoring to establish and monitor these zones with requirements to cease surveys if a NARW enters the clearance zone. BOEM reviewed this request for an alternative and determined that it would be more suitable to address potential impacts of HRG surveys through mitigation and monitoring rather than as an EIS alternative. Refer to Appendix H, *Mitigation and Monitoring*, for BOEM's recommended measures to avoid or minimize impacts on marine mammals during construction and operation of the Project.
Maximum-case alternative	One commenter requested that BOEM include an alternative that combines the most-disruptive components for each option included in the PDE. When BOEM conducts an environmental review of a lessee's COP, BOEM considers the maximum-case scenario for each design parameter that is defined in the COP. Because BOEM already considers the maximum-case scenario as part of its review of the Proposed Action, the analysis of a maximum-case alternative and the Proposed Action would reach the same impact conclusion. This alternative was not carried forward for separate analysis because it is already analyzed in detail as the Proposed Action.

Alternative	Rationale for Dismissal
Alternate Energy Source	
Alternative energy source to meet the demand	Commenters suggested BOEM analyze alternative energy options such as onshore wind, electrical generation from tidal movements, solar energy, small modular nuclear reactors, or natural gas. Renewable Energy Lease Number OCS-A 0498 only authorizes the submission of a COP for offshore wind energy. Generation of any other form of energy would not be permitted under this lease. In order for BOEM to analyze other renewable energy options on the OCS (e.g., marine hydrokinetics (including tidal energy), a new leasing process would need to occur specifically for that energy source. In addition, analyzing onshore conventional and alternative energy development is outside BOEM's jurisdiction. Finally, this alternative is not responsive to the purpose and need and would not address BOEM's regulatory need to determine whether to approve, approve with modifications, or disapprove the COP to construct, operate, and conceptually decommission a commercial-scale wind energy facility within the Lease Area. Therefore, this alternative was not carried forward for detailed analysis.

HRG = high-resolution geophysical; NARW = North Atlantic right whale; NJDEP = New Jersey Department of Environmental Protection

2.2. Non-Routine Activities and Events

Non-routine activities and events associated with the proposed Project could occur during construction and installation, O&M, or decommissioning. Examples of such activities or events could include corrective maintenance activities, collisions involving vessels or vessels and marine life, allisions (a vessel striking a stationary object) involving vessels and WTGs or OSS, cable displacement or damage by anchors or fishing gear, chemical spills or releases, severe weather and other natural events, seismic activity, fires, and terrorist attacks. These activities or events are difficult to predict with certainty. This section provides a brief assessment of each of these potential events or activities.

- *Corrective maintenance activities:* These activities could be required as a result of other low-probability events, or as a result of unanticipated equipment wear or malfunctions. Ocean Wind anticipates housing spare parts for key Project components at an O&M facility to initiate repairs expeditiously.
- *Collisions and allisions:* These could result in spills (described below) or injuries or fatalities to wildlife (addressed in Chapter 3). Collisions and allisions are anticipated to be unlikely based on the following factors that would be considered for the proposed Project:
  - USCG requirement for lighting on vessels
  - NOAA vessel speed restrictions
  - The proposed spacing of WTGs and OSS
  - The lighting and marking plan that would be implemented, as described in Section 2.1.2.2.3
  - The inclusion of proposed Project components on navigation charts
- *Cable displacement or damage by vessel anchors or fishing gear:* This could result in safety concerns and economic damage to vessel operators and may require corrective action by Ocean Wind such as the need for one or more cable splices to an export or inter-array cable(s). However, such incidents are unlikely to occur because the proposed Project area would be indicated on navigational charts and the cable would be buried at least 4 feet (1.2 meters) deep or protected with hard armor.

- *Chemical spills or releases:* For offshore activities, these include inadvertent 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). All vessels would be certified by the Project to conform to vessel O&M protocols designed to minimize risk of fuel spills and leaks. Ocean Wind would be expected to comply with USCG and BSEE regulations relating to prevention and control of oil spills. Onshore, releases could potentially occur from construction equipment or HDD activities. All wastes 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.
- *Severe weather and natural events:* Extratropical storms, including northeasters, are common in the Lease Area from October to April. These storms bring high winds and heavy precipitation, which can lead to severe flooding and storm surges. Hurricanes that travel along the coastline of the eastern U.S. have the potential to affect the Lease Area with high winds and severe flooding. On average, hurricanes occur every 3 to 4 years within 90 to 170 miles of the New Jersey Coast (Ocean 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. 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 Facility Design Report and Fabrication and Installation Report according to international standards, 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. If severe weather caused a spill or release, the actions outlined above would help reduce potential impacts. Severe flooding or coastal erosion could require repairs, with impacts associated with repairs being similar to those outlined in Chapter 3 for construction activities. 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, similar to the construction and installation impacts described in Chapter 3. As discussed in Section 2.1.2.2.2, *Onshore Activities and Facilities*, the design of onshore facilities, including the TJBs and substations, accounts for erosion, more frequent high-intensity storm events, tidal surge, and sea level rise associated with climate change. Refer to Appendix I, *Supplemental Information*, for additional information regarding climate resiliency.
- *Seismic activity:* Three fault lines existing within northern New Jersey. Within 160 kilometers of the Project area, only minor (less than or equal to magnitude 4: non-damaging but felt) earthquakes have been recorded since 1783. Fault rupture is considered unlikely because no active or potentially active faults have been identified within or near the Project (Ocean Wind 2023). The impacts from seismic activity would be similar to those assessed for other non-routine events or activities.
- *Fires:* Malfunction of WTGs or OSS could potentially cause a fire. An Emergency Response Plan has been prepared by Ocean Wind as part of the COP (Ocean Wind 2023) to provide clear instructions regarding procedures during emergency incident scenarios, which include fires. The impacts from fires would be similar to those assessed for severe weather and natural events.
- *Terrorist attacks:* BOEM considers these unlikely, but impacts could vary depending on the magnitude and extent of any attacks. The actual impacts of this type of activity would be the same as the outcomes listed above. Therefore, terrorist attacks are not analyzed further.

2.3. Summary and Comparison of Impacts Among Alternatives

Table 2-4 provides a summary and comparison of the impacts under the No Action Alternative and each action alternative assessed in Chapter 3. Under the No Action Alternative, any potential environmental and socioeconomic impacts, including benefits, associated with the proposed Project would not occur; however, impacts could occur from other ongoing and planned activities. Section 3.1 provides definitions for **negligible**, **minor**, **moderate**, and **major** impacts.

Table 2-4 Summary and Comparison of Impacts Among Alternatives with No Mitigation Measures

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.4 Air Quality	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **moderate** impacts on air quality. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** adverse cumulative impacts due to emissions of criteria pollutants, VOCs, HAPs, and GHGs, mostly released during construction and decommissioning, and **minor** to **moderate beneficial** cumulative impacts on regional air quality after offshore wind projects are operational.	*Proposed Action:* The Proposed Action would have **minor** to **moderate** adverse impacts attributable to air pollutant and GHG emissions and accidental releases. The Project may lead to reduced emissions from fossil-fueled power-generating facilities and consequently **minor beneficial** impacts on air quality and climate. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute a noticeable increment to the **moderate** adverse and **moderate beneficial** cumulative impacts on air quality.	Alternatives B-1, B-2, and D could have slightly less adverse but not materially different impacts on air quality compared to the Proposed Action due to a reduced number of WTGs. Similarly, Alternatives B-1, B-2, and D could have slightly less beneficial impacts on air quality from displacement of fossil-fueled power generation compared to the Proposed Action. However, the overall impact level would be the same as for the Proposed Action: **minor** to **moderate** adverse and **minor beneficial**. Alternatives C-1 and C-2 would have the same number of WTGs as the Proposed Action and, therefore, the same anticipated emissions and impact levels. Under Alternative E, the offshore and onshore cable lengths, and thus the construction emissions, would be slightly greater than for the Proposed Action. However, the impact levels would be the same as for the Proposed Action: **minor** to **moderate** adverse and **minor beneficial**. The cumulative impacts associated with Alternatives B, C, D, and E when each is combined with the impacts from ongoing and planned activities (including offshore wind activities) would be the same as for the Proposed Action: **moderate** adverse and **moderate beneficial**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.5 Bats	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **negligible** to **minor** impacts on bats. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **negligible** to **minor** adverse cumulative impacts because bat presence on the OCS is anticipated to be limited and onshore bat habitat impacts are expected to be minimal.	*Proposed Action:* The Proposed Action would have **negligible** to **minor** impacts on bats, especially if tree clearing is conducted outside of the active season. The primary risks would be from potential onshore removal of habitat and operation of offshore WTGs (e.g., collision, barotrauma); however, occurrence of bats offshore is low and mortality is anticipated to be rare in the onshore or offshore environment. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an undetectable increment to the **negligible** to **minor** cumulative impacts on bats.	Alternatives B-1, B-2, and D may result in slightly less, but not materially different, negligible impacts on bats than those described under the Proposed Action. Alternative C-1 would have the same WTG number and overall Wind Farm Area footprint as the Proposed Action and, therefore, would have similar impacts on bats. Alternative C-2 would have the same number of WTGs as the Proposed Action, but compressed in a smaller footprint, and, therefore, would have similar impacts on bats. Alternative E would limit the export cable route to the more northerly route, which is analyzed as part of the Proposed Action and so impacts would be the same. Therefore, the impact levels of Alternatives B, C, D, and E would be the same as for the Proposed Action: **negligible** to **minor**. The cumulative impacts associated with Alternatives B, C, and D, when each combined with the impacts of ongoing and planned activities (including offshore wind activities), would be the same as for the Proposed Action: **negligible** to **minor**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.6 Benthic Resources	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **negligible** to **moderate** impacts on benthic resources. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** adverse cumulative impacts and could potentially include **moderate beneficial** impacts resulting from emplacement of structures (habitat conversion).	*Proposed Action:* The Proposed Action would have **negligible** to **moderate** adverse impacts and **moderate beneficial** impacts on benthic resources. Adverse impacts would primarily result from new cable emplacement, pile-driving noise, anchoring, and the presence of structures. Beneficial impacts would result from the presence of new structures. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an undetectable to noticeable increment to the **moderate** adverse and **moderate beneficial** cumulative impacts on benthic resources.	Alternatives B-1 and B-2 would reduce the number of WTGs compared to the Proposed Action, and so the impacts would be reduced compared to the Proposed Action. There would be fewer foundations and less inter-array cable, which would reduce impacts associated with the presence of structures and conversion of habitat from soft-bottom to scour protection. These alternatives would have impact levels of **negligible** to **minor** adverse and **moderate beneficial**. Under Alternatives C-1 and C-2, the overall impact level would be the same as for the Proposed Action (**negligible** to **minor** adverse and **moderate beneficial**), as the number of WTGs would remain the same and the overall footprint would remain the same or slightly less. Alternative D would remove 15 WTGs from the northeastern corner of the Wind Farm Area to minimize impacts on the sand ridge and trough features. Under this alternative, avoidance of the sand ridge and trough features would potentially benefit benthic communities. Alternative D would result in **negligible** to **minor** impacts and **moderate beneficial** impacts. Under Alternative E, impacts on SAV would be reduced and the overall impact level would be the same as for the Proposed Action: **negligible** to **minor** adverse and **moderate beneficial**. The cumulative impacts associated with Alternatives B, C, D, and E when each combined with the impacts from ongoing and planned activities (including offshore wind activities) would be the same as for the Proposed Action: **moderate** adverse and **moderate beneficial**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.7 Birds	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **minor** impacts on birds. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** adverse cumulative impacts but could include **moderate beneficial** impacts because of the presence of offshore structures.	*Proposed Action:* The Proposed Action would have **minor** adverse impacts on birds, primarily associated with habitat loss and collision-induced mortality from rotating WTGs and permanent habitat loss and conversion from onshore construction. **Minor beneficial** impacts would result from increased foraging opportunities for marine birds. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an undetectable increment to the **moderate** adverse and **moderate beneficial** cumulative impacts on birds.	Alternatives B-1, B-2, and D would reduce the number of WTGs compared to the Proposed Action, which may result in slightly less impacts on species with high collision sensitivity and high displacement sensitivity, but would not change the impact level: **minor** with **minor beneficial** impacts. Alternatives C-1 and C-2 would have the same number of WTGs as the Proposed Action and, therefore, would have same **minor** with **minor beneficial** impacts on birds. Under Alternative E, the rerouting of the Oyster Creek export cable in Barnegat Bay to avoid SAV would benefit bird species that use this habitat. Alternative E would slightly increase the length of the onshore cable route compared to the Proposed Action, but the cable would mostly be placed along the parking area and Central Avenue/Shore Road, minimizing impacts on vegetation and bird foraging and nesting habitat. Alternative E would have the same **minor** with **minor beneficial** impacts on birds as the Proposed Action. The cumulative impacts associated with Alternatives B, C, D, and E when each combined with the impacts from ongoing and planned activities (including offshore wind activities) would be the same as for the Proposed Action: **moderate** adverse and **moderate beneficial**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.8 Coastal Habitat and Fauna	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **moderate** impacts on coastal habitat and fauna. Currently, there are no other offshore wind activities proposed in the geographic analysis area. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** cumulative impacts on coastal habitat and fauna, primarily driven by climate change.	*Proposed Action:* The Proposed Action would have **moderate** impacts on coastal habitat and fauna, primarily driven by climate change. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an undetectable increment to the **moderate** cumulative impacts on coastal habitat and fauna.	Because Alternatives B, C, and D involve modifications only to offshore components, impacts on coastal habitat and fauna from those alternatives would be the same as those under the Proposed Action: **moderate**. Alternative E could affect slightly more habitat on Island Beach State Park than the Proposed Action and Alternatives B, C, and D, but impacts would remain limited overall. The impacts would be the same as those under the Proposed Action: **moderate**. The cumulative impacts of Alternatives B, C, D, and E when each combined with the impacts from ongoing and planned activities (including offshore wind) would be the same as those of the Proposed Action: **moderate**.
3.9 Commercial Fisheries and For-Hire Recreational Fishing	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **minor** to **major** impacts for commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing. The impacts could also include long-term **minor** to **moderate** **beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined	*Proposed Action:* The Proposed Action would have **minor** to **major** adverse impacts on commercial fisheries and **minor** to **moderate** adverse impacts on for-hire recreational fishing. The major impact rating for some fisheries and fishing operations is primarily driven by regulated fishing effort and climate change because of the potential disruptions to fishing operations in the Project area. The impacts of the Proposed Action could also include long-term **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an appreciable increment to the	Alternatives B-1 and B-2, and D would reduce the number of WTGs compared to the Proposed Action, providing fishing vessels in the Lease Area with more area to operate and fish and reducing the potential for gear entanglement and loss. However, the impact level is anticipated to be the same as for the Proposed Action: **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreational fishing operations, with long-term **minor** to **moderate** **beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations. Alternatives C-1 and C-2 would have the same number of WTGs as the Proposed Action and, therefore, would have the same overall impact levels as the Proposed Action: **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreational fishing operations, with

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
	with all planned activities would result in a **minor** to **major** adverse cumulative impact on commercial fisheries and **minor** to **moderate** adverse cumulative impact on commercial fisheries because some commercial fisheries and fishing operations would experience substantial long-term disruptions. There would be a **minor** to **moderate** adverse cumulative impact on for-hire recreational fishing. This impact rating is primarily driven by the presence of offshore structures, regulated fishing effort, and climate change. The cumulative impacts could also include long-term **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.	**minor** to **major** adverse cumulative impacts on commercial fisheries and **minor** to **moderate** adverse cumulative impact on for-hire recreational fishing. Cumulative impacts could also include long-term **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations.	long-term **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations. Alternative E would provide a slight benefit to commercial and for-hire recreational fisheries by reducing the impact on SAV, a nursery habitat for targeted species, but the impact level would be the same as for the Proposed Action: **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreational fishing operations, with long-term **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations. The cumulative impacts of Alternatives B, C, D, and E when each combined with the impacts from ongoing and planned activities would be the same as for the Proposed Action: **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreational fishing operations, with long-term **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.10 Cultural Resources	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **moderate** impacts on cultural resources, primarily as a result of dredging, cable emplacement, and activities that disturb the seafloor. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** cumulative impacts on cultural resources.	*Proposed Action:* The Proposed Action would have **moderate** impacts on cultural resources primarily from the introduction of intrusive visual elements, which alter character-defining ocean views of historic properties onshore that contribute to the resource's eligibility for the NRHP and result in a loss of historic or cultural value; and dredging, cable emplacement, and activities that disturb the seafloor, which result in damage to or destruction of submerged archaeological sites or other underwater cultural resources (e.g., shipwreck, debris fields, ancient submerged landforms) from offshore bottom-disturbing activities, resulting in a loss of scientific or cultural value. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an appreciable increment to the **moderate** cumulative impacts on cultural resources.	Alternatives B-1, B-2, C-1, C-2, and D would have the same **moderate** impact level on cultural resources as the Proposed Action. While the degree of visual impacts on cultural resources under Alternatives B-1 and B-2 would be lower than under the other alternatives, these impacts would still require comparable mitigation. Alternative E would have the same overall **moderate** impact level on cultural resources as the Proposed Action. The cumulative impacts of Alternatives B-1, B-2, C-1, C-2, and D when each combined with the impacts from ongoing and planned activities (including other offshore wind activities) would be the same as for the Proposed Action: **moderate**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.11 Demographics Employment, and Economics	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **minor** adverse impacts and **minor beneficial** impacts on demographics, employment, and economics. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **minor** adverse and **moderate beneficial** cumulative impacts.	*Proposed Action:* The Proposed Action would have **minor** adverse and **moderate beneficial** impacts on demographics, employment, and economics. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an undetectable to noticeable increment to the **minor** adverse and **moderate beneficial** cumulative impacts on demographics, employment, and economics.	Alternatives B-1, B-2, and D would result in a slight reduction in both adverse and beneficial impacts on demographics, employment, and economics compared to the Proposed Action because of the reduced number of WTGs, but the overall impact would be the same: **minor** adverse impacts and **moderate** beneficial impacts. Alternatives C-1, C-2, and E would not change the number of WTGs and therefore the impacts are anticipated to be the same as those of the Proposed Action: **minor** adverse and **moderate** beneficial. The cumulative impacts of Alternatives B, C, D and E when each combined with the impacts from ongoing and planned activities (including other offshore wind activities) would be the same as for the Proposed Action: **minor** adverse and **moderate beneficial**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.12 Environmental Justice	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in impacts on environmental justice populations ranging from **minor** to **moderate** adverse to **minor beneficial**. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** cumulative impacts because environmental justice populations would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts.	*Proposed Action:* The Proposed Action would have a range of impacts, such as minor impacts resulting from the disruption of marine activities during offshore cable installation and impacts of noise on commercial and for-hire fishing, and moderate impacts due to the long-term presence of structures in the offshore environment and secondary impacts on fishing vessels or at onshore seafood processing and distribution facilities. Potential minor beneficial impacts would result from port utilization and the enhanced employment opportunities. Overall, BOEM expects that impacts of the Proposed Action on environmental justice populations would be **moderate** because environmental justice populations would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts. The Proposed Action would not result in disproportionately "high and adverse" impacts on environmental justice populations. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute a noticeable increment to the **moderate** cumulative impacts on environmental justice populations.	Impacts of Alternatives B-1, B-2, C-1, C-2, D, and E would be the same as those of the Proposed Action for environmental justice populations and would range from minor to moderate adverse to minor beneficial, and are anticipated to be **moderate** overall. These action alternatives would not result in disproportionately "high and adverse" impacts on environmental justice populations. The cumulative impacts of Alternatives B, C, D, and E when each combined with the impacts from ongoing and planned activities (including other offshore wind activities) would be the same as for the Proposed Action: **moderate**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.13 Finfish, Invertebrates, and Essential Fish Habitat	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **moderate** impacts on finfish, invertebrates, and EFH. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** cumulative impacts on finfish, invertebrates, and EFH. It is anticipated that the greatest impact on finfish and invertebrates would be caused by ongoing regulated fishing activity and climate change.	*Proposed Action:* The Proposed Action would result in **negligible** to **moderate** impacts for finfish, invertebrates, and EFH. The primary impacts on finfish would be from noise during construction and operation of the proposed Project. Long-term impacts on EFH from construction and installation of the Proposed Action would be minor, as the resources would likely recover naturally over time. The Proposed Action would have negligible to minor impacts on invertebrates through temporary disturbance and displacement, habitat conversion, and behavioral changes, injury, and mortality of sedentary fauna. The presence of structures may have a minor beneficial effect on invertebrates through an “artificial reef effect.” Despite invertebrate mortality and varying extents of habitat alteration, BOEM expects the long-term impact on invertebrates from construction and installation of the Proposed Action to be minor, as the resources would likely recover naturally over time. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute a noticeable increment to the **negligible** to **moderate** cumulative impacts on finfish, invertebrates, and EFH.	Alternatives B-1, B-2, and D would reduce the number of WTGs and would slightly reduce impacts on finfish, invertebrates, and EFH compared to the Proposed Action, given that there would be fewer foundations developed and, therefore, less permanent loss of habitat and lower noise impacts during associated pile driving; however, the impact level would be the same as for the Proposed Action: **negligible** to **moderate**. Alternatives C-1 and C-2 would have no significant change to the **negligible** to **moderate** impacts under the Proposed Action, as the number of WTGs would remain the same and the overall footprint would remain the same or slightly less. Alternative E would result in impacts similar to those described under the Proposed Action: **negligible** to **moderate**. The cumulative impacts of Alternatives B, C, D, and E when each combined with the impacts from ongoing and planned activities (including other offshore wind activities) would be the same as for the Proposed Action: **negligible** to **moderate**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.14 Land Use and Coastal Infrastructure	*No Action Alternative:* Continuation of existing environmental trends and activities under the No Action Alternative would result in **negligible** adverse and **minor beneficial** impacts on land use and coastal infrastructure**.** *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **minor** adverse cumulative impacts and **minor beneficial** cumulative impacts.	*Proposed Action:* The Proposed Action would result in **minor** adverse with **minor beneficial** impacts on land use and coastal infrastructure. Beneficial impacts would result from port utilization. Adverse impacts would primarily result from land disturbance during onshore installation of the cable route and substation, accidental spills, and construction noise and traffic. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute a noticeable increment to the **minor** adverse and **minor beneficial** cumulative impacts.	Alternatives B-1, B-2, C-1, C-2, and D would have the same impacts on land use and coastal infrastructure as the those of Proposed Action—**minor** adverse with **minor beneficial** impacts. Because there would be fewer WTGs under these alternatives, there would be less potential for contamination from unforeseen spills or accidents, less light being emitted from offshore, and less need for port facilities for shipping, berthing, and staging. However, under all of these alternatives, the majority of the WTGs would still be visible and there would be no meaningful difference in impacts on land use and coastal infrastructure. Alternative E would have the same impacts on land use and coastal infrastructure as the those of Proposed Action: **minor** adverse with **minor beneficial** impacts. Alternative E would slightly increase the onshore portion of the Oyster Creek export cable route, resulting in increased impacts on land use associated with temporary construction activity compared to the Proposed Action. The overall impact magnitudes would be the same because the cable corridors would follow existing right-of-way and the primary impacts would be limited to the duration of construction. The cumulative impacts of Alternatives B, C, D, and E when each is combined with the impacts from ongoing and planned activities (including offshore wind activities) would be the same as for the Proposed action: **minor** adverse and **minor beneficial**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.15 Marine Mammals	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **minor** to **moderate** impacts on mysticetes (with exception of NARW), odontocetes, and pinnipeds. For NARW, the No Action Alternative would result in **moderate** to **major** impacts. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities (including other offshore wind activities) would result in **moderate** impacts on mysticetes, odontocetes, and pinnipeds, except for the NARW, on which impacts could be **moderate** to **major**.	*Planned Action:* BOEM anticipates that the impacts resulting from the Proposed Action would result in **moderate** impacts for mysticetes, except for the NARW, which would be **moderate** to **major**. BOEM anticipates that impacts from the Proposed Action would result in **minor** adverse impacts for odontocetes and pinnipeds and could include **minor beneficial** impacts due to the presence of structures. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an undetectable to noticeable increment to the **moderate** adverse impact for mysticetes, **minor** adverse impact for odontocetes and pinnipeds, and **moderate** to **major** impact for NARW.	Alternatives B-1, B-2, C-1, and D would result in the same impacts on marine mammals as described for the Proposed Action, with some impacts being minimally decreased in duration and geographic extent. The impacts resulting from the alternatives individually would be **minor** and **minor beneficial** for odontocetes and pinnipeds, **moderate** for most mysticetes, and **moderate** to **major** for NARW. Alternative C-2 would install the same number of WTGs as the Proposed Action; therefore, the impacts would be similar to those of the Proposed Action and would range from **minor** to **major** and could include beneficial impacts. Alternative E would likely have the same **minor** to **major** adverse impacts and could also result in beneficial impacts on marine mammals as the Proposed Action. While Alternative E could result in reduced acreage of SAV potentially affected, the overall impacts on marine mammals from the alternative would not be materially different from those of the Proposed Action. The cumulative impacts of Alternatives B, C, D, and E when each combined with the impacts from ongoing and planned activities (including offshore wind activities) would be the same as for the Proposed action: **moderate**, except for the NARW, which would be **moderate** to **major**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.16 Navigation and Vessel Traffic	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **moderate** impacts on navigation and vessel traffic. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** impacts primarily due to the presence of structures and increased vessel traffic, leading to congestion at affected ports, an increased likelihood of collisions and allisions, and increased risk of accidental releases.	*Proposed Action:* The Proposed Action would result in **moderate** impacts on navigation and vessel traffic. Impacts include changes in navigation routes due to the presence of structures and cable emplacement, delays in ports, degraded communication and radar signals, and increased difficulty of offshore SAR or surveillance missions within the Wind Farm Area. Some commercial fishing, recreational, and other vessels would choose to avoid the Wind Farm Area, leading to potential congestion of vessels along the Wind Farm Area borders. The increase in potential for marine accidents, which may result in injury, loss of life, and property damage, could produce disruptions for ocean users in the geographic analysis area. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute a noticeable increment to the **moderate** cumulative impacts on navigation and vessel traffic.	Alternatives B-1, B-2, and D would reduce the number of WTGs, incrementally decreasing impacts on navigation and vessel traffic safety compared to the Proposed Action, but would not change the overall impact level from **moderate**. The proposed buffer (0.81- to 1.08-nm) between Ocean Wind 1 and Atlantic Shores South would improve vessel navigation and SAR by providing additional space for transiting between the two lease areas. While Alternative C-2 would compress the WTG layout, the spacing between structures would be within USCG's preferred range for safe navigation of vessels less than 200 feet in length, and would not have a substantive change in impacts on navigation and vessel traffic. With Ocean Wind 1's adoption of a separation agreement with Atlantic Shores South into the Proposed Action, impacts of Alternatives C-1 and C-2 would be the same as for the Proposed Action: **moderate.** Under Alternative E, the rerouting of the Oyster Creek export cable in Barnegat Bay would not result in a discernable difference in impacts on navigation and vessel traffic compared to the Proposed Action. Alternative E would result in the same **moderate** impacts. The cumulative impacts associated with Alternatives B, C, D, and E when each is combined with the impacts from ongoing and planned activities (including other offshore wind activities) would be the same as for the Proposed Action: **moderate**.
3.17 Other Uses	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result	*Proposed Action:* The Proposed Action would result in **negligible** impacts for marine mineral extraction and cables and pipelines; **minor** impacts for aviation and air traffic, radar systems, and most	Impacts of Alternatives B-1 and B-2 would be similar to those of the Proposed Action for marine mineral extraction, military and national security uses, aviation and air traffic, cables and pipelines, and scientific research and surveys,

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
	in **negligible** impacts for marine mineral extraction, marine and national security uses, aviation and air traffic, cables and pipelines, and radar systems and **moderate** impacts on scientific research and surveys. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **negligible** to **minor** cumulative impacts for marine mineral extraction, aviation and air traffic, and cables and pipelines; **moderate** cumulative impacts for radar systems due to WTG interference; **minor** cumulative impacts for military and national security uses except for USCG SAR operations, which would have **moderate** cumulative impacts; and **major** cumulative impacts for scientific research and surveys.	military and national security uses; **moderate** impacts for USCG SAR operations; and **major** impacts for NOAA's scientific research and surveys. The installation of WTGs in the Project area would result in increased navigational complexity and increased allision risk for vessel traffic and low-flying aircraft and would result in line-of-sight interference for radar systems. Additionally, the presence of structures would exclude certain areas within the Project area occupied by Project components (e.g., WTG foundations, cable routes) from potential vessel and aerial sampling and affect survey gear performance, efficiency, and availability for NOAA surveys supporting commercial fisheries and protected-species research programs. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute a noticeable increment to the **negligible** to **minor** cumulative impacts for aviation and air traffic, cables and pipelines, marine mineral extraction, and most military and national security uses; **moderate** cumulative impacts for radar systems and USCG SAR operations; and **major** cumulative impacts for NOAA's scientific research and surveys.	with the overall impact ratings of **negligible** to **major**. Alternatives B-1 and B-2 could potentially decrease impacts on radar systems by removing the WTGs closest to the shore, which would possibly reduce line-of-sight impacts; however, localized, long-term, **minor** impacts on radar systems are still anticipated. Impacts of Alternative C-1 would be similar to those of the Proposed Action for marine mineral extraction, military and national security uses, aviation and air traffic, cables and pipelines, and scientific research and surveys, with the overall impact ratings of **negligible** to **major**. Alternative C-1 could potentially increase adverse impacts on radar systems by adding an additional 8 WTGs to the northern portion of the Lease Area closest to the shore, which would possibly increase line-of-sight impacts; however, localized, long-term, **minor** impacts on radar systems are still anticipated. Impacts of Alternative C-2 would be similar to those of the Proposed Action for marine mineral extraction, aviation and air traffic, cables and pipelines, and radar, with the overall impact ratings of **negligible** to **major**. Although Alternative C-2 would reduce the array spacing to no less than 0.99 nm between rows, the overall magnitude of impacts on scientific research and surveys would remain similar to those described for the Proposed Action and would result in **major** impacts, as the area would still likely be excluded from survey operations because the spacing between WTGs would be less than 1 nm. Impacts of Alternative D would be similar to those of the Proposed Action for cables and pipelines, marine mineral extraction, military and

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
			national security uses, radar, and aviation and air traffic, with the overall impact ratings of **negligible** to **major**. Alternative D could potentially reduce localized impacts on scientific research and surveys by avoiding placing structures in sand ridges and troughs; however, the structures present throughout the remainder of the Lease Area would exclude certain portions of the Project area from potential vessel and aerial sampling, resulting in **major** impacts on scientific research and surveys. Impacts of Alternative E would be similar to those of the Proposed Action for marine mineral extraction, military and national security uses, aviation and air traffic, cables and pipelines, radar, and scientific research and surveys, with the overall impact ratings of **negligible** to **major**. While Alternative E would limit the onshore export cable route on Island Beach State Park to the northern option, there are no mapped mineral extraction areas or pipelines reasonably close to the offshore export cable route that could be affected by this alternative. The cumulative impacts associated with Alternatives B, C, D, and E when each is combined with the impacts from ongoing and planned activities (including offshore wind activities) would be the same as for the Proposed Action.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.18 Recreation and Tourism	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **negligible** impacts on recreation and tourism. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** adverse and **minor beneficial** cumulative impacts on recreation and tourism.	*Proposed Action:* The Proposed Action would result in **moderate** adverse and **minor beneficial** impacts on recreation and tourism. Impacts would result from short-term impacts during construction: noise, anchored vessels, and hindrances to navigation from the installation of the export cable and WTGs; and the long-term presence of cable hardcover and structures in the Wind Farm Area during operations, with resulting impacts on recreational vessel navigation and visual quality. Beneficial impacts would result from the reef effect and sightseeing attraction of offshore wind energy structures. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an undetectable to noticeable increment to the **moderate** adverse, and **minor beneficial** cumulative impacts on recreation and tourism.	Impacts of Alternatives B-1, B-2, and D would be similar to those of the Proposed Action for recreation and tourism except for the impact of the presence of structures. Construction would install fewer WTGs and associated inter-array cables, which would slightly reduce the construction footprint and installation period. The impact level is anticipated to remain the same as for the Proposed Action: **moderate** adverse and **minor beneficial**. Impacts of Alternatives C-1 and C-2 would be similar to those of the Proposed Action for recreation and tourism except for the impact of the presence of structures. Under these alternatives, the change in the WTG positions is not anticipated to be noticeable to the observer or affect recreational boating to a meaningful degree. The impact level is anticipated to remain the same as for the Proposed Action: **moderate** adverse and **minor beneficial**. Under Alternative E would not result in a discernable difference in impacts on recreation and tourism compared to the Proposed Action. Alternative E would result in the same **moderate** adverse and **minor beneficial** impacts. The cumulative impacts associated with Alternatives B, C, D, and E when each is combined with the impacts from ongoing and planned activities (including offshore wind activities) would be the same as for the Proposed Action: **moderate** adverse and **minor beneficial**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.19 Sea Turtles	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **minor** impacts on sea turtles. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **minor** cumulative impacts on sea turtles. Potential impacts on sea turtles from multiple construction activities within the same calendar year could affect migration, feeding, breeding, and individual fitness. The foundations from WTG and OSS may provide foraging and sheltering opportunities; however, the significance of this reef effect is unknown and any beneficial impacts would be negligible.	*Proposed Action:* The Proposed Action would result in **negligible** to **minor** adverse impacts and could include potentially **minor beneficial** impacts. Beneficial impacts are expected to result from the presence of structures creating an artificial reef effect. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an undetectable to noticeable increment to the **minor** cumulative impact on sea turtles. The main drivers are pile-driving noise and associated potential for auditory injury, the presence of structures, ongoing climate change, and ongoing vessel traffic posing a risk of collision.	Alternatives B-1, B-2, C-1, and D would include exclusion of proposed WTGs and lead to the same types of impacts on sea turtles as described for the Proposed Action. The impacts resulting from the alternatives individually would be similar to those of the Proposed Action and would range from **negligible** to **minor** adverse and could include potentially **minor beneficial** impacts. Alternative C-2 would compress the layout and have the same types of impacts on sea turtles. Although this alternative would result in a decreased construction and operational footprint, the impacts resulting from the alternative would be similar to those of the Proposed Action and range from **negligible** to **minor** and could potentially include **minor beneficial** impacts. Alternative E would result in reduced acreage of SAV affected by cable emplacement; the impacts resulting from the alternative alone would be similar to those of the Proposed Action and range from **negligible** to **minor** and could include potentially **minor beneficial** impacts. The cumulative impacts associated with Alternatives B, C, D, and E when each is combined with the impacts from ongoing and planned activities (including offshore wind activities) would be the same as for the Proposed Action: **minor**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.20 Scenic and Visual Resources	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **minor** to **moderate** impacts on scenic and visual resources. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all other planned activities would result in **major** cumulative impacts on visual and scenic resources due to addition of new structures, nighttime lighting, onshore construction, and increased vessel traffic.	*Proposed Action:* Impacts of the Proposed Action on scenic and visual resources would range from **negligible** to **major.** The main drivers for this impact rating are the major adverse impacts associated with the presence of structures, lighting, and vessel traffic. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute an appreciable increment to the **major** adverse cumulative impact on scenic and visual resources.	Alternatives B-1 and B-2 would reduce the number of WTGs visible from the seascape and landscape compared to the Proposed Action, which may result in diminished impacts on scenic and visual resources but would not change the overall impact level of **negligible** to **major** impacts. The impacts of Alternatives C-1, C-2, D, and E on scenic and visual resources would be similar to the impacts of the Proposed Action: **negligible** to **major**. The cumulative impacts associated with Alternatives B, C, D, and E when each is combined with the impacts from ongoing and planned activities (including other offshore wind activities) would be the same as for the Proposed Action: **major**.
3.21 Water Quality	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **moderate** impacts on water quality. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** impacts, primarily driven by the unlikely event of a large-volume, catastrophic release.	*Proposed Action:* The Proposed Action would result in **moderate** impacts on water quality primarily due to sediment resuspension and accidental releases. The impacts are likely to be temporary or small in proportion to the geographic analysis area and the resource would recover completely after decommissioning. *Cumulative Impacts of the Proposed Action:* The Proposed Action would result in **moderate** cumulative impacts.	Alternatives B-1, B-2, and D may result in slightly less, but not materially different, moderate impacts on water quality due to a reduced number of WTGs that would need to be constructed and maintained. Alternatives C-1 and C-2 would have the same WTG number as the Proposed Action and, therefore, would have similar moderate impacts on water quality. Alternative E would result in similar, but not materially different, moderate impacts on water quality in relation to sediment disturbance and turbidity and onshore ground disturbance. Therefore, the **moderate** impacts would be the same as those of the Proposed Action. The cumulative impacts of Alternatives B, C, D, and E when each combined with impacts from ongoing and planned activities (including offshore wind activities) would be the same as those of the Proposed Action: **moderate**.

Resource	No Action Alternative	Alternative A Proposed Action	Differences Among Action Alternatives
3.22 Wetlands	*No Action Alternative:* Continuation of existing environmental trends and ongoing activities under the No Action Alternative would result in **moderate** impacts on wetlands. *Cumulative Impacts of the No Action Alternative:* The No Action Alternative combined with all planned activities would result in **moderate** cumulative impacts, primarily through land disturbance.	*Proposed Action:* The Proposed Action may affect wetlands through short-term or permanent disturbance from activities within or adjacent to these resources. Considering the avoidance, minimization, and mitigation measures required under federal and state statutes (e.g., CWA Section 404), construction of the Proposed Action would likely have **moderate** impacts on wetlands. *Cumulative Impacts of the Proposed Action:* The Proposed Action would contribute a noticeable increment to the **moderate** cumulative impact on wetlands.	Because Alternatives B, C, and D involve modifications only to offshore components, and offshore components would not contribute to impacts on wetlands, impacts on wetlands from those alternatives would be the same as those under the Proposed Action: **moderate**. Alternative E would have the same **moderate** impacts on wetlands as the Proposed Action. Impacts on wetlands would not be materially different because land disturbance would remain small, and implementation of mitigation measures and regulatory compliance would minimize impacts related to onshore ground disturbance. The cumulative impacts from Alternatives B, C, D, and E when each combined with impacts from ongoing and planned activities (including offshore wind activities) would be the same as those of the Proposed Action: **moderate**.

GHG = greenhouse gas; HAP = hazardous air pollutant; IPF = impact-producing factor; NARW = North Atlantic right whale; SAR = search and rescue; VOC = volatile organic compound

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3. Affected Environment and Environmental Consequences

This chapter analyzes the impacts of the Proposed Action and alternatives by establishing the baseline (or existing condition) of affected resources, predicting the direct and indirect impacts,[1] and then evaluating those impacts when added to the existing baseline and considered in the context of the reasonably foreseeable impacts of future planned activities. This chapter thus addresses the affected environment, also known as the existing baseline, for each resource area and the potential environmental consequences to those resources from implementation of the alternatives described in Chapter 2, *Alternatives*. In addition, this section addresses the impact of the alternatives when combined with other past, present, or reasonably foreseeable planned activities, i.e., cumulative impacts, using the methodology and assumptions outlined in Chapter 1, *Introduction*, and Appendix F, *Planned Activities Scenario*. The geographic analysis area for each resource is described and depicted in the beginning of each resource section, and Appendix F describes other ongoing and planned activities within the geographic analysis areas. These actions may be occurring on the same time scale as the proposed Project or could occur later in time but are still reasonably foreseeable.

In accordance with Section 1502.21 of the CEQ regulations implementing NEPA, BOEM identified information that was incomplete or unavailable for the evaluation of reasonably foreseeable impacts analyzed in this chapter. The identification and assessment of incomplete or unavailable information is presented in Appendix D, *Analysis of Incomplete or Unavailable Information*.

The No Action Alternative is first analyzed to predict the impacts of the baseline (as described in Section 1.6.1), the status quo. A subsequent analysis is conducted to assess the cumulative impacts on baseline conditions as future planned activities occur (as described in Section 1.6.2). Separate impact conclusions are drawn based on these separate analyses. This Final EIS also conducts separate analyses to evaluate the impacts of the action alternatives when added to the baseline condition of resources (as described in Section 1.6.1) and to evaluate cumulative impacts by analyzing the incremental impacts of the action alternatives when added to both the baseline (as described in Section 1.6.1) and the impacts of future planned activities (as described in Section 1.6.2).

BOEM has identified Alternative A (Proposed Action) in combination with Alternative E as the Preferred Alternative. Alternative E narrows the export cable route options in the PDE and cannot be implemented independently. Analysis of the impacts of the Preferred Alternative is the analysis as it is presented under Alternative A (Proposed Action) and Alternative E.

3.1. Impact-Producing Factors

BOEM has completed a study of impact-producing factors (IPF) on the North Atlantic OCS to consider in an offshore wind development planned activities scenario (BOEM 2019). That study is incorporated in this document by reference. The IPF study:

[1] Direct and indirect effects are defined in CEQ's NEPA implementing regulations (40 CFR 1508.1(g)). *Effects* or *impacts* means changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and include the following: (1) direct effects, which are caused by the action and occur at the same time and place; and (2) indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems.

- Identifies cause-and-effect relationships between renewable energy projects and resources potentially affected by such projects.
- Classifies those relationships into IPFs through which renewable energy projects could affect resources.
- Identifies the types of actions and activities to be considered in a cumulative impacts scenario.
- Identifies actions and activities that may affect the same physical, biological, economic, or cultural resources as renewable energy projects and states that such actions and activities may have the same IPFs as offshore wind projects.

The BOEM (2019) study identifies the relationships between IPFs associated with specific past, present, and reasonably foreseeable future actions in the North Atlantic OCS. BOEM determined the relevance of each IPF to each resource analyzed in this Final EIS. If an IPF was not associated with the proposed Project, it was not included in the analysis. Table 3.1-1 provides a brief description of the primary IPFs involved in this analysis, including examples of sources and activities that result in each IPF. The IPFs cover all phases of the Project, including construction, O&M, and conceptual decommissioning. Each IPF is assessed in relation to ongoing activities, planned activities, and the Proposed Action. Planned activities include planned non-offshore wind activities and future offshore wind activities.

In addition to adverse effects, beneficial effects may accrue from the development of the proposed Project and renewable energy sources on the OCS in general. The study *Evaluating Benefits of Offshore Wind Energy Projects in NEPA* (BOEM 2017) examines this in depth. Benefits from the development of offshore wind energy projects, in particular offshore wind projects, can accrue in three primary areas: electricity system benefits, environmental benefits, and socioeconomic benefits, which are further examined throughout this chapter.

Table 3.1-1 Primary Impact-Producing Factors Addressed in this Analysis

IPF	Sources and Activities	Description
Accidental releases	• Mobile sources (e.g., vessels) • Installation, operation, and maintenance of onshore or offshore stationary sources (e.g., renewable energy structures, transmission lines, cables)	Refers to unanticipated release or spills into receiving waters of a fluid or other substance such as fuel, hazardous materials, suspended sediment, trash, or debris. Accidental releases are distinct from routine discharges, the latter typically consisting of authorized operational effluents controlled through treatment and monitoring systems and permit limitations.
Discharges/intakes	• Vessels • Structures • Onshore point and non-point sources • Dredged material ocean disposal • Installation, operation, and maintenance of submarine transmission lines, cables, and infrastructure	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, and seawater cooling system effluent, among others. These discharges are generally restricted to uncontaminated or properly treated effluents that may have best management practice or numeric pollutant concentration limitations imposed through USEPA National Pollutant Discharge Elimination System permits or USCG regulations.
Air emissions	• Internal combustion engines (such as generators) aboard stationary sources or structures • Internal combustion engines within mobile sources such as vessels or vehicles	Refers to the release of gaseous or particulate pollutants into the atmosphere. Releases can occur on- and offshore.
Anchoring	• Anchoring of vessels • Attachment of a structure to the sea bottom by use of an anchor, mooring, or gravity-based weighted structure (i.e., bottom-founded structure)	Anchors, anchor chain sweep, mooring, and the installation of bottom-founded structures can alter the seafloor.

IPF	Sources and Activities	Description
Electric and magnetic fields	• Substations • Power transmission cables • Inter-array cables • Electricity generation	Power generation facilities and cables produce electric fields (proportional to the voltage) and magnetic fields (proportional to flow of electric current) around the power cables and generators. 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.
Land disturbance	• Onshore construction • Onshore land use changes • Erosion and sedimentation • Vegetation clearance	Refers to land disturbances for any onshore construction activities.
Lighting	• Vessels or offshore structures above or under water • Onshore infrastructure	Refers to the presence of light above the water onshore and offshore as well as underwater associated with offshore wind development and activities that utilize offshore vessels.
Cable emplacement and maintenance	• Dredging or trenching • Cable placement • Seabed profile alterations • Sediment deposition and burial • Mattress and rock placement	Refers to disturbances associated with installing new offshore submarine cables on the seafloor, commonly associated with offshore wind energy.
Noise	• Aircraft • Vessels • Turbines • Geophysical (HRG surveys) and geotechnical surveys (drilling) • Construction equipment • Operations and maintenance • Vibratory and impact pile driving • Dredging and trenching • UXO detonations	Refers to 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 turbines themselves or interactions of the turbines with wind and waves.
Port utilization	• Expansion and construction • Maintenance • Use • Revitalization	Refers to effects associated with port activity, upgrades, or maintenance that occur only as a result of the Project. Includes activities related to port expansion and construction from increased economic activity and maintenance dredging or dredging to deepen channels for larger vessels.

IPF	Sources and Activities	Description
Presence of structures	• Onshore and offshores structures including towers and transmission cable infrastructure	Refers to effects associated with onshore or offshore structures other than construction-related effects, including the following: • Space-use conflicts • Fish aggregation/dispersion • Bird attraction/displacement • Marine mammal attraction/displacement • Sea turtle attraction/displacement • Scour protection • Allisions • Entanglement • Gear loss/damage • Fishing effort displacement • Habitat alteration (creation and destruction) • Migration disturbances • Navigation hazard • Seabed alterations • Turbine strikes (birds, bats) • Viewshed (physical, light) • Microclimate and circulation effects • Loss and displacement of survey sampling area
Traffic	• Aircraft • Vessels • Vehicles	Refers to marine and onshore vessel and vehicle congestion, including vessel strikes of sea turtles and marine mammals, collisions, and allisions. Vessels include those used for construction, O&M, and monitoring surveys.
Gear utilization	• Monitoring surveys	Refers to entanglement and bycatch from gear utilization during fisheries and benthic monitoring surveys.
Energy generation/ security	• Wind energy production	Refers to the generation of electricity and its provision of reliable energy sources as compared with other energy sources (energy security). Associated with renewable energy development operations.
Climate change	• Emissions of greenhouse gases	Refers to the effects of climate change, such as warming and sea level rise, and increased storm severity or frequency. Ocean acidification refers to the effects associated with the decreasing pH of seawater from rising levels of atmospheric carbon dioxide.

Source: BOEM 2019.

3.2. Mitigation Identified for Analysis in the Environmental Impact Statement

During the development of the EIS and in coordination with cooperating agencies, BOEM considered potential additional mitigation measures that could further avoid, minimize, or mitigate impacts on the physical, biological, socioeconomic, and cultural resources assessed in this document. Mitigation measures required through completed consultations with respect to environmental statutes such as Section 7 of the ESA are listed in Table H-2 in Appendix H, *Mitigation and Monitoring*, and incorporated in the preferred alternative.[2] Other measures identified during development of this EIS are listed in Table H-3 in Appendix H. BOEM has identified several of these additional measures as incorporated in the Preferred Alternative. Table H-4 identifies measures that may be required by authorizations and permits issued to the lessee. The measures identified in Tables H-2 and H-3 are analyzed in the relevant resource sections in Chapter 3. The additional mitigation measures presented in Tables H-3 and H-4 may not all be within BOEM's statutory and regulatory authority to require; however, other jurisdictional governmental agencies may potentially require them. Mitigation measures for completed consultations, authorizations, and permits are analyzed in each respective resource section in Chapter 3 of the Final EIS. BOEM may choose to incorporate additional measures identified in Table H-3 in the ROD and adopt those measures as conditions of COP approval. As previously discussed, all Ocean Wind-committed measures are part of the Proposed Action (see Section 2.1 for details).

3.3. Definition of Impact Levels

This Final EIS uses a four-level classification scheme to characterize potential beneficial and adverse impacts of alternatives, including the Proposed Action. Resource-specific adverse and beneficial impact level definitions are presented in each resource section.

When considering duration of impacts this Final EIS uses the following terms:

- Short-term effects are effects that may extend up to 3 years. Construction and conceptual decommissioning activities are anticipated to occur for a duration of 2 to 3 years. An example would be clearing of onshore shrubland vegetation during construction; the area would be revegetated when construction is complete and, after revegetation is successful, this effect would end. Short-term effects may be further defined as being temporary if the effects end as soon as the activity ceases. An example would be road closures or traffic delays during onshore cable installation. Once construction is complete, the effect would end.
- Long-term effects are effects that may extend for more than 3 years, and may extend for the life of the Project (35 years[3]). An example would be the loss of habitat where a foundation has been installed.

[2] While this EIS analyzes all of the mitigation measures expected to be required through consultations and MMPA authorization, BOEM anticipates that some necessary authorizations for the proposed Project may issue after BOEM reaches a decision on the COP, in which case BOEM can include conditions of approval to ensure that its approval remains consistent with the terms of those future approvals.

[3] As noted in Section 2.1.2.3, BOEM assumes in this Final EIS that the proposed Project would have an operating period of 35 years. Ocean Wind's lease with BOEM (Lease OCS-A 0498) has an operational term of 25 years that commences on the date of COP approval. (See https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/NJ/NJ-SIGNED-LEASE-OCS-A-0498.pdf; see also 30 CFR 585.235(a)(3).) Ocean Wind would need to request and be granted an extension of its operational term from BOEM under the regulations at 30 CFR 585.425 et seq. in order to operate the proposed Project for 35 years. While Ocean Wind has not made such a request, this EIS uses the longer period in order to avoid possibly underestimating any potential effect.

- Permanent effects are effects that extend beyond the life of the Project. An example would be the conversion of land to support new onshore facilities or the placement of scour protection that is not removed as part of decommissioning.

The following terms are used to describe the incremental impact of the action alternative in relation to the cumulative impacts from all ongoing and planned activities, including both non-offshore wind and offshore wind activities.

- Undetectable: The incremental impact contributed by the action alternative to impacts from all ongoing and planned activities is so small that it is impossible or extremely difficult to discern.
- Noticeable: The incremental impact contributed by the action alternative, while evident and observable, is still relatively small in proportion to the impacts from all ongoing and planned activities.
- Appreciable: The incremental impact contributed by the action alternative constitutes a large portion of the impacts from all ongoing and planned activities.

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3.4. Air Quality (see Appendix G)

The reader is referred to Appendix G for a discussion of current conditions and potential impacts on air quality from implementation of the No Action Alternative, the Proposed Action, and other action alternatives.

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3.5. Bats (see Appendix G)

The reader is referred to Appendix G for a discussion of current conditions and potential impacts on bats from implementation of the No Action Alternative, the Proposed Action, and other action alternatives.

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3.6. Benthic Resources

This section discusses potential impacts on benthic resources, other than fishes and commercially important benthic invertebrates, from the proposed Project, alternatives, and ongoing and planned activities in the geographic analysis area. The benthic geographic analysis area, as shown on Figure 3.6-1, includes both a 10-mile (16.1-kilometer) radius/buffer around the Wind Farm Area and a 330-foot buffer around the export cable route corridors. The geographic analysis area is based upon where the most widespread impact (namely, suspended sediment) from the proposed Project could affect benthic resources. This area would account for some transport of water masses and for benthic invertebrate larval transport due to ocean currents. Although sediment transport beyond 10 miles (16.1 kilometers) is possible, sediment transport related to proposed Project activities would likely be on a smaller spatial scale than 10 miles (16.1 kilometers). Finfish, invertebrates of commercial or recreational value, and EFH are addressed in Section 3.13.

3.6.1 Description of the Affected Environment for Benthic Resources

The description of benthic resources in this section is supported by studies conducted by Ocean Wind as well as other studies reviewed in the literature. Geophysical data were collected by multibeam echosounder and sidescan sonar (Inspire 2021). Site-specific benthic data from 2017 through 2020 were collected to verify the multibeam echosounder and sidescan sonar results. Baseline SAV mapping surveys to delineate the extent and percentage cover of SAV beds in the vicinity of the Project were conducted between 2019 and 2022 using aerial imagery and underwater drop-camera imagery. Six months prior to the commencement of cable-installation activities, and within the SAV growing season (late-April to October), an additional pre-construction SAV characterization survey will be conducted to refine and update the results from the baseline SAV mapping surveys (COP Volume II, Appendix E; Ocean Wind 2023). Survey methodologies included bottom grabs for grain-size analysis and habitat characterization, as well as drop-camera footage for habitat imagery. Geophysical data provide delineations of different types of surface sediments within the Project area. A SAV survey was completed for Barnegat Bay in two phases: aerial photography in 2019 and transect-based seagrass observations along the proposed cable route in 2020 (COP Volume II, Appendix E; Ocean Wind 2023). This study characterized the distribution, density, and species of SAV present within the proposed Oyster Creek export cable route where it crosses Barnegat Bay, a back-bay estuary. Phase 2 SAV survey was conducted in October 2020 to identify the presence, extent, density, and species composition of SAV beds within the southern export cable route at Island Beach State Park and the export cable routes making landfall at the Holtec property, Bay Parkway, and Lighthouse Drive. Supplemental field survey of the northern export cable route at Island Beach State Park was performed in October 2021.

Additional field surveys to characterize SAV were performed in June and July 2022 (Inspire 2022a) at the potential second Bay Parkway, Nautilus Drive, Lighthouse Drive, and marina landfalls on the west side of Barnegat Bay as well the prior channel area on the east side of Barnegat Bay to provide additional baseline SAV data to inform Project design and avoidance.

A larger-scale, non-project-specific study was also undertaken that characterized offshore wind lease areas in northeast WEAs (Guida et al. 2017). This study compiled data from numerous sources, including from NOAA-National Centers for Environmental Information for bathymetric data, Northeast Fisheries Science Center (NEFSC) for physical and biological oceanography, NEFSC fisheries independent trawl survey for demersal fish and shellfish, and U.S. Geological Survey’s usSEABED data for surficial sediment data.

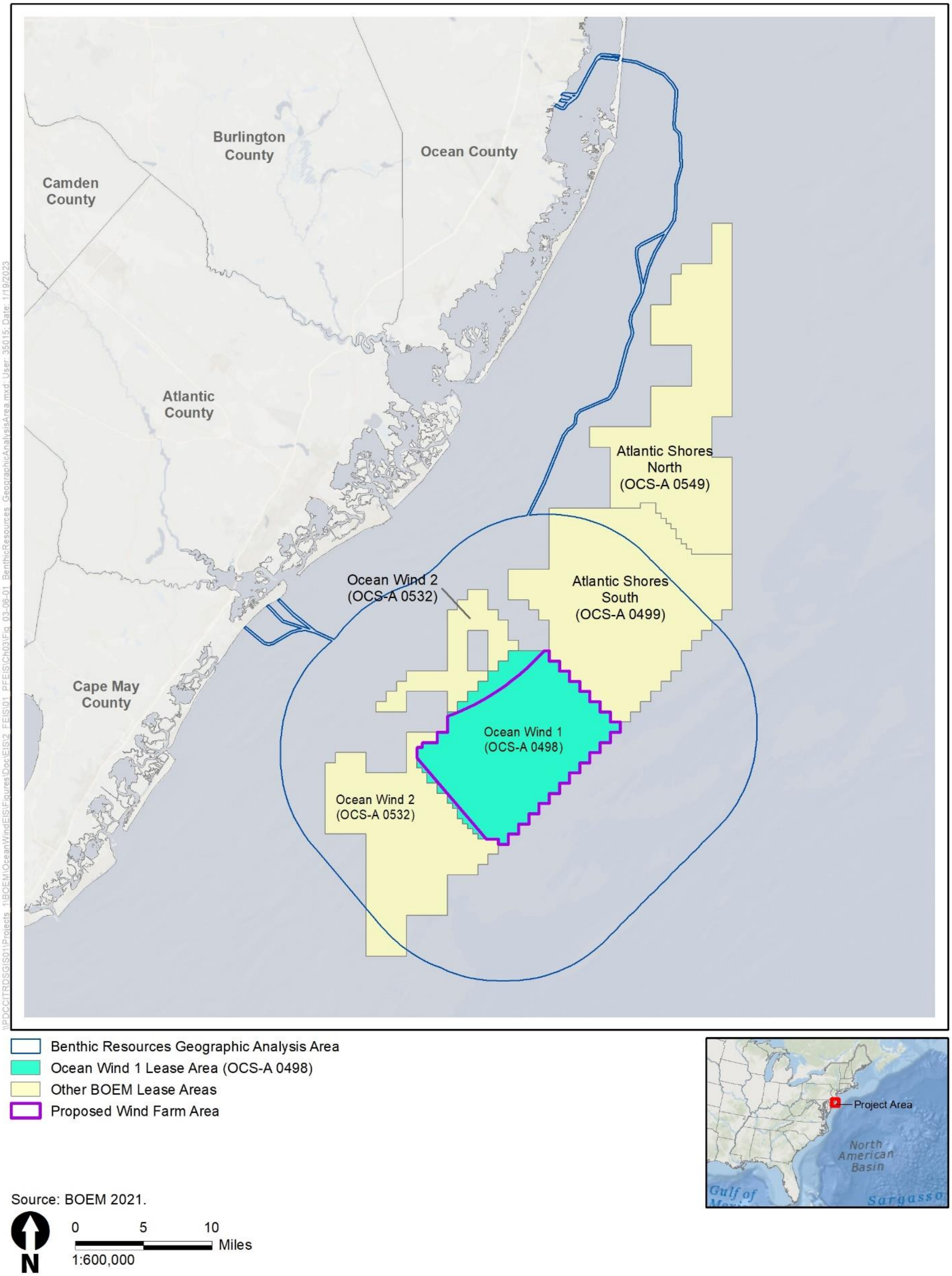

Figure 3.6-1 Benthic Resources Geographic Analysis Area

Offshore Project Area

The Wind Farm Area is on the Southern Mid-Atlantic Bight shelf, with the export cable routes extending from the Wind Farm Area to coastal and back-bay areas. The Wind Farm Area has low-degree seaward slopes and depth contours generally paralleling the shoreline. Predominant bottom features include a series of ridges and troughs that are closely oriented in a northeast-southwest direction, although side slopes are typically less than 1 degree, although vertical relief may be as much as 49 feet (15 meters). As such, cable installations would follow the contours of the ridges and troughs (Guida et al. 2017). Previous studies of the Mid-Atlantic Bight have described trough sediments as characterized by finer sediments and higher organic matter, while ridges are characterized by relatively coarser sediments. Differences in benthic invertebrate assemblages, likely driven by differences in sediment characteristics, have been observed that include increased diversity and biomass within troughs (Rutecki at al. 2014). This may subsequently influence distribution of fish and shellfish, as found by Vasslides and Able (2008) and Slacum et al. (2010). Ridge and trough habitat features are common in the mid-Atlantic OCS and not unique to the Project area (Pickens et al. 2020).

The Wind Farm Area is a relatively flat expanse of predominantly soft sediments. The Mid-Atlantic Ocean Data Portal and the Nature Conservancy (Greene et al. 2010) have characterized, through a small study, sediments of the Offshore Project area as ranging from fine (0.005 to 0.010 inch [0.125 to 0.25 millimeter]) to coarse (0.02 to 0.039 inch [0.5 to 1 millimeter]) sands at depths of 82 to 148 feet (25 to 45 meters).

Sand ridge and trough features provide macroscale habitats for finfish and macro-invertebrates on the inner continental shelf of the U.S. Mid-Atlantic region and the Gulf of Mexico. These habitat complexes are described as transition zones that may enhance biological productivity and concentrate organisms at several trophic levels and are a link between the invertebrate community and the demersal fish assemblage (Byrnes et al. 2000). Regionally, previous studies of the Mid-Atlantic Bight have found that ridge crests may be 5 meters or more higher than troughs (Byrnes et al. 2000), resulting in higher wave-generated currents and a graded substrate where much of the silt and clay have been removed, leaving a coarser substrate on the crests (when compared with the troughs). A 2022 survey (Inspire 2022a) of the ridge and trough habitats in the northeastern portion of the Lease Area also indicated physical and biological differences between the crests (ridges) and troughs of these habitats; however, compared to the regional study, ridge crests were more homogeneous than troughs, and the sediments on the crests were primarily fine to medium sands compared with troughs that exhibited greater variation in sediments, ranging from very fine sand to sandy gravel. Sands with shells (shelly sand) were also found along the troughs.

Based on sampling conducted on behalf of Ocean Wind (Inspire 2021), the Wind Farm Area is dominated by sand and muddy sand interspersed with small to large patches of coarse sediment and interspersed with small to large patches of coarse substrate such as pebbles or cobbles. Smaller areas of low-density boulders were also documented. The Inspire (2021) study describes the Oyster Creek and BL England export cable routes similarly, with increasing mud and sandy mud habitats near the Atlantic shore. Similar to the results of the 2021 survey, the vast majority of the impacts on habitats based on the 2022 survey would be to soft-bottom habitat, with a small portion of impacts on complex (inclusive of coarse) habitats. Except for SAV habitat, the composition of benthic habitats in potential permanent and temporary impact footprints was similar to the composition in the Project area, indicating little difference among alternatives with respect to overall composition of benthic habitats affected by the Project.

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

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

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

A number of benthic invertebrates in the Atlantic region support valuable commercial fisheries. Commercially important invertebrates present in the geographic analysis area include American lobster (*Homarus americanus*), sea scallop (*Placopecten magellanicus*), hard clam (*Mercenaria mercenaria*), Atlantic surfclam (*Spisula solidissima*), white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), ocean quahog (*Arctica islandica*), and blue crab (*Callinectes sapidus*). EFH has been designated for most of these species (i.e., sea scallop, Atlantic surfclam, ocean quahog, and brown, pink, and white shrimp) and the Project area includes EFH for quahog, surfclam, and sea scallop. In addition to their commercial value, the large, dominant species that support invertebrate fisheries play important ecological roles in benthic communities (see Section 3.13 for further discussion of EFH and commercially important species).

The location of existing artificial reef sites near the Project were identified from the NOAA Office of Coastal Management InPort library. Eleven artificial reefs were identified in the general vicinity of the Proposed Action; however, only four are entirely or in part within the geographic analysis area for benthic resources (Figure 3.6-2): Atlantic City reef, Great egg reef, Ocean City reef, and Deepwater reef. Collectively, these four reef areas represent approximately 6.5 square miles (16.8 km^2) of extensively modified seafloor due to the placement of structures such as ships, tanks, railroad cars, concrete debris, and reef balls.

Inshore Project Area

The estuarine portion of the Oyster Creek export cable route was primarily mud and sandy mud with SAV on the shorelines of the route and a small area of low-density boulders. A trend was identified by Taghon et al. (2017) of finer sediments near the western bank and coarser sediments toward the eastern shoreline. In addition, sand waves are present, which are small-scale microhabitats formed by prevailing currents and winds that are generally mobile slopes of sediment on the seabed (NYSERDA 2019). Sediment bedforms such as sand waves, sand bars, and ripples develop as a response of the seafloor to hydrodynamic conditions. Total organic content ranged from 0.02 to 5.7 percent (Taghon et al. 2017). Barnegat Bay is relatively shallow (average depth 3.6 feet [1.1 meters]) and poorly flushed (25 to 30 days), and, therefore, a highly eutrophic estuary (Kennish et al. 2007; Gilbert et al. 2010). Eutrophication is a result of surface water inflows, atmospheric deposition, and direct groundwater discharges and can lead to algal growth, altered invertebrate communities, and loss of SAV (Kennish et al. 2007). From 1980 to 2010, SAV declined by as much as 25 percent in Barnegat Bay (Gilbert et al. 2010). The estuarine portion of the BL England export cable route is a short (approximately 150-meter) crossing of Peck Bay at the Roosevelt Boulevard bridge. Peck Bay is generally shallow (1 to 2 feet deep) with a navigational channel along its eastern shore (NOAA chart 12316). A corridor through the northern end of Peck Bay/southern end of Great Egg Harbor Bay was included in the benthic habitat assessment (Inspire 2021). Sediment types along that corridor were sand and muddy sand or mud and sandy mud. The proposed crossing at the southern extent of Peck Bay is between two marinas and includes a dredged channel into Crook Horn Creek. SAV is an EFH habitat area of particular concern (HAPC) and a Special Aquatic Site ("vegetated shallows") under the CWA. SAV provides three-dimensional physical structure and is important nursery habitat where juvenile vertebrates and invertebrates typically experience higher density, growth, and survival (Lefcheck et al. 2019). It also provides other ecosystem services such as primary production, nutrient cycling, carbon sequestration, stabilization of sediments, and shoreline protection (Lefcheck et al. 2019). It is a highly productive inshore habitat sensitive to physical disruption and degradation of water quality.

Eelgrass declines in distribution and abundance are also attributed to stress from invasive species such as green crabs (Neckles 2015) and invasive tunicates (Wong and Vercaemer 2012; Carman et al. 2019). Indirect impacts of anthropogenic activities include global warming (e.g., seagrass wasting disease), sea-level rise, carbon dioxide (CO_2) and ultraviolet increase (Duarte 2002), degraded water quality and increased turbidity, shading, altered currents, resuspension of contaminated sediments, contamination from spills or discharges, and altered food webs and competition (Nascimento et al. 2019; Waycott et al. 2022). More-intense rain events and coastal storms have been associated with climate change and are expected to increase in the future. Impacts of climate change such as reduced salinities, stronger storms, and more turbid water are also stressors for eelgrass (Short et al. 2016). The physical stress to organisms from climate change impacts can also increase the opportunity for disease. For example, eelgrass is threatened by seagrass wasting disease (in warmer ocean temperatures) (Graham et al. 2021).

CO_2 in the atmosphere results in global warming and climate change and is primarily a result of human activities such as fossil fuel burning and deforestation (Novak et al. 2020). Because coastal habitats, including SAV, are important mechanisms in reducing CO_2 emissions, potential impacts on these habitats result in increased emissions and climate change impacts.

Seagrass loss rates have increased from 0.9 percent per year before 1940 to 7 percent per year globally since 1990 and have therefore reduced the capacity for carbon storage by seagrass beds (Mcleod et al. 2011). Dramatic declines in SAV are also documented throughout New Jersey and Barnegat Bay in particular (for example, see Kennish et al. 2007, 2011). Although declines in water quality have been associated with SAV losses in New Jersey, direct losses through development, dredging, trenching, and other bottom-disturbing activities further exacerbates the widespread impacts. Consequently, seagrass conservation and restoration plans can contribute to blue carbon strategies to mitigate climate change (Duarte et al. 2013; Novak et al. 2020; Howard et al. 2017; Mcleod et al. 2011).

Loss of seagrass habitat is reportedly due primarily to reduced water quality from sediment and nutrient runoff from anthropogenic sources, and from direct impacts such as dredging and trawling (Pendleton et al. 2012). Regardless of the cause, the loss of SAV such as eelgrass results in the loss of ecosystem services they provide, including organic carbon sequestration, and potentially leads to CO_2 emissions when sediment organic carbon deposits are eroded and exposed to aerobic conditions (Novak et al. 2020).

While coastal vegetated ecosystems compose only 0.05 percent of the plant biomass on land, they store a comparable amount of carbon per year, making them one of the most important carbon sinks and mitigators of excess of CO_2 on the planet (Duarte et al. 2005; Nellemann et al. 2009; Mcleod et al. 2011). Seagrasses, like mangroves and tidal marshes, have been identified as important sources of biological carbon sequestration, known as “blue carbon” (Novak et al. 2020; Macreadie et al. 2019; Howard et al. 2017; Duarte et al. 2013; Mcleod et al. 2011). In addition, estuarine, ocean shelf, and deep sea sediment carbon stocks may approach 30 percent of the carbon in seagrass meadow sediments (Duarte et al. 2017). Loss of SAV (e.g., seagrasses) has been shown to result in increased CO_2 emissions due to the resulting decline in biological sequestration of carbon. Seagrass meadows accumulate large carbon stocks in both biomass and sediments and, although some carbon is used by fauna or remineralized in adjacent ecosystems, carbon is also buried or exported beyond the seagrass beds (Novak et al. 2020; Duarte et al. 2013, 2017; Howard et al. 2017). Novak et al. (2020) found that the average sediment organic carbon stock in the upper 30 centimeters for eelgrass in New England (2,832 ± 416 mass of carbon per m^2) was found to be similar to worldwide estimates for eelgrass (2,721 ± 989 mass of carbon per m^2), but lower than global estimates that include all seagrass species (19,420 ± 202 mass of carbon per m^2).

Howard et al. (2017) report that anthropogenic conversion and degradation of coastal wetlands such as SAV can lead to major emissions because much of the carbon stored in the soils is released back into the atmosphere and ocean (Howard et al. 2017; Pendleton et al. 2012), shifting the systems from net sinks to sources of carbon. Pendleton et al. (2012) report carbon storage in the top meter of sediment, including biomass, is an estimated 140 tons of carbon per hectare (14,000 mass of carbon per m^2) in seagrasses, a conservative estimate given that the carbon may be stored in as much as 6 meters of sediment and biomass) and the potential CO_2 emissions due to loss of seagrasses are an estimated 512 tons per hectare. Seagrasses, though having lower per-hectare carbon stocks than mangroves and salt marshes, contribute the second most to global blue carbon emissions based on current rates of global annual loss rate (land use conversion) of seagrasses of 0.4–2.6 percent (Pendleton et al. 2012).

Direct damage to seagrass blades may recover quickly; however, damage or uprooting of rhizomes may take years to recover naturally (Orth et al. 2017). Compensatory mitigation for impacts on seagrass are difficult and may not always result in restoration of SAV to pre-impact conditions (Bologna and Sinnema 2012). Therefore, avoidance and minimization of impacts on these habitats are important.

SAV in Barnegat Bay and Great Egg Harbor Bay was initially surveyed for the Project through aerial photography in 2019, followed by quadrat sampling in Barnegat Bay along transect lines in 2020) and subsequent surveys in summer 2022 (COP Volume II, Appendix E; Ocean Wind 2023). The quadrat surveys documented the outer extents of SAV beds identified from the aerial survey and obtained representative information on SAV species and density. The two most common species of seagrass in New Jersey back barrier lagoons are eelgrass (*Zostera marina*) and widgeon grass (*Rupia maritima*). Eelgrass was the dominant type of SAV identified and widgeon grass (*Rupia maritima*) was documented in less than 0.4 percent of all quadrats surveyed. The distribution of seagrass described from the aerial survey is generally consistent with New Jersey Department of Environmental Protection (NJDEP) survey results from 1986 (NJDEP 1986).

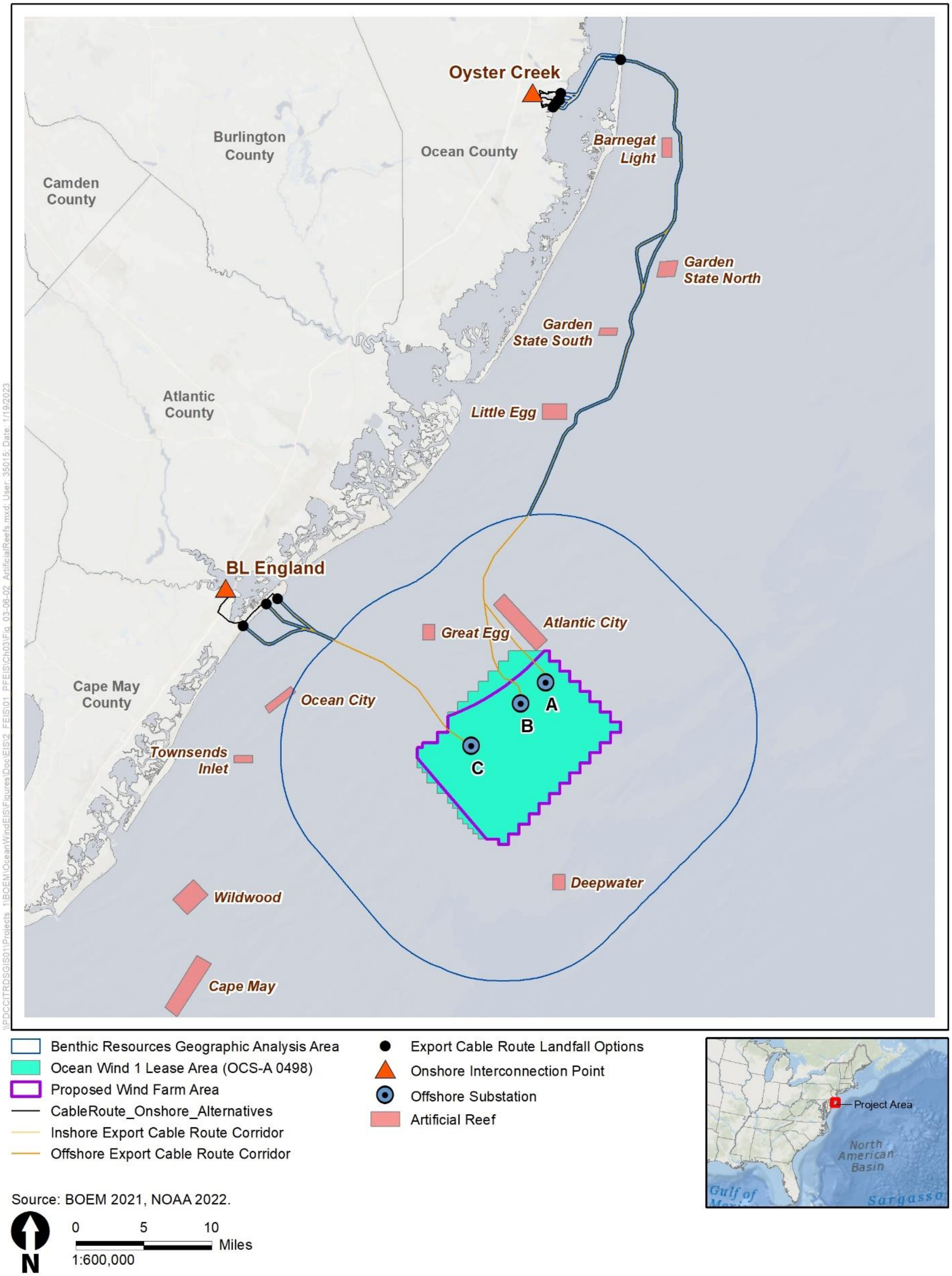

Figure 3.6-2 Artificial Reef Sites

In the fall of 2019, Ocean Wind conducted aerial SAV mapping surveys in Barnegat Bay and Great Egg Harbor. The survey was conducted to incorporate methodologies from previous studies (Lathrop and Haag 2011) and existing agency guidelines (Colarusso and Verkade 2016). The survey was conducted via aerial photography in October 2019 in Barnegat Bay and in Great Egg Harbor. The areas of SAV documented in the Phase 1 Survey were used to inform the more intensive Phase 2 Survey effort.

Sparse to moderate seagrass was identified near the proposed Peck Bay crossing during the 2019 aerial survey and was not identified at this location in historical imagery (NJDEP 1979). Survey results for Great Egg Harbor are mapped on Figure 2 of Appendix E of the COP (Ocean Wind 2023). Phase 2 surveys were not performed in Great Egg Harbor.

In July 2022, additional underwater video SAV data were collected at four areas in Barnegat Bay where SAV beds were delineated by aerial survey in 2019 (Inspire 2022a). In general, the SAV data collected in July 2022 corroborate Ocean Wind's previous SAV surveys. Within each survey area, acres of SAV from aeral imagery in 2019 are similar to the acres estimated from the 2022 underwater video transects, with the exception of the northernmost survey area on the western side of Barnegat Bay where no SAV beds were observed in the video data collected in 2022 (similar to the in-water data collected in 2020), although the aerial imagery from 2019 suggested about 9.5 acres of SAV. This discrepancy is likely due to challenges in discerning between SAV and macroalgal beds using aerial imagery and highlights the importance of verified in-water data. At the other survey areas, the SAV acreage estimated from the 2022 video transects was generally higher than what was derived from the 2019 delineations. This is likely due to the coarse spatial resolution of towed video transects, resulting in conservative polygon interpolations, compared to the aerial imagery approach. In the prior channel at Island Beach State Park, water depth limits SAV growth; however, SAV was observed with sparse coverage (single or double shoots) in the channel and with patchy or complete coverage along the shallow flanks of the channel (as also documented in the 2021 survey).

Additional discussion of previously conducted studies related to SAV presence and density is provided in the EFH Assessment (BOEM 2022a) and COP Volume III, Appendix E (Ocean Wind 2023).

SAV and other estuarine habitats such as shoals, mudflats, and inter-tidal marshes within the New Jersey coastal bays are important spawning, nursery, and feeding grounds for numerous aquatic species. Great Bay and the Mullica River estuary, which are between the Oyster Creek and BL England cable routes, for example are an HAPC (discussed further in the EFH Assessment) for sandbar shark (*Carcharhinus plumbeus*), which uses this area as nursery (pupping) grounds (Merson and Pratt 2007). Similarly, summer flounder (*Paralichthys dentatus*) HAPC includes SAV within Barnegat Bay and other designated summer flounder EFH.

Barnegat Bay also supports important invertebrate species such as hard clams (*Mercenaria mercenaria*), soft clams (*Mya arenaria*), blue mussels (*Mytilus edulis*), bay scallops (*Argopecten irradian*s), and eastern oyster (*Crassostrea virginica*) although population levels are markedly below historical levels (Ford 1997; Dacanay 2015). Hard clams within the Oyster Creek export cable route are primarily low density with a few patches of moderate and high density (NJDEP 2012). Commercially important invertebrate taxa are discussed in more detail in Section 3.13.

Barnegat Bay is an Estuary of National Importance and part of the National Estuarine Research Reserve System. It is one of 28 estuaries in the USEPA National Estuary Program, the aim of which is to restore and maintain the water quality and ecological integrity of estuaries of national significance (USEPA 2009). Under this program, a Comprehensive Conservation and Management Plan (Barnegat Bay Partnership 2021) for the estuary has been developed and is implemented by the Barnegat Bay Partnership.

Benthic invertebrate communities within Barnegat Bay are abundant and generally highly diverse and have shown few changes from 1965 to 2010 (Taghon et al. 2017). Samples collected from 2012 to 2014 were numerically dominated by Polychaeta followed by Malacostraca. BOEM Guidelines include identification of potentially sensitive seafloor habitats, such as corals, SAV beds, and ecologically valuable cobble and boulder habitat (BOEM 2019, 2020a). Of these, SAV was observed within Barnegat Bay and Peck Bay (Inspire 2021). Neither coral nor cobble and boulder habitat were observed within the Offshore Project area. Several artificial reefs are documented in the Offshore Project area. Four artificial reef areas (Barnegat Light) are mapped offshore, adjacent to the Oyster Creek offshore export cable corridor, and one is mapped offshore, adjacent to the BL England offshore export cable corridor (COP Volume II, Section 2.2.6.1.5; Ocean Wind 2023). No aquaculture leases presently occur in the vicinity of BL England. Four shellfish leases (37 acres) and one research lease occur in the vicinity of Oyster Creek with the primary shellfish growout of oysters and hard clams (COP Volume II, Section 2.3.4.1.3; Ocean Wind 2023). The offshore export cable to the southernmost landfall option for Oyster Creek traverses an aquaculture lease area on the west side of Barnegat Bay (COP Volume II, Figure 2.2.5-2; Ocean Wind 2023). A single obstruction/wreck was identified in the Wind Farm Area (COP Volume II, Appendix E; Ocean Wind 2023).

3.6.2 Environmental Consequences

3.6.2.1. Impact Level Definitions for Benthic Resources

Definitions of impact levels are provided in Table 3.6-1.

Table 3.6-1 Impact Level Definitions for Benthic Resources

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts on species or habitat would be adverse but so small as to be unmeasurable.
	Beneficial	Impacts on species or habitat would be beneficial but so small as to be unmeasurable.
Minor	Adverse	Most adverse impacts on species would be avoided. Adverse impacts on sensitive habitats would be avoided; adverse impacts that do occur would be temporary or short term in nature.
	Beneficial	If beneficial impacts occur, they may result in a benefit to some individuals and would be temporary to short term in nature.
Moderate	Adverse	Adverse impacts on species would be unavoidable but would not result in population-level effects. Adverse impacts on habitat may be short term, long term, or permanent and may include impacts on sensitive habitats but would not result in population-level effects on species that rely on them.
	Beneficial	Beneficial impacts on species would not result in population-level effects. Beneficial impacts on habitat may be short term, long term, or permanent but would not result in population-level benefits to species that rely on them.
Major	Adverse	Adverse impacts would affect the viability of the population and would not be fully recoverable. Adverse impacts on habitats would result in population-level impacts on species that rely on them.
	Beneficial	Beneficial impacts would promote the viability of the affected population or increase population resiliency. Beneficial impacts on habitats would result in population-level benefits to species that rely on them.

3.6.3 Impacts of the No Action Alternative on Benthic Resources

Section 3.1 of the Final EIS explains the approach to predicting impacts related to the No Action Alternative. When analyzing the impacts of the No Action Alternative on benthic resources, BOEM considered the impacts of past and ongoing trends and activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for benthic resources. BOEM separately analyzes how resource conditions will be affected over time as reasonably foreseeable activities are implemented. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*. Separate impact conclusions are presented for both scenarios.

3.6.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for benthic resources described in Section 3.6.1, *Description of the Affected Environment for Benthic Resources*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on benthic resources are generally associated with inshore dredging, coastal development, offshore construction including bottom disturbance and habitat conversion, and climate change. Impacts associated with climate change have the potential to alter species distributions and increase individual mortality and disease occurrence. There are no ongoing offshore wind activities within the geographic analysis area for benthic resources.

Accidental releases: Although USCG prohibits the dumping of environmentally damaging trash or debris (International Convention for the Prevention of Pollution from Ships, Annex V, Public Law 100−220 (101 Stat. 1458)), accidental releases would continue to occur as a result of ongoing activities. Impacts of accidental releases are relative to their magnitude. Smaller releases are expected to occur at a higher frequency and to be less severe, while major releases are expected to be rare but have more impacts. The impacts of accidental releases on benthic resources are likely to be negligible because large-scale releases are unlikely and impacts from small-scale releases would be localized and short term, resulting in little change to benthic resources.

Anchoring: Ongoing activities include vessels anchoring within the inshore and offshore geographic analysis area. Anchoring would cause increased turbidity levels and would have the potential for physical contact to cause mortality of benthic resources. Anchor drag would increase impacts, potentially resulting in scarring or additional damage to benthic habitats. Inshore activities additionally have the potential to affect SAV, which may take longer to recover. Impacts would therefore be moderate.

Electromagnetic fields (EMF): EMF would result from existing transmission or communication cables. There are four in-service cables along the offshore export cable corridor, although none have been identified near the Wind Farm Area. Specific impacts associated with EMF are described in detail in Section 3.6.3.2. Due to the small footprint of existing undersea transmission lines within the benthic geographic analysis area and the fact that EMF decreases rapidly with distance from the cable, impacts from EMF would be minor.

Cable emplacement and maintenance: Impacts from cables or undersea transmission lines may result from maintenance of existing cables, if needed. Cable maintenance activities infrequently disturb benthic resources and cause temporary increases in suspended sediment; these disturbances would be local and limited to the emplacement corridor. Sediment deposition could have adverse impacts on some benthic resources, especially eggs and larvae, including smothering and loss of fitness. Impacts may vary based on season. Benthic resources in the geographic analysis area are generally adapted to the turbidity and periodic sediment deposition that occur naturally in the geographic analysis area. Due to the limited footprint of existing cables and short duration of this type of activity, this would be a minor impact.

Noise: Underwater sound is a pervasive issue throughout the world's oceans. Vessel traffic, seismic surveys, and active naval sonars are the main anthropogenic contributors to low- and mid-frequency noises in oceanic waters (Henderson et al. 2008), with vessel traffic the dominant contributor to ambient sound levels in frequencies below 200 Hertz (Hz) (Arveson and Vendittis 2000; Veirs et al. 2016). Noise from construction occurs frequently nearshore of populated areas in the mid-Atlantic but infrequently offshore. The intensity and extent of noise from construction is difficult to generalize, but impacts are local and temporary. Ongoing site characterization surveys and scientific surveys produce noise around sites of investigation. These activities can disturb benthic resources in the immediate vicinity of the investigation. The extent depends on equipment used, noise levels, and local acoustic conditions. Noise from pile driving occurs periodically in nearshore areas when piers, bridges, pilings, and seawalls are installed or upgraded. Noise transmitted through water or through the seabed can cause injury to or mortality of benthic resources in a small area around each pile and can cause short-term stress and behavioral changes to individuals over a greater area. The extent depends on pile size, hammer energy, and local acoustic conditions. Infrequent trenching activities for pipeline and cable laying, as well as other cable burial methods, emit noise. These disturbances are localized and temporary and extend only a short distance beyond the emplacement corridor. Impacts of this noise are typically less prominent than the impacts of the physical disturbance and sediment suspension. Detectable impacts of noise on benthic resources would rarely, if ever, overlap from multiple sources.

These noise sources are intermittent and spatially limited and are not expected to have measurable impacts on benthic resources; therefore, impacts are expected to be negligible.

Port utilization: Ongoing sediment dredging for navigational purposes would occur in shallow and nearshore areas, resulting in localized, short-term impacts (habitat alteration, injury and mortality) on benthic resources through seabed profile alterations, as well as through the sediment deposition. Dredging typically occurs only in sandy or silty habitats, which are abundant in the geographic analysis area and are quick to recover from disturbance. Sediment deposition could have adverse impacts on some benthic resources, especially eggs and larvae, including smothering and loss of fitness. Impacts may vary based on season. Where dredged materials are disposed of, benthic resources are smothered. However, such areas are typically recolonized naturally in the short term. Most sediment-dredging projects have time-of-year restrictions to minimize impacts on benthic resources. Benthic resources in the geographic analysis area are generally adapted to the turbidity and periodic sediment deposition that occur naturally in the geographic analysis area. Individual projects would have benthic impacts associated with dredging, which may be moderate but localized.

Presence of structures: Pre-existing or small-scale structures include docks, artificial reefs, and potentially scour protection for existing submarine cables. These structures may entangle fishing gear, leading to benthic disturbance and also provide novel surfaces for colonization and recruitment of marine fauna that. This may have moderate adverse impacts for existing benthic resources as faunal assemblages shift, altering local food web dynamics, increasing the opportunity for invasive and nonnative species and potentially a resulting in regional changes due to shifts from soft-sediment to hard-substrate communities (described below). Structures may result in moderate benefits to colonizers. Benefits of structures occur due to the attraction of mobile organisms like decapods, demersal and pelagic fish, and apex predators, resulting in effects similar to those of artificial reefs or fish aggregating devices (Dannheim et al. 2019; Langhamer 2016). However, while underwater cables and armoring structures on the seafloor can act as artificial reefs, there is very little evidence of colonization by nonnative species (Taormina et al. 2018).

Discharges: The gradually increasing amount of vessel traffic is increasing the total permitted discharges from vessels. Many discharges are required to comply with permitting standards established to ensure potential impacts on the environment are minimized or mitigated. Impacts would therefore be negligible.

Regulated fishing effort: Ongoing commercial and recreational regulations for finfish and shellfish implemented and enforced by the State of New Jersey or NOAA, depending on jurisdiction, will affect benthic resources by modifying the nature, distribution, and intensity of fishing-related impacts, including those that disturb the seafloor (trawling, dredge fishing). Under adequate regulations, impacts of regulated fishing activities on benthic resources will be moderate.

Climate change: Ongoing emissions of CO_2 are leading to ocean acidification, which contributes to reduced growth and the inhibition of calcification, resulting in adverse impacts on benthic resources with calcareous shells. Laboratory experiments have shown the negative impacts of ocean acidification in several marine calcifiers, including echinoderm, bivalve, coral, and crustacean species (Kurihara 2008). Another study found the immune response of the sea urchin may be compromised under near-future ocean warming and acidification (Brothers et al. 2016). In seagrasses, combined increased water temperature and lower salinity associated with climate change can result in increased mortality (Salo and Pedersen 2014). Warmer waters also provide opportunities for invasive species to become established. Climate change is expected to continue to lead to warming of the oceans, which is altering the distribution of benthic resources and ecological relationships and providing opportunities for disease, invasives species establishments, and loss of habitat. Impacts from climate change are expected to be moderate.

3.6.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with other planned activities (without the Proposed Action). Planned offshore wind projects in the geographic analysis area depicted on Figure 3.6-1 include Ocean Wind 2 and Atlantic Shores South. Planned non-offshore wind activities that may affect benthic resources include new submarine cables and pipelines, tidal energy projects, marine minerals extraction, dredging, military use, marine transportation, fisheries use and management, global climate change, and oil and gas activities (see Section F.2 in Appendix F for a complete description of planned activities). These activities may result in bottom disturbance and habitat conversion, but population-level effects would not be expected. The paragraphs below provide an overview of what is known regarding the IPFs described above. See Table F1-3 for a summary of potential impacts associated with planned non-offshore wind activities by IPF for benthic resources. Planned non-offshore wind activities would have the same types of impacts from accidental releases, anchoring, EMF, cable emplacement and maintenance, noise, port utilization, presence of structures, and regulated fishing effort that are described in detail in Section 3.6.3.1 for ongoing non-offshore wind activities.

BOEM expects planned offshore wind activities to affect benthic resources through the following primary IPFs.

Accidental releases: Accidental releases may increase as a result of planned non-offshore wind and planned offshore wind activities. The risk of any type of accidental release would be increased primarily during construction, but also during operations and decommissioning of offshore wind facilities. Accidental releases of hazardous materials mostly consist of fuels, lubricating oils, and other petroleum compounds. Because most of these materials tend to float in seawater, they are unlikely to make contact with benthic resources. The chemicals with potential to sink or dissolve rapidly are predicted to dilute to non-toxic levels before they would reach benthic resources. In most cases, the corresponding impacts on benthic resources are unlikely to be detectable unless there is a catastrophic spill (e.g., an accident involving a tanker ship). Large-scale spills may be accompanied by the use of chemical dispersants during post-spill response. Crude oil treated with dispersants (specifically Corexit 9500A) has been shown to have higher toxicity to marine zooplankton and meroplankton than either the crude oil or dispersant alone (Rico-Martinez et al. 2012; Almeda et al. 2014a, 2014b). Benthic resources with planktonic larval stages may be susceptible to this toxicity, which may affect subsequent recruitment.

Invasive species can be released accidentally, especially during ballast water and bilge water discharges from marine vessels. Increasing vessel traffic related to the offshore wind industry would increase the risk of accidental releases of invasive species, primarily during construction. Invasive species releases may or may not lead to the establishment and persistence of invasive species. Although the likelihood of invasive species becoming established as a result of offshore wind activities is very low, the impacts of invasive species on benthic resources could be strongly adverse, widespread, and permanent if the species were to become established and out-compete native fauna. Such an outcome, however, is considered highly unlikely. The increase in this risk related to the offshore wind industry would be small in comparison to the risk from ongoing activities (e.g., trans-oceanic shipping).

Accidental releases of trash and debris may occur from vessels primarily during construction, but also during operations and decommissioning. Lessees must conduct all authorized activities in a manner that prevents unauthorized discharge of pollutants including marine trash and debris into the offshore environment (30 CFR 285.105). USCG similarly prohibits the dumping of environmentally damaging trash or debris (International Convention for the Prevention of Pollution from Ships, Annex V, Public Law 100−220 (101 Stat. 1458)).

However, higher-volume spills of toxic materials could occur due to unanticipated events, such as a vessel allision with a WTG foundation. BOEM assumes all vessels would comply with laws and regulations to minimize releases. If a release were to occur, it would be an accidental, localized event in the vicinity of work areas. The greatest likelihood of releases would be associated with nearshore project activities (e.g., transmission cable installation and transport of equipment and personnel from ports). However, there is no evidence that the anticipated volumes and extents would have detectable impacts on benthic resources.

The cumulative impacts of accidental releases on benthic resources are likely to be minor because large-scale releases are unlikely and impacts from small-scale releases would be localized and short term, resulting in little change to benthic resources. As such, accidental releases from offshore wind development would not be expected to appreciably contribute to cumulative impacts on benthic resources.

Anchoring: Offshore wind activities would increase vessel anchoring during survey activities and during construction, installation, maintenance, and decommissioning of offshore components. In addition, anchoring or mooring of meteorological towers or buoys could be increased. Anchoring would cause increased turbidity levels and would have the potential for physical contact to cause mortality of benthic resources. Anchor drag would increase impacts, potentially resulting in scarring or additional damage to benthic habitats. Using the assumptions in Table F2-2 in Appendix F, anchoring could affect up to 274 acres (1.1 km^2). Most impacts would be minor because impacts would be localized, turbidity would be temporary, and mortality of benthic resources from contact would be recovered in the short term. Impacts from anchoring associated with planned non-offshore wind activities would be moderate. Degradation of sensitive habitats and resources, such as SAV beds and hard-bottom habitats, if it occurs, could be long term to permanent, resulting in moderate cumulative impacts.

EMF: The marine environment continuously generates a variable ambient EMF. EMF would also emanate from new transmission or communication cables and new offshore export cables and inter-array cables constructed for offshore wind projects. Offshore wind projects (including Atlantic Shores South and Ocean Wind 2) would add an estimated 1,318 miles (2,121 kilometers) of cable to the geographic analysis area that would produce EMF in the immediate vicinity of cables for each project during operation. The Atlantic Shores South PDE for offshore export cables includes options for 230- to 275-kV high-voltage alternating current (HVAC) or 320- to 525-kV high-voltage direct current (HVDC) designs. The Atlantic Shores South COP also includes HVAC cable design for inter-array cables. Cable design for Ocean Wind 2 is not known at this time and could include HVAC or HVDC cables. BOEM would require these future submarine power cables to have appropriate shielding and burial depth to minimize potential EMF effects from cable operation. Remedial protection measures would be installed wherever the target burial depths cannot be met. EMF and substrate heating effects from these projects on benthic habitats would vary in extent and significance depending on overall cable length, the proportion of buried versus exposed cable segments, project-specific transmission design (e.g., HVAC or HVDC, transmission voltage), and the proximity of the affected habitat to the cable. For example, species with life stages that are surface-oriented or use pelagic habitats would not be exposed to EMF effects and would experience no effects on this habitat component. In contrast, species that use bottom or near-bottom habitats along the potential cable paths during one or more life stages may be exposed to EMF effects. The significance of these potential effects is dependent on habitat use (i.e., likelihood of exposure) and species-specific sensitivity to magnetic and electrical fields and heating effects. EMF strength diminishes rapidly with distance, and EMF that could elicit a behavioral response in an organism would likely extend less than 50 feet (15.2 meters) from each cable. Impacts of EMF on benthic habitats is an emerging field of study; as a result, there is a high degree of uncertainty regarding the nature and magnitude of effects on all potential receptors (Gill and Desender 2020). Recent reviews by Bilinski (2021), Gill and Desender (2020), Albert et al. (2020), and Snyder et al. (2019) of the effects of EMF on marine organisms in field and laboratory studies concluded that measurable, though minimal, effects can occur for some species, but not at the relatively low EMF intensities representative of marine renewable energy projects. Behavioral impacts from EMF, though observed at higher levels than are representative of offshore wind projects, were documented for lobsters near a direct current cable (Hutchison et al. 2018) and a domestic electrical power cable (Hutchison et al. 2020), including subtle changes in activity (e.g., broader search areas, subtle effects on positioning, and a tendency to cluster near the EMF source). There was no evidence of the cable acting as a barrier to lobster movement and no effects were observed for lobster movement speed or distance traveled. Additionally, faunal responses to EMF by marine fauna, including crustaceans and mollusks, include attraction to the source, interference with navigation that relies on natural magnetic fields, predator/prey interactions, avoidance or attraction behaviors, increased burrowing by polychaetes, increased exploratory and foraging behavior, and physiological and developmental effects (Bilinski 2021; Jakubowska et al. 2019; Hutchison et al. 2018; Taormina et al. 2018; Normandeau et al. 2011). Burrowing infauna and finfish may be exposed to stronger EMF, but little information is available regarding the potential consequences. Non-mobile infauna would be unable to move to avoid EMF. Any effects, however, would be local and would not have population-level impacts due to the small spatial scale of the impact relative to the available benthic habitat in the geographic analysis area.

Other studies, however, have found that EMF does not affect invertebrate behavior. For example, Schultz et al. (2010) and Woodruff et al. (2012, 2013) conducted laboratory experiments exposing American lobster and Dungeness crab (*Metacarcinus magister*) to EMF fields ranging from 3,000 to 10,000 milligauss and found that EMF did not affect their behavior. Assuming the other wind projects with HVAC cables in the geographic analysis area have similar array and export cable voltages as the Proposed Action, the induced magnetic field levels expected for the offshore wind projects are two to three orders of magnitude lower than those tested by Schultz et al. (2010) and Woodruff et al. (2012, 2013). Similarly, a field experiment in Southern California and Puget Sound, Washington found no evidence that the catchability of two crab species was influenced by the animals crossing an energized low-frequency submarine alternating current power cable (35 and 69 kV, respectively) to enter a baited trap. Whether the cables were unburied or lightly buried did not influence the crab responses (Love et al. 2017). While these voltages are between two and eight times lower than those expected for the offshore wind projects, the array and export cables would be shielded and buried at depth to reduce potential EMF from cable operation.

EMF levels would be highest at the seabed near cable segments that cannot be fully buried and are laid on the bed surface under protective rock or concrete blankets. Invertebrates in proximity to these areas could experience detectable EMF levels and minimal associated behavioral effects. These unburied cable segments would be short and widely dispersed. CSA Ocean Sciences, Inc. and Exponent in 2019 found that offshore wind energy development as currently proposed would have negligible effects, if any, on bottom-dwelling species. The information presented above indicates that EMF impacts on benthic fauna would be biologically insignificant, highly localized, and limited to the immediate vicinity of cables, and would be undetectable beyond a short distance; however, localized impacts would persist as long as cables are in operation. The affected area would represent an insignificant portion of the available benthic habitat; therefore, cumulative impacts on benthic resources would be minor.

Cable emplacement and maintenance: Construction of offshore submarine cables would cause short-term disturbance of seafloor habitats and injury and mortality of benthic resources in the immediate vicinity of the cable emplacement activities. The cable routes for other offshore wind projects have not been fully determined at this time. However, both export and inter-array cables are anticipated to be constructed through 2030 for other offshore wind projects within lease areas that are within or overlap the geographic analysis area (see Table F2-1 in Appendix F). The total area of disturbance resulting from new cable emplacement is presented in Table F2-2 in Appendix F. The area presented would be a small fraction of available habitat in the geographic analysis area and would be expected to recover relatively quickly. Impacts associated with cable emplacement in sensitive habitats such as areas with SAV or complex habitat such as cobble or boulders, where present, may take longer to recover.

Prior to cable emplacement, obstructions along the cable route are mapped and may be removed. UXO (e.g., bombs, bullets, shells, grenades, mines) is often present on the ocean floor. If UXO cannot be avoided, removal or detonation may be required to avoid risks to human lives. Physical removal of UXO disturbs the seabed in much the same way as cable installation. UXOs that are exploded in place disturb the ocean floor and can result in habitat loss, reduced water quality, and physical disturbance, harm, and mortality in fish and marine invertebrates (noise from UXO detonations is discussed in the *Noise* IPF below). A UXO blast in a Scotland offshore wind farm mobilized sediments into the water column in the vicinity of the explosion, although high sediment suspension was reportedly short lived and smaller in magnitude than the effects of a storm event (Beatrice Offshore Windfarm 2016). Other effects reported for the same offshore wind farm included loss of benthic habitat due to sediment suspension and deposition in addition to the seafloor disturbance, although the recovery of the seafloor due to inputs from surrounding unaffected areas was anticipated to be rapid. An assessment of the sediments found no raised levels of any hydrocarbon or metals across the wind farm and concluded the potential effects of resuspended sediment contaminants on benthic resources were negligible.

UXO clearance activities during critical periods can affect spawning or migration behavior in fish. At the Beatrice Offshore Windfarm, UXO clearance was undertaken outside the spawning window and no impacts on cod spawning were anticipated. UXO clearance activities may result in temporary loss or disturbance of spawning, nursery, or feeding habitat. The clearance of UXO has the potential to result in the loss of benthic habitat in the vicinity of the blast site, which is of importance to benthic invertebrate species. This impact is, however, predicted to be highly localized and therefore will not result in substantial areas of seabed being disturbed. Following disturbance, levels of suspended sediment in the water column are not expected to be substantially higher than background levels and the sandy and coarse sand sediments will settle back to the seabed relatively rapidly. Given the relatively high susceptibility of eggs and larvae to suspended and resettling sediment, there is the potential for early life stages to be affected by UXO detonation.

Seabed preparations (e.g., sand wave clearance, boulder relocation, pre-lay grapnel run) made prior to installation of cables as well as dredging and mechanical trenching used during cable installation can cause localized, short-term impacts (e.g., habitat alteration, injury, mortality) on benthic resources through seabed profile alterations, as well as through the sediment deposition. The level of impact from seabed profile alterations could depend on the time of year that they occur, especially if these alterations overlap with times and places of high benthic organism abundance or reproductive activity. Locations, amounts, and timing of dredging for offshore wind projects are not known at this time. The need for dredging depends on local seafloor conditions, assuming the areal extent of such impacts is proportional to the length of cable installed (see Table F2-1 in Appendix F). Dredging typically occurs only in sandy or silty habitats, which are abundant in the geographic analysis area and are quick to recover from disturbance, although full recovery of the benthic faunal assemblage may require several years (Wilber and Clarke 2007). Mechanical trenching, used in more resistant sediments (e.g., gravel and cobble), causes seabed profile alterations during use, although the seabed is typically restored to its original profile after utility line installation in the trench. Sand and gravel substrates typically take longer to recover to pre-disturbance conditions than habitats with finer grain sizes (Wilber and Clarke 2007).

Disturbed seafloor from construction of these projects may affect benthic resources; assuming other offshore wind projects use installation procedures similar to those proposed in the COP, the duration and extent of impacts would be limited and short term, and benthic assemblages would recover from disturbance. Particularly where routes intersect sensitive or complex habitat, impacts may be long term to permanent. For SAV, damage to seagrass blades may be more quickly recovered; however, damage or uprooting of rhizomes may take years to recover (Orth et al. 2017). Increased turbidity due to bottom disturbances associated with cable emplacement would reduce light availability to SAV. This short- to long-term impact would be most pronounced in the immediate vicinity of the disturbance. Cable installation in nearshore areas where SAV habitat is present would result in short-term to long-term, and therefore moderate, impacts on SAV due to habitat loss. Loss of SAV beds would also reduce carbon sequestration and increase CO_2 emissions, leading to negligible to minor adverse impacts related to ongoing climate change (see climate change, above, for greater detail).

When new cable emplacement and maintenance causes resuspension of sediments, increased turbidity could have an adverse impact on filter-feeding fauna such as bivalves. Within the New Jersey WEA, sand is the predominant sediment type, which would settle out of the water column quickly (Guida et al. 2017). There are lower percentages of finer sediments (mud) that would stay suspended longer and, therefore, travel farther. The impact of increased turbidity on benthic fauna depends on both the concentration of suspended sediment and the duration of exposure. Plume modeling for other wind development projects within the region and with similar sediment characteristics (Vineyard Wind 1, Block Island Wind Farm, and Virginia Offshore Wind Technology Advancement) predict that suspended sediment should usually settle well before 12 hours have elapsed (COP Volume II, Section 2.1.2.2.1; Ocean Wind 2023). BOEM expects relatively little impact from increased turbidity (separate from the impact of sediment deposition).

If the sediment that would be disturbed by construction activities contains elevated levels of toxic contaminants, sediment disturbances could affect water quality and the physiology of benthic organisms. Contaminated sediments are not known to be a problem in the geographic analysis area for benthic resources.

Sediment resuspended as a result of cable emplacement and maintenance activities would be deposited on the seafloor. Sediment deposition can result in adverse impacts on benthic resources, including smothering and changes to sediment quality profiles. Benthic organisms' tolerance to being covered by sediment (sedimentation) varies among species. Demersal winter flounder eggs were shown to have delayed hatching with as little as 0.04 inch (1 millimeter) of sedimentation (Berry et al. 2011). The sensitivity to sedimentation for shellfish varies by species and life stage. Some sessile shellfish may only tolerate 1 to 2 centimeters while other benthic organisms can survive burial in upward of 20 centimeters (Essink 1999). Areas closest to the disturbance would receive higher percentages of more coarse, rapidly settling sediments while finer sediments would settle over greater distances and be more diffuse. The greatest impacts would therefore be at the smallest spatial scales. The level of impact from sediment deposition and burial could depend on the time of year that it occurs, especially if it overlaps with times and places of high benthic organism abundance or reproductive activity.

Some types of cable installation equipment use water withdrawals, which can entrain planktonic larvae of benthic fauna (e.g., larval polychaetes, mollusks, crustaceans) with assumed 100-percent mortality of entrained individuals (COP Volume II, Section 2.2.5.2.1; Ocean Wind 2023). Due to the surface-oriented intake, water withdrawal could entrain pelagic eggs and larvae, but would not affect resources on the seafloor. However, the rate of egg and larval survival to adulthood for many species is very low (MMS 2009). Due to the limited volume of water withdrawn, BOEM does not expect population-level impacts on any given species.

Assuming the areal extent of such impacts is proportional to the length of cable installed (see Table F2-1 in Appendix F), such impacts from offshore wind activities would likely be on the order of 4.3 times more than the Proposed Action. Increased sediment deposition may occur during multiple years. The area with a greater sediment deposition from simultaneous or sequential activities would be limited, as most of the affected areas would only be lightly sedimented (less than 0.04 inch [1 millimeter]) and would recover naturally in the short term. Dredged material disposal during construction, if any occurs in the geographic analysis area, would cause localized, temporary turbidity increases and long-term sedimentation or burial of benthic organisms at the immediate disposal site. The impacts of burial would be mostly short term with less potential for long-term impacts. Sediment deposition and burial impacts on benthic resources from cable emplacement for other offshore wind projects would therefore be moderate.

Noise: Sound from offshore wind activities includes sound pressure, particle motion, and vibration. Sound pressure is the fluctuation in the density of the medium (e.g., sediments) due to the sound, particle motion refers to the movement of particles that make up the medium during that sound, and vibrations are initiated by direct contact of a sound source with the substrate, such as during pile driving, and by sound energy entering the substrate through the water from intense sources, such as seismic air guns (Popper et al. 2022). Sound pressure is heard by most terrestrial animals, including humans, and is not discussed further. However, most fishes, including all elasmobranchs and likely all sound-detecting invertebrates, hear via particle motion (Popper et al. 2022; Carroll et al. 2017). Fishes and aquatic invertebrates that live in, on, or close to the substrate (e.g., the seabed) may also be affected by vibrations. Sound pressure and particle motion can also emanate from the substrate back into the water column as a result of such vibrations (Hawkins et al. 2021). In a review of potential impacts of sound on fishes and aquatic invertebrates from offshore wind activities, Popper et al. (2022) identified substantial gaps in the understanding of these effects and concluded these gaps preclude an assessment of the potential impacts of sound from offshore development.

Noise can cause bivalves to close their valves and burrow deeper when subjected to noise and vibration stimuli, reducing respiration and other processes and potentially causing mortality (Roberts et al. 2016), although the duration of pile driving and small radius of potential effects on infaunal organisms is expected to be on the order of hours. With impulse impacts, such as those from pile driving, physiological sound thresholds may be exceeded for some species, resulting in injury or mortality, especially for affected species in the immediate vicinity. Noise transmitted through water or the seabed sediments would also be expected to affect benthic invertebrates. However, data are not available to adequately quantify these impacts (Popper et al. 2022).

Noise, in terms of sound pressure levels (SPL), from vessel traffic, construction, pile driving, seismic surveys, geophysical and geotechnical (G&G) survey activities, O&M, and trenching/cable burial could contribute to impacts on benthic resources. The most impactful noise is expected to result from pile driving. Noise from pile driving would occur during installation of foundations for offshore structures. This noise would be produced intermittently during installation of each foundation. One or more projects may install more than one foundation per day, either sequentially or simultaneously. Construction of offshore wind facilities in the geographic analysis area would likely occur over an assumed 5-year construction period (see Table F2-1 in Appendix F). Noise transmitted through water and through the seabed can cause injury to or mortality of benthic resources in a limited area around each pile and can cause short-term stress and behavioral changes to individuals over a greater area. The extent depends on pile size, hammer energy, and local acoustic conditions. The affected areas would likely be recolonized in the short term. In the planned activities scenario, noise from pile driving that causes behavioral changes could affect the same populations or individuals multiple times in a year or in sequential years, although impacts are expected to be minor.

Noise from G&G surveys of cable routes and other site characterization surveys for offshore wind facilities could also disturb benthic resources in the immediate vicinity of the investigation and cause temporary behavioral changes. G&G noise would occur intermittently over an assumed 5-year construction period (see Table F2-1 in Appendix F). Potential impacts of G&G activities for renewable energy on the Atlantic OCS (BOEM 2018 rev. 2021) included evaluations of impacts on benthic resources as they relate to EFH (e.g., habitat for prey). HRG surveys may result in some localized disturbance due to a number of IPFs associated with data collection activities, including vessel operations, accidental release of marine debris, drilling noise, and other benthic sampling activities. These activities may affect benthic invertebrates that are prey items for listed species (e.g., sturgeon, sea turtles) and thus may alter the diet composition of these species. However, because the amount of benthic habitat affected by routine activities would be temporary and extremely small relative to the available foraging habitat in the renewable energy regions, any effects on listed species resulting from benthic disturbance would be insignificant. Adverse effects on benthic habitat and communities from G&G activities (including noise) on the Atlantic OCS targeting sand resources are expected to be reversible and no impacts on hard-bottom communities would be anticipated from G&G surveys (BOEM 2014). G&G noise resulting from offshore wind site characterization surveys is less intense than G&G noise from seismic surveys used in oil and gas exploration; while seismic surveys create high-intensity, impulsive noise to penetrate deep into the seabed, offshore wind site characterization surveys typically use sub-bottom profiler technologies that generate less-intense sound waves for shallow penetration of the seabed. Seismic surveys are not expected in the geographic analysis area for benthic resources. Detectable impacts of G&G noise on benthic resources would rarely, if ever, overlap from multiple sources, but may overlap with behavioral impacts of pile-driving noise. Overlapping sound sources are not anticipated to result in a greater, more-intense sound; rather, the louder sound prevents the softer sound from being detected. Noise from G&G surveys is therefore expected to have a minor impact on benthic resources.

Noise from trenching/cable burial, O&M, and construction activities other than pile driving are expected to occur but would have little impact on benthic resources. Noise from inter-array and export cable trenching would be temporary and localized and extend only a short distance beyond the emplacement corridor. Impacts of trenching noise are typically less prominent than the impacts of the physical disturbances discussed above under the IPFs for new cable emplacement and maintenance and sediment deposition and burial. Finally, while noise associated with operational WTGs may be audible to some benthic fauna, this would only occur at relatively short distances from the WTG foundations and could cause physiological damage or avoidance responses (English et al. 2017). Proximity to the individual turbines is the strongest predictor of SPLs over factors such as wind speed and turbine size (Tougaard et al. 2020). Noise from construction activities other than pile driving may occur; however, little of that noise propagates for any substantial distance through the water, and, therefore, impacts on benthic resources are expected to be minor.

Mapped MEC/UXO disposal areas have already been excluded from potential offshore wind development, thereby reducing the likelihood of an encounter; the risk is further reduced or eliminated due to established protocols such as research, surveys, and risk analysis. While non-explosive methods may be employed to lift and move these objects, some may need to be removed by explosive detonation.

Underwater detonation explosions generate sound waves with high pressure levels that could cause disturbance and injury to marine fauna. Applying the “As Low as Reasonably Practical” risk mitigation process will help direct the investigation to identify MEC/UXO. A desktop analysis to investigate and identify UXO in unmapped areas will reduce risks and will be completed prior to equipment installation. Therefore, the potential for impacts from MEC/UXO would be negligible to minor, localized, and temporary or short term. The impacts of noise from offshore wind development would be expected to be moderate.

Information on noise impacts for benthic invertebrates is limited, but for fish species with particle motion detection, a recent study (Popper et al. 2014) provides information on temporary thresholds (temporary threshold shift [TTS]) (hearing loss), using 229 decibel (dB) re 1 micropascal (μPa) for mortality or potential mortal injury. Fish with swim bladders and particle motion detection ability had high likelihood of recoverable impairment at near and intermediate distances from explosions, but low levels of TTS at intermediate distances, while fish without swim bladders (particle motion detection) had a low likelihood of recoverable injury at intermediate distances, moderate likelihood of TTS at intermediate distances, and low levels of both effects at far distances of a few kilometers.

Port utilization: Port utilization and maintenance are expected to increase and there are several port improvement projects within the region. Increases in port utilization due to other offshore wind projects would also lead to increased vessel traffic. This increase in vessel traffic would be at its peak during construction activities over a period of 5 years and would decrease during operations but increase again during decommissioning (see Table F2-1 in Appendix F). In addition, any port expansion and construction activities related to the additional offshore wind projects would add to the total amount of disturbed benthic area (see Section F.2.6 in Appendix F), resulting in disturbance and mortality of individuals and short-term to permanent habitat alteration. Existing ports are heavily modified or impaired benthic environments, and future port projects would likely implement best management practices (BMP) to minimize impacts (e.g., stormwater management and turbidity curtains). Increased vessel traffic around ports would also increase physical impacts of vessel operation including impacts of wakes on shallow and shoreline habitats as well as erosion, scour, and turbidity impacts from vessels operating in shallower inshore waters. Impacts of increased port utilization, however, would be negligible because the degree of impacts on benthic resources would likely be undetectable outside the immediate vicinity of port expansion activities.

Presence of structures: The presence of structures can lead to impacts on benthic resources through entanglement and gear loss or damage, hydrodynamic disturbance, fish aggregation resulting in increased predation on benthic resources, and habitat conversion. These impacts may arise from foundations, scour/cable protection, and buoys and meteorological towers. Installation of major structures other than those supporting offshore wind projects are not anticipated within the geographic analysis area. There is the potential for new small-scale structures such as docks and coastal infrastructure to be constructed. Using the assumptions in Appendix F, the foreseeable offshore wind scenario would include up to 324 new foundations, 231 acres (0.9 km^2) of foundation scour protection, and 55 acres (0.2 km^2) of new hard protection atop cables. In the geographic analysis area, structures are anticipated predominantly on sandy bottom, with the exception of cable protection, which is more likely to be needed where cables pass through hard-bottom habitats. Projects may also install more buoys and meteorological towers. BOEM anticipates that structures would be added intermittently over an assumed 5-year period (see Table F2-1 in Appendix F) and that they would remain until decommissioning of each facility is complete. The potential locations of cable protection for other offshore wind activities have not been fully determined at this time; however, any addition of scour protection/hard-bottom habitat would represent substantial new hard-bottom habitat, as the geographic analysis area is predominantly composed of sand, mud, and gravel substrates. It is notable, however, that any new structures would be in addition to existing anthropogenic structures within the four artificial reef areas present, at least in part, in the geographic analysis area.

Installation of these structures would result in direct mortality of benthic organisms within the footprint of disturbance, suspension of sediments, increased turbidity, and burial of benthic organisms in immediate proximity to foundations or below scour/cable protection. The presence of structures would increase the risk of gear loss or damage by entanglement. The lost gear, moved by currents, can disturb, injure, or kill benthic resources. The intermittent impacts at any one location would likely be localized and short term, although the risk of occurrence would persist as long as the structures and debris remain.

Human-made structures, especially tall vertical structures such as foundations, alter local water flow (hydrodynamics) at a fine scale by potentially reducing wind-driven mixing of surface waters or increasing vertical mixing as water flows around the structure (Carpenter et al. 2016; Cazenave et al. 2016; Segtnan and Christakos 2015). Increased mixing may also result in warmer bottom temperatures, increasing stress on some shellfish and fish at the southern or inshore extent of the range of suitable temperatures. Finfish aggregate trends along the mid-Atlantic shelf have been shifting northeast into deeper waters (NOAA 2022); the presence of structures may reinforce these trends. The consequences for benthic resources of such hydrodynamic disturbances are anticipated to be undetectable to small, to be localized, and to vary seasonally. Structures, including tower foundations, scour protection around foundations, and various means of hard protection atop cables, create uncommon vertical relief in a mostly soft-bottom landscape. Structure-oriented fishes would be attracted to these locations. Increased predation upon benthic resources by structure-oriented fishes could adversely affect benthic communities in the immediate vicinity of the structure. These impacts are expected to be local and to persist as long as the structures remain. Depending on the balance of attraction and production, newly placed structures may affect the distribution of fish and shellfish among existing natural habitat, artificial reef sites, and newly emplaced structures.

The presence of structures would also result in new hard surfaces that could provide new habitat for recruitment of hard-bottom species (Daigle 2011). The increased local density of fish and shellfish may result in changes to sediment quality through the bio-deposition of organic matter and sloughing off of shells and attached organisms from the structures. New structures also have the potential to facilitate range expansion of both native and nonnative aquatic species through the stepping-stone effect. Colonization and recruitment of marine fauna to structures can result in the dispersion and propagation of nonnative species, especially in nearshore habitats. Like other biofouling organisms, nonnative species might be transported to WTGs via construction and maintenance vessels (Bray et al. 2017; Wilding et al. 2017). Structures may serve as “stepping stones” that connect otherwise unconnected areas and provide a means for nonnative species to disperse and colonize new areas that may have previously been inaccessible due to biogeographical barriers (Adams et al. 2014; Wilding et al. 2017; Bray et al. 2017). Connectivity created among structures, especially where nonnative and invasive species may be present, can alter habitats and adversely affect native species, including federally protected species. At the scale of planned offshore wind activities, the artificial reef effect could lead to regional changes, including a shift from soft-sediment to hard-substrate communities and, potentially, intertidal communities (Causon and Gill 2018). Due to the pre-existing network of artificial reefs in the mid-Atlantic OCS, however, it is unlikely that additional structures would measurably increase the potential for this effect.

Soft bottom is the dominant habitat type in the region, and species that rely on this habitat would not likely experience population-level impacts (Guida et al. 2017; Greene et al. 2010). The potential effects of wind farms on offshore ecosystem functioning have been studied using simulations calibrated with field observations (Raoux et al. 2017; Pezy et al. 2018). These studies found increased biomass for benthic fish and invertebrates.

However, some impacts, such as the loss of soft-bottom habitat and increased predation pressure on forage species near the structures, may be adverse. In light of the above information, BOEM anticipates that the impacts associated with the presence of structures may be moderate adverse to moderate beneficial depending on the receptor. The impacts on benthic resources resulting from the presence of structures would persist at least as long as the structures remain.

Discharges: There would be increased potential for discharges from vessels during construction, operations, and decommissioning. Offshore-permitted discharges would include uncontaminated bilge water and treated liquid wastes. There would be an increase in discharges, particularly during construction and decommissioning when vessel traffic would be highest, and the discharges would be staggered over time and localized. Additionally, components of anti-fouling paints and anti-corrosives may leach into surface waters. Anti-corrosion and anti-biofouling contamination necessary to maintain offshore infrastructures can also result in contamination due to galvanic anodes emitting substantial amounts of metals, and organic coatings may release organic substances due to weathering or leaching (Kirchgeorg et al. 2018). Contaminations from chemical emissions may include organic compounds such as bisphenol A and metals such as aluminum, zinc, and indium from corrosion and biofouling protection measures and sacrificial anodes (Lloret et al. 2022). These substances are presently considered to have a low environmental impact, but monitoring data are not sufficient to assess the environmental impact of this new source (Lloret et al. 2022). Impacts would be negligible because there does not appear to be evidence that the volumes and extents anticipated would have any impact on benthic resources.

3.6.3.3. Conclusions

Impacts of the No Action Alternative. Under the No Action Alternative, existing environmental trends and ongoing activities would continue. Benthic resources would continue to respond to IPFs introduced by ongoing activities. BOEM anticipates ongoing activities, including climate change and seafloor disturbances caused by sediment dredging and fishing using bottom-tending gear, to result in negligible to moderate impacts (e.g., disturbance, injury, mortality, habitat degradation, habitat conversion) on benthic resources. The No Action Alternative would result in **negligible** to **moderate** impacts on benthic resources.

Cumulative Impacts of the No Action Alternative. BOEM anticipates that the impacts of planned activities other than offshore wind development such as increasing vessel traffic; increasing construction; marine surveys; port expansion; channel-deepening activities; and installing new towers, buoys, and piers would have minor impacts on benthic resources. BOEM expects planned offshore wind activities to have short-term to permanent impacts (e.g., disturbance, injury, mortality, habitat degradation, habitat conversion) on benthic resources, primarily through pile-driving noise, anchoring, new cable emplacement, and the presence of structures during operations of offshore facilities (i.e., foundations, cable, and scour protection). BOEM anticipates that the cumulative impacts of the No Action Alternative would be **moderate** adverse and could potentially include **moderate beneficial** impacts resulting from emplacement of structures (habitat conversion). Offshore wind activities are expected to contribute considerably to several IPFs, primarily new cable emplacement and the presence of structures, namely foundations and scour/cable protection.

3.6.4 Relevant Design Parameters and Potential Variances in Impacts for the Action Alternatives

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than those described in the sections below. The following proposed PDE parameters (Appendix E) would influence the magnitude of the impacts on benthic resources:

- The total amount of scour protection for the foundations, inter-array cables, and offshore export cable corridors that results in long-term habitat alteration;

- The installation method of the export cable in the offshore export cable corridors and for inter-array and inter-link cables in the Wind Farm Area and the resulting amount of habitat temporarily altered;
- The number and type of foundations used for the WTGs and OSS: Ocean Wind could construct a maximum of 98 WTGs (monopile foundations) and three OSS (monopile or piled jacket foundations);
- The methods used for cable laying and landfalls, as well as the types of vessels used and the amount of anchoring;
- The amount of pre-cable-laying dredging or preparation, if any, and its location; and
- The time of year when foundation and cable installations occur.

Variability of the proposed Project design exists as outlined in Appendix E. Below is a summary of potential variances in impacts:

- The number, size, location, and amount of scour protection for WTG and OSS foundations: The level of impact related to foundations is proportional to the number of foundations installed; fewer foundations would present less hazard to benthic organisms.
- Offshore export cable routes and OSS footprints: The route chosen (including variants within the general route) and OSS footprints would determine the amount of habitat affected.
- Season of construction: Spring and summer are the primary spawning seasons for many benthic invertebrates as well as fish that lay demersal eggs. Project activities during these seasons would likely have greater impacts due to localized disruption of these processes and impacts on reproductive processes and sensitive early life stages.

Ocean Wind has committed to using standard underwater cables that have electrical shielding to control the intensity of EMF (BENTH-02) to minimize impacts on benthic resources. Ocean Wind has also committed to conducting surveys to identify potentially sensitive seabed habitats (BENTH-01) and areas of SAV along the proposed cable routes (BENTH-03) (COP Volume II, Table 1.1-2; Ocean Wind 2023).

Ocean Wind has developed a benthic monitoring plan to document the disturbance and recovery of marine benthic habitat and communities resulting from the construction and installation of Project components, including WTG scour protection as well as the inter-array cabling and offshore export cable corridor from the Wind Farm Area to shore (Inspire 2022b). The benthic survey would focus on seafloor habitat and benthic communities and make comparisons to areas unaffected by construction of the Project. Surveys would occur pre-construction and during construction, and at roughly the same time of year in years 1, 2, 3, and 5 post-construction. Potential equipment used during benthic surveys includes remotely operated vehicles, high-resolution video and photography, and sediment grabs. The underwater noise effects generated by the proposed multibeam echosounder and sidescan sonar methods used for habitat monitoring would be similar to, but of lower magnitude than, the HRG survey methods described in the COP (Ocean Wind 2023).

Ocean Wind has developed a Submerged Aquatic Vegetation Monitoring Plan (Inspire 2022b) and Submerged Aquatic Vegetation Preliminary Mitigation Plan (Ocean Wind 2022) to conduct baseline delineations and document conditions of SAV beds, assess potential impacts on these SAV beds as a result of the construction and operations of the inshore export cable(s) associated with the Project, and track recovery of these SAV beds over time to inform potential mitigation strategies.

SAV impacts from construction and installation of the Oyster Creek inshore export cables will be restored or mitigated to the greatest extent practicable, as described in the SAV Preliminary Mitigation Plan (Ocean Wind 2022). The scope of the plan is a result of discussions with NJDEP, NMFS, and BOEM and an evaluation of previous SAV restoration projects within Barnegat Bay. Restoration of SAV beds in areas where they have previously existed, or in areas disturbed by activity, have proven difficult to re-establish due to a number of biotic and abiotic factors, e.g., water quality and channel dredging. Without identifying and controlling for these factors, restoration activities are likely to have poor success. Ocean Wind is proposing a 3:1 mitigation ratio consisting of mapping efforts, monitoring activities, restoration of documented impacts at an in-situ 1:1 ratio, supplementary restoration to achieve the 3:1 mitigation ratio, and research to improve SAV mitigation in the future. Potential impacts on SAV habitat are anticipated due to cable installation and anchoring/mooring activities.

As part of the SAV Preliminary Mitigation Plan, existing SAV beds in Barnegat Bay along the impact corridor and their condition would be mapped and documented, using imagery where possible, and potential restoration areas would be identified. Pre- and post- construction monitoring would follow methods described in the SAV Monitoring Plan (Inspire 2022b). Data collection to characterize community composition of SAV will occur within three regions, the western bay site of cable installation, Island Beach State Park as the eastern bay site of cable installation, and a control site (Seaside Park). In-water surveys will take place within the SAV growing season (May–October) starting in 2023 (pre-construction and post-construction) and continuing annually during post-construction monitoring (2024–2033). The plan also includes a site-specific SAV Restoration Plan to monitor and evaluate abiotic factors relevant to SAV growth at each site, direct and indirect impacts to modify the spatial extent of restoration via a 4-year monitoring program, adaptive management refinement, restoration implementation. and continued monitoring of restored areas. Reporting will provide updates on progress and recommend future actions and a final synthesis report would be completed at the conclusion of SAV mitigation (anticipated in 2032).

3.6.5 Impacts of the Proposed Action on Benthic Resources

3.6.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.6.8, *Impacts of Alternative E on Benthic Resources*.

The sections below summarize the potential impacts of the Proposed Action on benthic resources during the various phases of the Proposed Action. Routine activities would include construction, O&M, and decommissioning of the Project, as described in Chapter 2, *Alternatives*.

Accidental releases: Accidental releases of trash and debris are discussed in Section 3.6.3.2. The Proposed Action would likely have negligible to no impact on benthic resources with respect to accidental release of trash and debris because both BOEM and USCG prohibit the discharge or disposal of solid debris into offshore waters under most circumstances.

Accidental releases would continue to occur as a result of ongoing activities. All vessels associated with the Proposed Action would comply with USCG requirements for the prevention and control of oil and fuel spills. However, higher-volume spills of toxic materials could occur due to unanticipated events, such as a vessel allision with a WTG foundation. Impacts of accidental releases are relative to their magnitude. Smaller releases are expected to occur at a higher frequency and to be less severe, while major releases are expected to be rare but have more impacts. As discussed in Section 3.6.3, non-routine events such as oil or chemical spills, potentially amplified by the use of chemical dispersants, can have adverse or lethal effects on marine life. However, modeling by Bejarano et al. (2013) predicts that the impact of smaller spills on benthic fauna would be low. Larger spills are unlikely but could have a larger impact on benthic fauna due to adverse effects on water quality (see Section 3.21, *Water Quality*). The impacts of accidental releases on benthic resources are likely to be negligible because large-scale releases are unlikely and impacts from small-scale releases would be localized and short term, resulting in little change to benthic resources. In the unlikely event that accidental spills should occur, adverse impacts on benthic habitats could range from minor to moderate adverse in significance depending on the size of the spill and the nature of the materials involved.

Accidental releases of invasive species could affect benthic resources; the risk of this type of release would be increased by the additional vessel traffic associated with the Proposed Action, especially traffic from foreign ports, primarily during construction. The potential impacts on benthic resources are described in Section 3.6.3.2.

Anchoring: Vessel anchoring would cause short-term impacts in the immediate area where anchors and chains meet the seafloor. Impacts on benthic resources would be greatest for sensitive benthic habitats (e.g., eelgrass beds, hard-bottom habitats). In addition to the anchoring disturbance that would occur under the No Action Alternative, the incremental impact of anchoring under the Proposed Action would affect 19 acres (0.08 km^2). All impacts would be localized, turbidity would be temporary, and mortality from physical contact would be recovered in the short term. Where SAV is present within the Oyster Creek export cable route, additional short-term impacts would result from anchor placement and retrieval. While anchor placement and chain sweep may damage seagrass blades, anchor drag and retrieval are likely to damage or uproot seagrass rhizomes, which may take years to recover (Orth et al. 2017). To minimize anchoring impacts, Ocean Wind has committed to an Applicant-proposed measure (APM) to avoid anchoring on sensitive habitat during construction activities (GEN-08; COP Volume II, Table 1.1-2; Ocean Wind 2023). Impacts are anticipated to be minor to moderate.

EMF: During operation, powered alternating current transmission cables would produce EMF (Taormina et al. 2018). To minimize EMF generated by cables, all cabling under the Proposed Action would include electric shielding (BENTH-02; COP Volume II Table 1.1-2; Ocean Wind 2023). The strength of the EMF increases with electrical current, but rapidly decreases with distance from the cable (Taormina et al. 2018). Ocean Wind would also bury cables to a target burial depth of up to 4 to 6 feet (1.2 to 1.8 meters) below the surface, well below the aerobic sediment layer where most benthic infauna live. Target burial depths would be determined following detailed design and the CBRA (COP Volume I, Section 6.1.1.6; Ocean Wind 2023). In some areas, it is anticipated that cable would be unable to be buried to the target depth and would instead be placed on or near the seafloor with overlying cable protection. Impacts of EMF are anticipated to be greater where this occurs, as the distance between the cable and biological receptors would be reduced.

The scientific literature provides some evidence of faunal responses to EMF by marine invertebrates, including crustaceans and mollusks (Hutchison et al. 2018; Taormina et al. 2018; Normandeau et al. 2011). A recent study of impacts of offshore wind EMF on crabs and lobster (Harsanyi et al. 2022) found that chronic exposure to 2.8-millitesla EMF throughout embryonic development may affect larval mortality, recruitment, and dispersal. Currents between 850 and 1,600 amperes are commonly used in subsea power cables, which would consequently produce an EMF of up to 3.20 milliteslas (1,600 amperes) on the cable surface in a perfect wire.

Some reviews (Gill and Desender 2020 and Albert et al. 2020) indicate the relatively low intensity of EMF associated with marine renewable projects would not result in impacts. Effects of EMF may include interference with navigation that relies on natural magnetic fields, predator/prey interactions, avoidance or attraction behaviors, and physiological and developmental effects (Taormina et al. 2018). Studies on the effects of EMF on marine animals have mostly been restricted to commercially important species (Section 3.9). The consequences of anthropogenic EMF have not been well studied in benthic resources (Gill and Desender 2020; Albert et al. 2020; Snyder et al. 2019). However, the EMF field intensity decreases with distance from the cable and thus the benthic component and the sediment closest to the cables have the most exposure (Albert et al. 2020). Exponent (2018) suggests that benthic invertebrates with limited mobility and occurring outside the sediments in which cables are buried would not be affected by Project-associated EMF. However, a preponderance of evidence suggests that inter-array and export cables could produce sufficient EMF to have potentially adverse effects on bivalve physiology, although the specific sensitivity of specific shellfish species likely to occur in the cable path remains unclear, as described in the EFH Assessment.

In the case of mobile species, an individual exposed to EMF would cease to be affected when it leaves the affected area. An individual may be affected more than once during long-distance movements; however, there is no information on whether previous exposure to EMF would influence the impacts of future exposure. Potential effects of EMF on fish and some invertebrates are detailed in Section 5.4 of the EFH Assessment. Benthic species such as the Atlantic sea scallop, Atlantic surfclam, and ocean quahog are likely to be exposed to EMF and heat effects from offshore export cable operation. The maximum induced magnetic field generated of 76.6 milligauss would attenuate to 1 milligauss within 32.8 feet (10 meters) of the cable. However, because the export cable would be buried to a minimum depth of 4 to 6 feet (1.2 to 1.8 meters) along the majority of its length, heat effects on juvenile and adult clams and other benthic infauna over buried cable segments would likely be insignificant. Cable segments at the transitions between fully buried and exposed cable segments would be buried at shallower depths, potentially exposing quahog and surfclam habitat and other benthic infauna to adverse thermal effects. As stated, however, these areas would be covered by concrete mattresses and rendered unsuitable habitat for benthic infauna so the two effect areas are not additive. In the absence of additional data, impacts on these resources cannot be quantified for EMF. However, based on available data, BOEM expects localized and long-term impacts on benthic resources from EMF from the Proposed Action.

Cable emplacement and maintenance: The primary infauna of ridge and trough habitat are polychaetes in the U.S. Atlantic and Gulf of Mexico, although a greater diversity of dominant taxa is reported for the Atlantic coast (Brooks et al. 2005). The polychaete worm *Spio filicornis* had the highest species ranking by abundance, followed by the amphipods *Unciola irrorata* and *Ampelisca vadorum*, in the Lease Area. In the Mid-Atlantic Bight, infaunal assemblages and productivity differ between ridges and troughs (Byrnes et al. 2000; Slacum et al. 2010). For example, sand dollars and filter-feeding epibenthos were more prevalent on shoal crests than in troughs (VIMS 2000). Similarly, data results from sediment profile camera/plan view camera and video collected at the sand ridge area in June 2022 indicated presence of sand dollars at both crests and troughs, with a distinctly higher average density along the crests (Inspire 2022a). In addition, the trough portions (or flat bottom) of the habitat generally have greater abundance, species richness, and species diversity, as well as greater abundance of benthic finfish, pelagic finfish, and pelagic invertebrates than ridges (or shoals); ridges with steeper elevation gradients had greater abundance than those with more gradual elevation changes (Slacum et al. 2010). Consequently, impacts would likely be greater in portions of the Lease Area with a greater concentration of steeper ridge and trough habitats.

Bathymetry data from the Lease Area (Inspire 2022a) indicate steeper elevation gradients in the eastern portion of the Lease Area; in addition, recent studies of the sediments found greater homogeneity in sediments of ridge crests, compared with the troughs, which had sediment types ranging from very fine sand to sandy gravel (Inspire 2022a). Therefore, impacts on ridge and trough habitats may be greater in the northeastern portion of the Lease Area.

In inshore areas, sand wave clearance may be required to install cables at a sufficient depth that they would not be uncovered as a result of sand wave mobility. Sand waves documented in the Wind Farm Area have wavelengths of up to 1,640 feet (500 meters) and heights up to 4.9 feet (1.5 meters). Cable emplacement and maintenance activities may flatten depressions and small sand waves, temporarily reducing benthic habitat suitability for species such as red and silver hake within the cable footprint. Prey organisms that use these habitats would also be displaced, potentially affecting habitat suitability for fish species. Trenching may leave behind temporary depressions. The extent of these natural features is difficult to quantify, as they are continually reshaped by natural sediment transport processes. Natural recovery from anthropogenic disturbance is likely to occur within several months of the disturbance, depending on timing relative to winter storm events. Due to their mobility, it is expected that the sand wave profiles would rapidly return after cable installation. Although it is anticipated that hydrodynamics would be altered by the presence of structures, it is not expected that this would be to a degree that prevents the processes of sand wave formation and migration.

Cable laying and construction would also result in the resuspension and nearby deposition of sediments as discussed in Section 3.6.3.2. In areas where displaced sediment is thick enough, organisms may be buried, which could result in mortality. Benthic species have a range of susceptibility to sedimentation based on life stage, mobility, and feeding mechanisms. Sediment within the Wind Farm Area is generally medium- to coarse-grained with areas of gravelly sand and gravel deposits near the Wind Farm Area (COP Volume I, Section 2.1.2.2.1; Ocean Wind 2023). Based on the grain sizes evaluated for similar projects in Massachusetts, Rhode Island, and Virginia, the medium- to coarse-grained sand deposits near the Wind Farm Area are likely to settle to the bottom of the water column quickly and sand re-deposition would be minimal and close, estimated within 525 feet (160 meters) of the trench centerline (COP Volume I, Section 2.1.2.2.1; Ocean Wind 2023). Finer sediments within the export cable route, closer to shore and in back-bay areas, would stay suspended longer and potentially be transported farther depending on local currents. Based on modeling for a similar project (BOEM 2015), maximum deposition would still be anticipated nearest to the disturbance. Within 328 feet (100 meters) of the trench, deposition would not be expected to exceed 0.4 inch (1 centimeter). Substantial impacts on seagrass outside of the immediate vicinity of the cable due to sedimentation from the one-time installation of cables are unlikely. Seagrasses have vertical structure that can accommodate a degree of burial greater than would be expected from the one-time resuspension and settling of dredged material (Lewis and Erftemeijer 2006). As with other impacts related to disturbance of benthic habitat, benthic assemblages would be expected to recover in the short term, resulting in negligible impacts on benthic resources.

Cable emplacement activities would result in mortality, injury, or displacement of benthic fauna in the path of construction as well as possible damage to sensitive habitats such as SAV, which is present within the Oyster Creek export cable route, and low-density boulder fields, which are present in the Wind Farm Area and Oyster Creek export cable route. Under the Proposed Action, multiple landings on the western shore of Barnegat Bay and two export cable routes west of Island Beach State Park are under consideration for the Oyster Creek export cable route, with varying degrees of potential impacts on SAV. The seafloor would be disturbed by cable trenches, dredging (if required), anchoring, and cable protection. No disturbance or impacts are anticipated for beaches along any of the export cable routes. All beaches would be crossed by HDD at a minimum depth of 30 feet (9.1 meters). The BL England export cable route would pass under Crook Horn Creek to the south of Roosevelt Boulevard Bridge at Peck Bay via HDD. Entry/exit pits would be entirely within previously disturbed areas of the Roosevelt Boulevard right-of-way and SAV would not be affected (further detail provided in Section 3.22, *Wetlands*).

Two cable route options are proposed to cross Island Beach State Park and enter Barnegat Bay. The northern option, identified as the Prior Channel Route, reduces potential impacts on SAV beds by following a previously dredged channel. The depth and sediments of the approximately 122-foot-wide previously dredged channel is not conducive to supporting SAV growth and, as such, is largely devoid of SAV beds. HDD was considered for the Prior Channel Route, but the area needed for a 50-meter separation of the cables and adequate spacing for drills would extend beyond the channel and disturb adjacent SAV beds during cable installation. Other concerns include adequate room to reduce the risk of inadvertent returns of drilling fluids, and conflict with park operations due to the setback required for HDD for burial depth and avoidance of inadvertent returns from drilling fluids. Consequently, an open-cut method is proposed. For the southern route option, engineering constraints limit the maximum length of a potential HDD installation to approximately 360 meters, so HDD would require an exit pit location within intact SAV beds.

SAV impacts from construction and installation of the Oyster Creek inshore export cables would be restored or mitigated as described in the SAV Preliminary Mitigation Plan (Ocean Wind 2022).

BOEM expects the Proposed Action alone to lead to unavoidable, short- to long-term impacts on benthic resources from this IPF. Despite unavoidable mortality, damage, or displacement of invertebrate organisms, the area affected by the construction footprint for cable emplacement would be just 4 percent of the Wind Farm Area and the area affected within the export cable routes would similarly represent a small fraction of available benthic habitat. BOEM does not expect population-level impacts on benthic species (i.e., generally accepted ecological and fisheries methods would be unable to detect a change in population, which is the number of individuals of a particular species that live within the geographic analysis area) as a result of the Proposed Action. Benthic fauna would recolonize disturbed areas that have not been displaced by new structures in the short term (Byrnes et al. 2004). Within Barnegat Bay, emplacement of cables would have acute lethal impacts on benthic invertebrates, including shellfish such as the hard clam and bay scallop, within the footprint of disturbance. Ocean Wind estimates that cable emplacement for the Oyster Creek offshore export cable would result in up to 121 acres of benthic disturbance in shellfish habitat (COP Volume II Table 2.2.5-6; Ocean Wind 2023). Impacts may also result from associated sediment deposition and burial. Recovery of seagrass following benthic disturbance may occur over longer time frames, extending into long-term impacts over multiple years.

Offshore construction could also cause adverse impacts on benthic communities from loss or conversion of habitat. Based on the activities described in the COP, the Proposed Action could affect SAV in Barnegat Bay within the Oyster Creek export cable route. Monitoring of SAV around the Oyster Creek inshore export cable route is included in the benthic monitoring plan (GEN-06; COP Volume II Table 1.1-2; Ocean Wind 2023). Habitat features in the form of ridges and troughs, sand waves, and boulders (greater than 50 centimeters) are present in the Wind Farm Area and export cable route corridors; however, disturbance for cable emplacement would be temporary and short term. Ridge and trough formations are most conspicuous in the vicinity of 15 WTGs proposed in the northeastern portion of the Lease Area; impacts due to the foundations and installation of inter-array cable associated with these 15 WTGs would result in an estimated 728 acres of bottom impacts. Estimates of maximum impacts for sand wave (222 acres) and boulder clearance (2,220 acres) total 2,240 acres (refer to the EFH Assessment for more detail). Contractors and engineers for Ocean Wind would perform additional surveys and evaluation of geological conditions in the surface and shallow subsurface layers as a part of the CBRA (COP Volume I, Section 6.1.1.6; Ocean Wind 2023) prior to developing the precise route. Array cables would be installed via hydroplow where possible, with alternative methods to include surface lay, trenching, jetting, pre-plowing and plowing, vertical injection, and controlled-flow excavation as necessary. Several of these methods use water withdrawals that could entrain benthic larvae (MMS 2009). Due to the limited duration and area involved, BOEM does not expect population-level impacts. The consequences of increased turbidity caused by this IPF are discussed in Section 3.6.3.2.

Benthic recovery processes are relevant to understanding the likely duration of impacts on benthic resources. Neighboring benthic communities that have similar habitats and assemblages would recolonize disturbed areas. Succession would begin with more mobile, early-colonizer species with progression toward a mature assemblage over time. The restoration of marine soft-sediment habitats occurs through a range of physical (e.g., currents, wave action) and biological (e.g., bioturbation, tube building) processes (Dernie et al. 2003). Impacts and recovery times would vary depending on habitat types, which can generally be separated into the high-energy oceanic environment versus the low-energy estuarine environment. In general, physical processes are more important in high-energy environments, while biological processes dominate in low-energy environments. In high-energy environments, repopulation can often be largely attributed to bedload transport of adult and juvenile organisms. Recovery of invertebrate communities in low-energy environments is more dependent upon larval settlement and recruitment and adult migration. Therefore, rates of recolonization and succession can vary considerably among benthic communities. Recovery of the benthic species would likely require several months to a year or more (Dernie et al. 2003; Lewis et al. 2002). Recovery to a pre-construction state may take 2 to 4 years or more (Van Dalfsen and Essink 2001; Boyd et al. 2005). Fauna in dynamic environments are prone to natural sediment movement and deposition due to strong tidal currents and waves. Therefore, they are able to recover from disturbances more rapidly. Benthic meiofauna are known to recover from sediment disturbances more rapidly than the macrobenthos; recolonization up to pre-disturbance densities has occurred within weeks or less, and entire assemblages have recovered within 90 days (MMS 2009). Monitoring benthic function around cable installations is included in the benthic monitoring plan (GEN-06; COP Volume II Table 1.1-2; Ocean Wind 2023).

Although recovery times of invertebrates specific to disturbance from cable emplacement are not available, reported recovery times for sand removal (mining) from these habitats may offer some insight. Recovery times generally ranged from 3 months to 2.5 years at sand mining sites and varied by taxonomic group: polychaetes and crustaceans recovered most quickly (several months) while deep-burrowing mollusks were slowest to recover and occurred over several years (Brooks et al. 2005). Adverse impacts on infauna from sand removal were associated with depressions left in the sediments after dredging that collect fine sediments that may change the sediment composition (Byrnes et al. 2004), dredging during the peak recruitment period of spring and summer, and fragmentation of habitats that reduced opportunities for recolonization. Opportunistic species would likely colonize newly disturbed areas, followed by later successional species that have superior competitive abilities (Slacum et al. 2010). Adverse impacts from cable emplacement may affect ridge and trough habitats by reducing connectivity between and among ridge and trough areas, removal or alteration of sediments, and direct and indirect mortality of benthic invertebrates. Adverse impacts may be greater in ridge and trough habitats with steeper gradients, such as those in the northeastern portion of the Project area. Cable emplacement that results in depressions or fragmentation of habitat would be expected to have temporary, short- to long-term, negligible to minor impacts on the ridge and trough habitats, depending on the location of the cables. Habitats within the Oyster Creek inshore export cable route corridor are sand and mud with recent or historical SAV presence. Impacts from installation of the export cable would result from direct disturbance of benthic habitats, resuspension and nearby deposition of sediments, and emplacement of cable protection resulting in habitat conversion. Direct disturbance could result in the injury or mortality of organisms within the footprint of the export cable, primarily sessile or slow-moving benthic invertebrates such as hard clam and bay scallop, or non-motile early life stages such as the demersal, adhesive eggs and could damage SAV habitat present along both the eastern and western shorelines of Barnegat Bay. Benthic community structure is expected to recover rapidly, within a few months of the activity. Impacts from seabed disturbance due to open-cut trenching and HDD are anticipated to be localized and short term due to their temporary nature.

Ocean Wind has developed a SAV Monitoring Plan (Inspire 2022b) to document baseline delineations and conditions of SAV beds, assess potential impacts on these SAV beds as a result of the construction and operations of the inshore export cable(s) associated with the Project, and track recovery of these SAV beds over time to inform potential mitigation strategies. The proposed SAV Preliminary Mitigation Plan (Ocean Wind 2022) outlines Ocean Wind’s proposed process to ensure that any impacts on SAV incurred during construction and installation activities of the Ocean Wind 1 export cable that cannot be avoided or minimized are adequately mitigated. The recontoured area would be replanted with native wetland vegetation and would be monitored for a minimum of 5 years post-construction to confirm shoreline stabilization and adequate vegetative cover.

Ocean Wind has committed to a benthic monitoring plan (GEN-06; COP Volume II Table 1.1-2; Ocean Wind 2023) that would apply to construction, operations, and decommissioning. Monitoring would be implemented to ensure that environmental conditions are monitored and reasonable actions are taken to avoid and minimize seabed disturbance and sediment dispersion, which would minimize potential impacts on benthic resources. Actions to avoid and minimize seabed disturbance and sediment dispersion would require the same tools used in installation and would have similar impacts via disturbance to the seafloor (e.g., mortality, sedimentation). However, the disturbance would not exceed that caused by the initial installation and the affected area should be substantially smaller.

Bathymetric profiles indicate sand ridge heights are approximately 8 meters, with a length of approximately 1.5 kilometers (Ocean Wind 2022). A higher spatial resolution of baseline conditions of the benthic habitat across sand ridges, including troughs and crests, will be acquired prior to construction to document baseline conditions. Triplicate transects of sediment profile imaging/plan view stations will be set up across the sand ridge features to follow planned inter-array cable routes and transects perpendicular to cable corridors will also be surveyed. A total of 25 sediment profile imaging/plan view stations along each transect will be sampled and results analyzed. Baseline data will be collected, in the first calendar year post-installation (year 0) and at year 1 and year 2 during operation. After year 2, if benthic function measured with sediment profile imaging/plan view is indistinguishable from baseline conditions, no further monitoring will occur. Alternatively, if benthic function is impaired and differences between baseline and post-construction persist, monitoring would continue at defined intervals until the benthos resemble baseline conditions or are no longer impaired (up to a maximum of 5 years of monitoring). Greater detail on monitoring is provided in the EFH Assessment.

Ocean Wind's conservative estimate of detonation in place of up to 10 UXOs would result in temporary habitat loss, reduced water quality, and physical disturbance, harm, and mortality in fish and marine invertebrates, as described in Section 3.6.3.2 (noise from UXO detonations is discussed in the *Noise* IPF below). If necessary, detonations would occur on up to 10 different days and would not occur from January 1 through April 30 to avoid impacts on marine mammals. The acres of physical disturbance to the seafloor as a result of detonating the UXO have not been estimated.

During construction, cable emplacement and maintenance activities could lead to short-term impacts including habitat alteration, injury, and mortality; however, impacts on benthic resources would be negligible.

Noise: Activities associated with the Proposed Action that could cause underwater noise effects are impact pile driving (installation of WTGs and OSS), vibratory pile driving (installation and removal of cofferdams at landfall sites), geophysical surveys (HRG surveys), detonations of UXO, vessel traffic, aircraft, cable installation, dredging, and WTG operation. The natures of the impacts of noise from G&G surveys, WTG O&M, pile driving, cable burial or trenching, and UXO on benthic resources are described in Section 3.6.3.2. Noise, in terms of SPL, from vessel traffic, construction, pile driving, seismic surveys, G&G survey activities, O&M, and trenching/cable burial would contribute to impacts on benthic resources, as described in Section 3.6.3.2. Impacts of G&G activities would include localized disturbance associated with data collection, vessel operations, drilling noise, and other survey activities. These activities would be temporary, short term, and small compared to the size of the Lease Area, resulting in negligible impacts on benthic resources under the Proposed Action. Additional discussion specific to G&G-related noise impacts is presented in the Biological Assessment (BA) (BOEM 2022b) and Appendix C of the acoustic modeling report (Küsel et al. 2021).

The most substantial noise produced from the Proposed Action would be from pile driving during installation of up to 101 foundations. Given that most benthic species in the region are either mobile as adults or planktonic as larvae, disturbed areas (either through injury or mortality) would likely be recolonized naturally. The highest levels of noise from offshore wind occur during construction and are associated with pile driving for fixed-bottom turbine installation and UXO detonations; noise produced during operation of the wind farm is expected to be lower than during construction (SEER 2022). Marine invertebrates have been considered less susceptible than mammals and fish to loud noise and vibration because they generally do not possess air-filled spaces like swim bladders or middle ears; however, noise at the levels associated with pile driving has been reported to cause short-term behavioral responses in marine invertebrates within approximately 10 meters of the disturbance (Brand and Wilson 1996, after BOEM 2020b). If injury or mortality occurred to benthic organisms, the affected areas would likely be recolonized in the short term, and no population-level impacts would be expected (SEER 2022). Impacts would therefore be localized, short term, and minor. The Underwater Acoustic and Exposure Modeling Report (COP Volume II, Appendix R-2; Ocean Wind 2023) describes operational noise as low frequency (60 to 300 Hz) and of relatively low SPLs. It concludes that, "It is unlikely that WTG operations will cause injury or behavioral responses to marine fauna, so the risk of impact is expected to be low."

Overall, impacts on benthic resources from noise are anticipated to be localized and short term, and may be negligible to minor, depending on the duration of activities. The most impactful sub-IPFs for noise are pile driving and UXO detonation; the impacts would be proportional to the number of piles being driven and the number of UXOs being detonated. The Proposed Action includes installation of up to 101 foundations. The number of UXO detonations is estimated at ten and to occur over shorter periods of time than monopile installation, resulting in a smaller overall impact when compared with pile driving.

Port utilization: The Proposed Action would not directly result in any port expansion or construction activities and would therefore not have direct impacts on benthic resources from these activities. Likewise, any port improvements are not dependent on the Proposed Action being analyzed in this EIS. However, multiple projects are proposed to increase port capacity that may support the Proposed Action (see Section F.2.6 in Appendix F). Impacts on benthic resources from port construction or upgrades would be local to those ports and would support not just the Proposed Action but other offshore wind projects and general maritime activity as well. Any increase in port utilization would be highest during construction, minor during operation, and moderate during decommissioning. Impacts on benthic resources would be localized and minor.

Presence of structures: Under the Proposed Action, the presence of structures could result in various impacts. The natures of these impacts on benthic resources are described in Section 3.6.3.2. The Proposed Action could result in up to 101 foundations and 255 acres (1.0 km^2) of scour (84 acres) and cable (171 acres) protection that could cause temporary to permanent impacts of the types discussed in Section 3.6.3.2. Bathymetry data from the Lease Area (Inspire 2022a) indicate steeper-elevation gradients in the eastern portion of the Lease Area. Therefore, impacts on ridge and trough habitats may be greater in the northeastern portion of the Lease Area. However, based on the 2022 benthic survey (Inspire 2022a), the vast majority of the impacts would be on soft-bottom habitat, with a small portion of impacts on complex (inclusive of coarse) habitats. Impacts from the foundations and inter-array cable protection (if needed) associated with the 15 WTGs in the northeastern portion of the Lease Area, where impacts on ridge and trough habitats may be greater, would affect an estimated 728 acres of sea bottom. The presence of inter-array cable protection and WTGs (foundations and scour protection) may alter the vertical relief and bottom complexity important to forage species and serve as a refuge for prey. The presence of novel structures and hard substrates within the ridge and trough system could affect these ecosystem dynamics that support a more complex habitat and more diverse benthic and demersal fish assemblages. Impacts may include reduced habitat complexity and biodiversity as well as potential loss of trophic linkages between invertebrate and demersal fish assemblages that characterize these habitats. Impacts on benthic invertebrate assemblages can subsequently affect fish and shellfish assemblages, as described by Vasslides and Able (2008) and Slacum et al. (2010).

The presence of WTGs is expected to result in wind-wake alterations in and around the Wind Farm Area. Some authors have suggested this could result in changes to ocean stratification (mixing) that can reduce nutrient supplies to the surface ocean and alter net primary productivity. Numerical modeling by Daewel et al. (2022) shows the associated wind wakes in the North Sea provoke large-scale changes in annual primary production with local changes of up to ±10% not only at the offshore wind farm clusters, but also distributed over a wider region. Model simulations by Christiansen et al. (2022) show the emergence of large-scale wake effects that lead to changes in vertical and lateral flow sufficient to affect stratification in the southern North Sea and eventually enhance the stratification during the decline of the summer stratification toward autumn (more detail on the impacts of wind wake is presented in Section 3.13, *Finfish, Invertebrates, and Essential Fish Habitat*). Importantly, net primary productivity is driven by photosynthesis in marine phytoplankton and accounts for half of global-scale photosynthesis and supporting major ocean ecosystem services (Field 1998). There are few empirical data showing the impact of WTGs on ocean stratification (Tagliabue et al. 2021), although recent models have demonstrated ocean mixing as a result of the wind-wake effect of WTGs in the North Sea (Carpenter et al. 2016; Floeter et al. 2017; Dorrell et al. 2022). Preliminary results from Chen et al. (2021) demonstrate the turbulent mixing in and around WTGs and subsequent significant reductions in horizontal larval dispersion and increased offshore dispersal. Model results suggest these changes could alter larval abundance in the Nantucket Lightship Closed Area off the southern New England coast (Chen et al. 2021). Hydrodynamic modeling to examine the impacts of WTGs on fish larvae in the Mid-Atlantic Bight showed changes in depth-averaged currents, wave height, and temperature associated with various build-out scenarios; however, subsequent shifts were not considered overly relevant to larval settlement in the three fish species examined (Johnson et al. 2021). However, interannual changes in net primary productivity in the North Atlantic are poorly correlated with parallel changes to stratification and emphasize the importance of other physical mechanisms, especially the Gulf Stream (Tagliabue et al. 2021). Potential impacts on net primary productivity in the North Atlantic from the Proposed Action may occur but, without additional data, impacts are considered negligible when compared with the effects of the Gulf Stream.

Once construction is complete, the presence of the WTG and OSS foundations could result in some alteration of local water currents, which could produce sediment scouring and alter benthic habitat. Local changes in scour and sediment transport close to a foundation may alter sediment grain sizes and benthic community structure (Lefaible et al. 2019), though this impact is expected to be minimal due to the use of scour protection for each foundation. These effects, if present, would exist for the duration of the Proposed Action and would be reversed only after the Project has been decommissioned, although they may be permanent if scour protection is left in place.

The presence of structures would also result in new hard surfaces that could provide new habitat for recruitment of hard-bottom species and structure-oriented communities (Daigle 2011). Soft bottom is the dominant habitat type in the region, and species that rely on this habitat would not likely experience population-level impacts (Guida et al. 2017; Greene et al. 2010). Results from ecosystem models that incorporate survey data indicate increased diversity and biomass for benthic fish and invertebrates around foundation structures in the offshore environment (Lefaible et al. 2019; Raoux et al. 2017; Pezy et al. 2018). This indicates that offshore wind farms can generate some beneficial impacts on local ecosystems. However, some impacts such as the loss of soft-bottom habitat may be adverse depending on the resource affected. BOEM anticipates that the impacts associated with the presence of structures would be long term and minor to moderate beneficial. The impacts on benthic resources resulting from the presence of structures would persist as long as the structures remain. Monitoring the colonization and succession of epifauna on novel surfaces (foundations, scour protection, and cable protection) as well as enrichment of surrounding soft-bottom habitats is included in the benthic monitoring plan (GEN-06; COP Volume II Table 1.1-2; Ocean Wind 2023).

The presence of structures would increase the risk of gear loss or damage by entanglement. The lost gear, moved by currents, can disturb, injure, or kill benthic resources. The impacts at any one location would likely be localized and short to long term, although the risk of occurrence would persist as long as the structures and debris remain. Overall, this is anticipated to have a minimal impact on benthic resources.

Discharges: The Proposed Action would result in an increased potential for discharges from vessels during construction, operations, and decommissioning. Offshore permitted discharges would include uncontaminated bilge water and treated liquid wastes. There would be an increase in discharges and chemical emissions, particularly during construction and decommissioning, and the discharges would be staggered over time and localized. Impacts on benthic resources from vessel discharges, if any, would be localized, short term, and negligible. Discharges may also include anti-corrosion and anti-biofouling contamination, the release of organic substances, and chemical emission from corrosion and biofouling protection measures (described in Section 3.6.3). These substances are presently considered to have a low environmental impact, but monitoring data are not sufficient to assess the environmental impact of this new source (Lloret et al. 2022). Impacts would be negligible because there does not appear to be evidence that the volumes and extents anticipated would have any impact on benthic resources.

3.6.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned activities.

Accidental releases: The Proposed Action would contribute an undetectable increment to the cumulative impacts of accidental releases, which would likely be negligible and short term. Most of the risk of accidental releases of invasive species comes from ongoing activities, and the impacts (mortality, decreased fitness, disease) due to other types of accidental releases are expected to be negligible and short term.

Anchoring: Cumulative anchoring impacts could collectively affect up to 293 acres (1.2 km^2) (although some of this may occur after the resource has recovered from the earlier impacts). Degradation of sensitive habitats such as SAV or hard-bottom habitats, if it occurs, could be long term to permanent. Therefore, the Proposed Action would contribute a noticeable increment to the minor to moderate anchoring impacts on benthic resources that could occur.

EMF: The undetectable incremental impact contributed by the Proposed Action would slightly increase the impacts of EMF in the geographic analysis area beyond those described under the No Action Alternative. However, the cumulative impact on benthic resources would likely still be minor and localized but long term.

Cable emplacement and maintenance: Locations, amounts, and timing of dredging for other offshore wind projects are not known at this time. Assuming the areal extent of such impacts is proportional to the length of cable installed (see Table F2-1 in Appendix F), such impacts from offshore wind activities would likely be on the order of 4.3 times more than under the Proposed Action. Additional impacts from this IPF may result from other non-offshore wind projects and maritime activities.

The Proposed Action would contribute a noticeable increment to cumulative impacts on benthic resources (i.e., disturbance, injury, and mortality) from new cable emplacement associated with other projects in the geographic analysis area. Cable emplacement and maintenance under the Proposed Action is estimated to affect up to 1,935 acres (7.8 km^2) of seafloor within the export cable routes and 1,850 acres (7.5 km^2) in the Wind Farm Area. This would be in addition to the impacts caused by cable emplacement and maintenance described under the No Action Alternative. Although cable routes and lengths for other offshore wind projects are not known at this time, using the assumptions in Appendix F, the total seafloor disturbance from new cable emplacement under the Proposed Action and other offshore wind projects is estimated to be 8,424 acres (34.1 km^2). In most locations, the affected areas are expected to recover naturally, and impacts would be short term because seabed scars associated with jet plow cable installation are expected to recover in a matter of weeks, allowing for rapid recolonization (MMS 2009). Mechanical trenching, which could be used in coarser sediments, could result in more intense disturbances and a greater width of the impact corridor, and is also expected to recover naturally. Overall impacts of cable emplacement on benthic habitats are anticipated to be negligible to moderate, depending on the location and the method of cable emplacement. Most adverse impacts would be avoided and adverse impacts that do occur would be temporary or short term in nature.

Noise: The Proposed Action includes installation of up to 101 foundations while other planned offshore activities include an additional 323 foundations. The Proposed Action would contribute an undetectable increment to the cumulative noise impacts because construction of the Proposed Action would have minimal overlap with construction of other offshore wind projects in the geographic analysis area and there would be limited potential for combined impacts on benthic resources.

Port utilization: The Proposed Action would contribute an undetectable increment to the cumulative impacts of increased port utilization on benthic resources, which would likely be negligible.

Presence of structures: There are two other offshore wind projects proposed in the geographic analysis area with up to an additional 324 foundations and 593 acres (2.4 km^2) of scour (231 acres) and cable protection (362 acres). The Proposed Action would contribute a noticeable increment to the cumulative impacts on benthic resources, which likely would be long term and moderate adverse to moderate beneficial.

Discharges: Maritime activity including offshore development, recreation, and shipping would likely increase in the foreseeable future. The Proposed Action would contribute an undetectable increment to the cumulative impacts of discharges wind on benthic resources, which would be negligible.

3.6.5.3. Conclusions

Impacts of the Proposed Action. Activities associated with the construction and installation, O&M, and conceptual decommissioning in the Wind Farm Area and export cable route corridors would affect benthic resources by causing temporary habitat disturbance; permanent habitat conversion; and behavioral changes, injury, and mortality of benthic fauna. BOEM anticipates the impacts resulting from the Proposed Action would range from **negligible** to **moderate** adverse to **moderate beneficial**. Accidental releases, discharges, and EMF would result in negligible impacts; cable emplacement, noise, and port utilization would result in minor impacts; anchoring would result in minor to moderate impacts; and the presence of structures would result in minor to moderate beneficial impacts. The most prominent IPFs are expected to be new cable emplacement, noise from pile driving, anchoring (particularly where it may affect SAV), and the presence of structures. In general, the impacts are likely to be local and to not alter the overall character of benthic resources in the geographic analysis area. Despite benthic mortality and temporary or permanent habitat alteration, BOEM expects the overall impact on benthic communities would be minor, because most adverse impacts that do occur would be temporary or short term in nature.

Cumulative Impacts of the Proposed Action. The incremental impacts contributed by the Proposed Action to the cumulative impacts on benthic resources would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts from the Proposed Action would be **moderate** and **moderate beneficial** for benthic resources in the geographic analysis area. The main drivers for this impact rating are bottom disturbance including the emplacement of cables/structures and the long-term presence of structures and scour/cable protection. The Proposed Action would contribute to the cumulative impact rating primarily through temporary impacts due to new cable emplacement and permanent impacts from the presence of structures (i.e., cable protection measures and foundations).

BOEM has considered the possibility of a significant impact resulting from invasive species and considers it unlikely; this level of impact could occur if an invasive species were to adversely affect benthic ecosystem health or habitat quality at a regional scale. While it is an impact that should be considered, it is also unlikely to occur and the incremental increase in this risk due to the Proposed Action is negligible. While moderate adverse impacts are anticipated from the Proposed Action, most resources would likely recover in the short term when the affecting agents were gone, with or without the use of remedial or mitigating actions. Although some of the proposed activities, IPFs, or both analyzed could overlap, BOEM does not anticipate that this would alter the impact rating.

Table 3.6-2 Maximum Design Impacts on Benthic Resources

Project Component	Duration	Project Element	Impact (acres)[1]				
			Maximum Impact				Anticipated Impact[2]
			Complex Habitat	Heterogenous Complex Habitat	Soft Bottom	Total	Total
WTG & OSS Foundations	Permanent	Foundations	1.6	0.05	4.36	6.01	Up to 7
		Foundation Scour Protection	6.2	0.7	29.7	36.57	Up to 37
	Temporary	WTG & OSS Seafloor Disturbance	651.3	54.2	4,030.0	4,735.5	Up to 474
Array & Substation Interconnection Cables	Permanent	Cable Protection	25.79	0.75	148.04	174.58	Up to 24
	Temporary	Cable Installation and Seafloor Preparation	214.25	6.25	1,232.89	1,453.39	Up to 2,035
BL England Offshore Export Cable & 35th Street Landfall	Permanent	Cable Protection	0.3	0	23.7	24.0	Up to 4
	Temporary	Cable Installation & Seafloor Preparation	2.3	0	198.0	200.3	Up to 320
		Cofferdam Excavation & Anchoring	1.3	0	22.5	23.8	Up to 5
Oyster Creek Offshore & Inshore Export Cable & Landfalls at Island Beach State Park and at the farm	Permanent	Cable Protection	66.36	0	80.41	146.77	Up to 17
	Temporary	Cable Installation & Seafloor Preparation	554.57	0	673.96	1,228.53	Up to 1,430
		Cofferdam Excavation & Anchoring	26.93	0	28.51	55.44	Up to 12

[1] Maximum acreages as presented in Attachment 1 of the *Ocean Wind Offshore Wind Farm Benthic Habitat Mapping and Benthic Assessment to Support Essential Fish Habitat Consultation*. Assumptions, context, and additional information are presented within the source table.
[2] Actual temporary impacts may be based on additional assumptions such as percentage of area to be affected or PDE maximums.

3.6.6 Impacts of Alternatives B and C on Benthic Resources

Impacts of Alternatives B and C. Alternatives B-1 and B-2 would remove up to 19 WTG from the two most shoreward (northwest) rows within the Wind Farm Area to reduce visual impacts.

Under Alternatives B-1 and B-2, the extent of permanent and temporary impacts would be reduced when compared with the Proposed Action, with the greater reduction occurring under Alternative B-1 (Table 3.6-3). Alternatives B-1 and B-2 would remove up to 19 WTGs from the two most shoreward (northwest) rows within the Wind Farm Area to reduce visual impacts. These alternatives would predominantly reduce impacts on soft-bottom habitats (Table 3.6-4). Although acres of total permanent impacts were lower for Alternative B-2 when compared with other alternatives, impacts on heterogeneous complex and complex habitat types were greater than those estimated for Alternative D (Table 3.6-4). Impacts on soft-bottom habitat were somewhat reduced for Alternative B-2 when compared with the Proposed Action and the other alternatives. Alternatives B-1, B-2, C-1, and C-2 had fewer acres of impacts on complex habitat but impacts on heterogeneous complex habitats for these alternatives were similar to impacts under the Proposed Action.

Under Alternative C-1, up to eight WTGs (the entirety of the most northeast row of WTGs) would be relocated to the northwest boundary of the Lease Area, and under Alternative C-2 the array of WTGs would be compressed such that inter-row spacing would be reduced. Alternative C-1 is a relocation of structures and would shift approximately 0.6 acre of permanent impacts from soft-bottom habitat to complex habitat. Alternative C-2 would involve minor shifts in structure locations; permanent habitat impacts are not expected to appreciably change from those of the Proposed Action.

For these alternatives, no changes would be made to the export cable routes; therefore, there would be no changes to impact evaluations outside the Wind Farm Area. Prior to construction of these alternatives, additional geotechnical or engineering surveys (necessary to determine the new WTG placements) may result in a small, temporary increase in vessel use and bottom disturbance (with associated impacts as described in Section 3.6.5) unaccounted for in the Proposed Action. BOEM anticipates that this disturbance would be short term and localized, particularly compared to other proposed Project activities, and have minimal incremental impacts on benthic resources relative to the Proposed Action.

Table 3.6-3 Maximum Potential Impacts (acres) on Benthic Habitat from WTG and OSS Foundations under Alternatives B-1, B-2, C-1, C-2,[1] and D

Alternative	Permanent		Temporary	Total
	Foundations	Scour Protection	Seafloor Disturbance	
Proposed Action	6.01	36.57	4,735.51	4,778.09
B-1	5.8	33.13	4,318.49	4,357.42
B-2	5.56	29.47	3,837.19	3,872.22
C-1	6.0	36.42	4,751.67	4,794.09
C-2	6.01	36.42	4,751.66[2]	4,794.09[2]
D	5.66	30.93	4,029.71	4,066.3

[1] Maximum acreages as presented in Attachment 1 of the *Ocean Wind Offshore Wind Farm Benthic Habitat Mapping and Benthic Assessment to Support Essential Fish Habitat Consultation*. Assumptions, context, and additional information are presented within the source table.
[2] Alternative C-2 is not evaluated in the source table. No difference is expected for permanent impacts, as the number of foundations would not change. Seafloor disturbance is expected to be slightly lower based on the reduction of WTG spacing in this alternative.

The removal of up to 19 WTGs from the Wind Farm Area under Alternatives B-1, B-2, or C-1 would proportionally reduce the area permanently affected by foundations and scour protection, although Alternative C-1 appears to have a minor reduction, as shown in Table 3.6-3. This removal of WTGs as well as the reduction of spacing between WTGs under Alternative C-2 would similarly reduce the total area of disturbance due to removal or reduction of required inter-array cables. Under Alternative C-1, if WTGs were relocated as opposed to removed, there would likely be a comparable total area of benthic impacts relative to the Proposed Action (subject to re-routing of inter-array cables). Alternative C-1 would also reduce the number of WTG and associated inter-array cables from within ridge and trough features in the northeast Lease Area. For Alternatives B-1, B-2, C-1, and C-2, the overall impact ratings associated with each of these alternatives are anticipated to be the same as under Proposed Action. The most substantial difference would be relative to the presence of structures, which would be reduced by as many as 19 foundations, although overall impacts from the presence of structures would have an equivalent impact rating.

Cumulative Impacts of Alternatives B and C. The incremental impacts contributed by these alternatives to the overall impacts on benthic resources would be similar to those under the Proposed Action. This impact rating is driven mostly by ongoing activities, such as climate change and bottom-tending fishing gear, as well as by the construction, installation, and presence of offshore wind structures.

3.6.6.1. Conclusions

Impacts of Alternatives B and C. The anticipated **negligible** to **minor** impacts and **moderate beneficial** impacts associated with Alternatives B-1, B-2, C-1, and C-2 would not be substantially different than those of the Proposed Action. While these action alternatives could slightly change the impacts on benthic resources, ultimately the same, or highly similar, construction, operation, and decommissioning impacts would still occur, with the most pronounced being related to foundation and cable emplacement, bottom disturbance, and the presence of structures. These alternatives may result in slightly less, but not significantly different, impacts on benthic resources relative to those described under the Proposed Action.

Cumulative Impacts of Alternatives B and C. The incremental impacts contributed by the alternatives to the cumulative impacts on benthic resources would range from undetectable to noticeable. Incremental impacts on benthic resources would be slightly less due to fewer WTGs or shorter inter-array cables but not substantially different from those of the Proposed Action. BOEM anticipates that Alternatives B-1, B-2, C-1, and C-2 when each combined with the impacts from ongoing and planned activities including offshore wind would result in **moderate** and **moderate beneficial** impacts on benthic resources in the geographic analysis area.

3.6.7 Impacts of Alternative D on Benthic Resources

Impacts of Alternative D. Alternative D would remove up to 15 WTGs from the northeastern corner of the Wind Farm Area to reduce impacts on sand ridge and trough features. Removing these WTGs would reduce impacts on the ridge and trough habitats. Slacum et al. (2010) concluded that steeper gradients are characterized by greater abundance of benthic finfish, pelagic finfish, and pelagic invertebrate and the flat-bottom habitats also have been reported to have more benthic invertebrates than the shoals themselves, which suggests that the gradient of productivity may represent an ecotone across these habitats. Impacts on benthic habitats from wind farm components are compared for Alternatives A through D in Table 3.6-4.

Overall, acres of impacts on heterogeneous complex and complex habitat under this alternative would be lower than all other action alternatives. Acres of impacts on soft-bottom habitat would be similar to acres of impacts for the Proposed Action. Differences due to inter-array cables are not apparent in calculations

(Alternative E is not included because it varies only between Island Beach State Park and landfall and may be combined with any of the other alternatives; impacts on SAV are presented for Alternative E in Section 3.6.8, below).

The sand ridge and trough features are stable features that provide habitat complexity and are common throughout the eastern OCS (Rutecki et al. 2014). Troughs are characterized by finer sediments and higher organic content, while ridges are characterized by coarser sediments. These characteristics subsequently influence infauna and meiofaunal assemblages, which subsequently may influence assemblages of higher trophic-level fish and shellfish. These features aid in trophic interactions, linking planktonic communities and higher-level predators. Sand ridges provide vertical relief and bottom complexity that are important to forage species and serve as a refuge for prey. The presence of novel structures and hard substrates within the ridge and trough system could affect these ecosystem dynamics.

Under Alternative D, impacts would be reduced from the Proposed Action due to as many as 15 fewer foundations (less foundation and scour protection) and fewer miles of inter-array cable would be required. Permanent impacts on complex habitat (NOAA habitat complexity category) would be reduced and soft-bottom habitat impacts would increase under Alternative D (Table 3.6-4). This would primarily reduce impacts (both adverse and beneficial) associated with the presence of structures and conversion of habitat from existing bottom to scour protection.

Other IPFs associated with installation (primarily anchoring and bottom disturbance) would similarly be reduced proportionally to the reduction in infrastructure required. Avoidance of the sand ridge and trough features would potentially benefit benthic communities, as they serve as a structural complex important in mediating physical and mechanical forces, predation, and providing refuge, resting, feeding, and spawning habitat. These sand ridge and trough complexes are generally characterized by higher fish production, benthic faunal density, and species diversity than adjacent benthic habitats.

Table 3.6-4 Comparison of Maximum Potential Impacts (acres) on Benthic Habitat from WTGs and Inter-array Cables under Alternatives A, B, C, and D

Project Component	Impact	Maximum Impact (acres)			
		Complex Habitat	Heterogenous Complex Habitat	Soft Bottom	Total
Inter-array Cables					
A–D	Protection (long-term)	25.48	0.75	141.78	169.48
	Installation (short-term)	211.48	6.25	1,180.61	1,410.67
Wind Turbine Generators					
A	Foundation	0.4	0.05	1.90	2.33
	Scour Protection	6.0	0.7	29.1	35.98
	Seafloor Disturbance	640.4	54.2	4,004.9	4,037.1
B-1	Foundation	0.3	0.1	1.8	2.12
	Scour Protection	5.2	0.7	26.6	32.54
	Seafloor Disturbance	622.2	54.3	3,607.0	3,635.3
B-2	Foundation	0.3	0.1	1.	1.88
	Scour Protection	5.0	0.7	23.1	28.88
	Seafloor Disturbance	576.0	54.3	3,172.0	3,196.7
C-1 and C-2	Foundation	0.3	0.1	1.9	2.32
	Scour Protection	5.7	0.7	29.4	35.83
	Seafloor Disturbance	696.8	54.3	3,965.6	3,997.0

Project Component	Impact	Maximum Impact (acres)			
		Complex Habitat	Heterogenous Complex Habitat	Soft Bottom	Total
D	Foundation	0.3	0.05	1.68	1.98
	Scour Protection	4.3	0.7	25.3	30.34
	Seafloor Disturbance	512.2	51.2	3,431.3	3,458.3

[1] Maximum acres as presented in *Ocean Wind EFH Assessment*, updated October 2022.

Cumulative Impacts of Alternative D. The incremental impacts contributed by Alternative D to cumulative impacts would be similar to those of the Proposed Action. This impact rating is driven mostly by ongoing activities, such as climate change and bottom-tending fishing gear, as well as by the construction, installation, and presence of offshore wind structures.

3.6.7.1. Conclusions

Impacts of Alternative D. The anticipated **negligible** to **minor** impacts and **moderate beneficial** impacts associated with Alternative D would not be substantially different than those of the Proposed Action with respect to most habitat types. Alternative D would eliminate impacts associated with installation, maintenance, and decommissioning of 15 new structures and associated inter-array cables on the ridge and trough formations and their associated benthic assemblages. The area that would be avoided is approximately 16 square miles (10,240 acres) and includes three ridge/trough formations.

Impacts on benthic resources in the remainder of the Wind Farm Area and export cable route corridors would not change. The most pronounced impacts on benthic resources would be related to foundation and cable emplacement, anchoring (particularly where it may affect SAV), and the presence of structures. This alternative may result in reduced impacts on heterogeneous complex habitat and benthic resources relative to those described under the Proposed Action but would have nearly the same overall acres of impacts on the seafloor as the Proposed Action.

Cumulative Impacts of Alternative D. The incremental impacts contributed by Alternative D to the cumulative impacts on benthic habitat would range from undetectable to noticeable. BOEM anticipates that the impacts of Alternative D when combined with ongoing and planned activities including offshore wind would be **moderate** and **moderate beneficial**. Incremental impacts on benthic resources would be slightly less due to fewer WTGs and inter-array cables within the ridge and trough formations but not substantially different from those of the Proposed Action.

3.6.8 Impacts of Alternative E on Benthic Resources

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. Under Alternative E, the Oyster Creek export cable route in the vicinity of Island Beach State Park would be limited to the northern option (Prior Channel Route) developed to minimize impacts on SAV in Barnegat Bay. This route would make landfall on Island Beach State Park and continue north before entering Barnegat Bay at a location where SAV impacts along the eastern shore of the bay could be minimized. Alternative E would continue to affect SAV at the landfalls on the western shore of Barnegat Bay, consistent with the Proposed Action. Table 3.6-5 compares the estimated acreage of SAV that could be affected under both route options based on five different data sources from 1979, 1985–1987, 2003, 2009, and from Ocean Wind's surveys. Although the acreage of SAV potentially affected by Alternative E would be reduced compared to the Proposed Action if Ocean Wind elected to use the southern crossing option (Table 3.6-5), recovery of seagrass where it is affected could still take multiple years.

Table 3.6-5 SAV Impacts of Alternative E Compared to the Proposed Action

Data	Proposed Action: Southern ECR Option (Acres)	Alternative E: Northern ECR Option (Acres)
1979 Data	15.25	0.89
1985–1987 Data	13.17	14.01
2003 Data	11.78	1.8
2009 Data	13.86	8.35
Ocean Wind Survey Data	15.25	0.89

Source: Ocean Wind 2023.
ECR = export cable route

Alternative E would have the same number of WTGs as the Proposed Action but a slightly different cable route to avoid SAV and would still require trenching except where trenchless methods are implemented. Impacts of Alternative E on benthic resources such as SAV would be reduced compared to the Proposed Action. However, impacts on benthic resources from other IPFs would be the same as for the Proposed Action.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts on benthic resources would be similar to that of the Proposed Action. The main drivers for benthic impacts are bottom disturbance from cable emplacement, the installation of structures, and placement of scour and cable protection in combination with other ongoing and planned activities.

3.6.8.1. Conclusions

Impacts of Alternative E. The anticipated impacts associated with Alternative E would be similar to those of the Proposed Action but impacts on SAV within Barnegat Bay would be greatly reduced. Impacts on benthic resources in the remainder of the export cable route corridors and Wind Farm Area would be slightly higher than those of the Proposed Action, with the most pronounced impacts being related to foundation and cable emplacement, anchoring, and the presence of structures. Offshore impacts would be slightly greater based on a larger Oyster Creek export cable route footprint than under the Proposed Action. This alternative may result in less, but not significantly different, impacts on benthic resources relative to those described under the Proposed Action based on the lower acreage of SAV potentially affected (Table 3.6-5). Moderate impacts would still be associated with the presence of structures in the Wind Farm Area. However, this alternative would result in substantial reduction in impacts on SAV, primarily due to the revised cable alignment and use of HDD to avoid SAV impacts. BOEM anticipates the impacts resulting from Alternative E alone would range from **negligible** to **minor**, including the presence of structures, which may result in **moderate beneficial** impacts.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts on benthic resources would be undetectable to noticeable. Incremental impacts on benthic resources from Alternative E would be lower than those of the Proposed Action based on SAV avoidance. BOEM anticipates that the impacts associated with Alternative E when combined with the impacts from ongoing and planned activities including offshore wind would be **moderate** and **moderate beneficial** on benthic resources.

3.6.9 Proposed Mitigation Measures

Several measures are proposed to minimize impacts on benthic resources (Appendix H, Table H-2 and H-3). In the Draft EIS, BOEM analyzed NMFS-proposed measures to minimize impacts on benthic habitat. After publication of the Draft EIS, BOEM conducted consultation with NMFS pursuant to Section 305(b) of the MSA (i.e., EFH consultation), which resulted in NMFS issuing EFH Conservation Recommendations that replace the NMFS-proposed measures analyzed in the Draft EIS. EFH Conservation Recommendations are analyzed collectively in Table 3.6-6. If one or more of the measures analyzed below are adopted by BOEM or cooperating agencies, some adverse impacts on benthic resources could be further reduced.

Table 3.6-6 Measures Resulting from Consultations (Also Identified in Appendix H, Table H-2): Benthic Resources

Measure	Description	Effect
Live and Hard Bottom Impact Monitoring	The Lessee would develop and implement a monitoring plan for live and hard-bottom features that may be affected by proposed activities, including assessing the recovery time for these sensitive habitats. BOEM recommends that all monitoring reports classify substrate conditions following the Coastal and Marine Ecological Classification Standards (CMECS), including live bottoms (e.g., SAV and corals and topographic features). The plan would also include a means of recording observations of any increased coverage of invasive species in the affected hard-bottom areas.	Monitoring impacts would document the extent of impacts, including invasive species; quantify the need for potential restoration activities, e.g., for SAV impacts; and help to inform the potential impacts of the proposed activities on live and hard-bottom habitat. This measure would not affect the impact determination for benthic habitats.
Live and Hard Bottom Mapping and Avoidance	Vessel operators would be provided with maps of sensitive hard-bottom habitat in OSW project area, as well as a proposed anchoring plan that would avoid or minimize impacts on the hard-bottom habitat to the greatest extent practicable. These plans would be provided for all anchoring activity, including construction, maintenance, and decommissioning.	Mapping sensitive areas would identify areas to be avoided or areas in which impacts would be minimized to the extent practicable and would reduce impacts on these areas during proposed construction, maintenance, and decommissioning activities.

Measure	Description	Effect
Intake Screens on Pump Intakes for In-shore Hydraulic Dredges	All hydraulic dredge intakes should be covered with a mesh screen or screening device that is properly installed and maintained to minimize potential for impingement or entrainment of fish species. The screening device on the dredge intake should prevent the passage of any material greater than 1.25" in diameter, with a maximum opening of 1.25"x 6". Water intakes should be positioned at an appropriate depth to avoid or minimize the entrainment of eggs and larvae. Intake velocity should be limited to less than 0.5 ft/sec.	This measure minimizes potential for impingement or entrainment of eggs and larvae. While this would reduce the impact of hydraulic dredging on eggs and larvae, the measure would not reduce the impact level of minor for cable emplacement.
Scour and Cable Protection	To the extent technically and economically feasible, the Lessee must ensure that all materials used for scour and cable protection consist of natural or engineered stone that does not inhibit epibenthic growth. The materials selected for protective purposes should mirror the natural environment and provide similar habitat functions.	The use of natural or engineered stone would not inhibit epibenthic growth and would provide three-dimensional complexity. This type of scour protection would most nearly replicate natural habitat features. This measure would reduce impacts on benthic habitat composition and structural complexity and, in the case of cable protection, reduce the time required for colonization by habitat-forming organisms. While long-term impacts from these structures would remain, the time required to achieve beneficial effects would decrease.

Measure	Description	Effect
EFH Conservation Recommendations	EFH Conservation Recommendations from NMFS were transmitted by letter dated February 24, 2023. EFH Conservation Recommendations for activities under BOEM's jurisdiction were provided for WTG and cable removal and relocation (micrositing), habitat alteration minimization, noise mitigation, and contents of the Benthic Habitat and Fisheries Monitoring Plans. EFH Conservation Recommendations for activities under USACE's jurisdiction were provided for offshore impact minimization, inshore/estuarine habitat impact minimization, and compensatory mitigation.	WTG and cable removal and relocation (micrositing) would reduce benthic impacts on the most unique and spatially limited components of the ridge and trough features. While this would provide an incremental reduction of impacts on sensitive habitats, it would not reduce the impact rating for any of the Proposed Action's IPFs. Offshore habitat alteration minimization recommendations and inshore/ estuarine habitat recommendations would reduce impacts on benthic habitat composition and structural complexity and, in the case of cable protection, reduce the time required for colonization by habitat-forming organisms. While long-term impacts from these structures would remain, the time required to achieve beneficial effects would decrease. Noise mitigation recommendations of additional noise dampening at pile installation near sensitive sites would reduce injury to or mortality of benthic resources and the potential for stress and behavioral changes to individuals over a greater area.

ft/sec = foot per second; OSW = offshore wind

Table 3.6-7 Additional Proposed Measures (Also Identified in Appendix H, Table H-3): Benthic Resources

Measure	Description	Effect
Cable protection (NYSDOS-proposed)	Avoid the use of concrete mattresses as cable protection (in all areas, but most critically within sand ridge/trough habitat features and the NJ to NY Connector Fairway) to the extent possible.	The effect of this measure would be similar to the effects of the Scour and Cable protection measure analyzed in Table 3.6-6.

3.6.9.1. Measures Incorporated in the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.6-6 and Table H-2 in Appendix H, *Mitigation and Monitoring*, are incorporated in the Preferred Alternative. BOEM has identified the following additional measures in Table 3.6-7 as incorporated in the Preferred Alternative: cable protection (NYSDOS). These measures, if adopted, would have the effect of reducing the potential for interactions with sensitive benthic habitat in nearshore waters and ridge and trough habitats in the Lease Area. While the impact determination for benthic resources, described in

Section 3.6.2, would not change, the combination of these measures (Table 3.6-6 and Table 3.6-7) would ensure the effectiveness of, and compliance with, APMs already analyzed as part of the Proposed Action.

3.7. Birds (see Appendix G)

The reader is referred to Appendix G for a discussion of current conditions and potential impacts on birds from implementation of the No Action Alternative, the Proposed Action, and other action alternatives.

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3.8. Coastal Habitat and Fauna (see Appendix G)

The reader is referred to Appendix G for a discussion of current conditions and potential impacts on coastal habitat and fauna from implementation of the No Action Alternative, the Proposed Action, and other action alternatives.

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3.9. Commercial Fisheries and For-Hire Recreational Fishing

This section discusses potential impacts on commercial fisheries and for-hire recreational fishing from the proposed Project, alternatives, and ongoing and planned activities in the commercial fisheries and for-hire recreational fishing geographic analysis area. The commercial fisheries and for-hire recreational fishing geographic analysis area, as shown on Figure 3.9-1, includes the waters managed by the New England Fishery Management Council (NEFMC) and Mid-Atlantic Fishery Management Council (MAFMC) for federal fisheries within the U.S. Exclusive Economic Zone (from 3 to 200 nm [5.6 to 370.4 kilometers] from the coastline, plus the state waters (out to 3 nm [5.6 kilometers] from the coastline) from Maine to North Carolina. The boundaries for the geographic analysis area were developed to consider impacts on federally permitted vessels operating in all fisheries in state and U.S. Exclusive Economic Zone waters surrounding the proposed Project.

Due to size of the geographic analysis area, the analysis for this EIS focuses on the commercial fisheries and for-hire recreational fishing that would likely occur in the Project area or be affected by Project-related activities, while providing context within the larger geographic analysis area.

A description of the affected environment and potential impacts related to private recreational anglers is included within Section 3.18, *Recreation and Tourism*. This section specifically discusses commercial fisheries and for-hire recreational fishing.

3.9.1 Description of the Affected Environment for Commercial Fisheries and For-Hire Recreational Fishing

Commercial Fisheries

This section provides an overview of commercial fisheries management and the economic value of fisheries in the geographic analysis area and Project area.

The primary source for regional fisheries data (Mid-Atlantic and New England regions) was Vessel Trip Report data provided by NMFS. The summary Vessel Trip Report data included catch estimates by fishing location combined with NMFS estimates of revenue using ex-vessel price data drawn from commercial fisheries data dealer reports. The primary source of fisheries data within the Lease Area was NMFS's *Socioeconomic Impacts of Atlantic Offshore Wind Development* website (https://www.fisheries.noaa.gov/resource/data/socioeconomic-impacts-atlantic-offshore-wind-development), which summarizes commercial fisheries data for each proposed WEA along the U.S. Atlantic coast. In addition, figures developed by BOEM based on NMFS Vessel Monitoring System (VMS) data provided by NMFS (2019) are included and provide additional information about fishing activities in the Lease Area.

To the extent that data are available, the commercial fishing described here includes fishing activity in both state and federal waters for those vessels issued federal fishing permits from the NMFS Greater Atlantic Region. Data on the average annual revenue of federally permitted vessels by Fishery Management Plan (FMP) fishery, gear type, and port of landing are summarized. In general, the data presented focus on those FMP fisheries, species, gear types, and ports that are relevant to commercial fishing activity in the Project area.

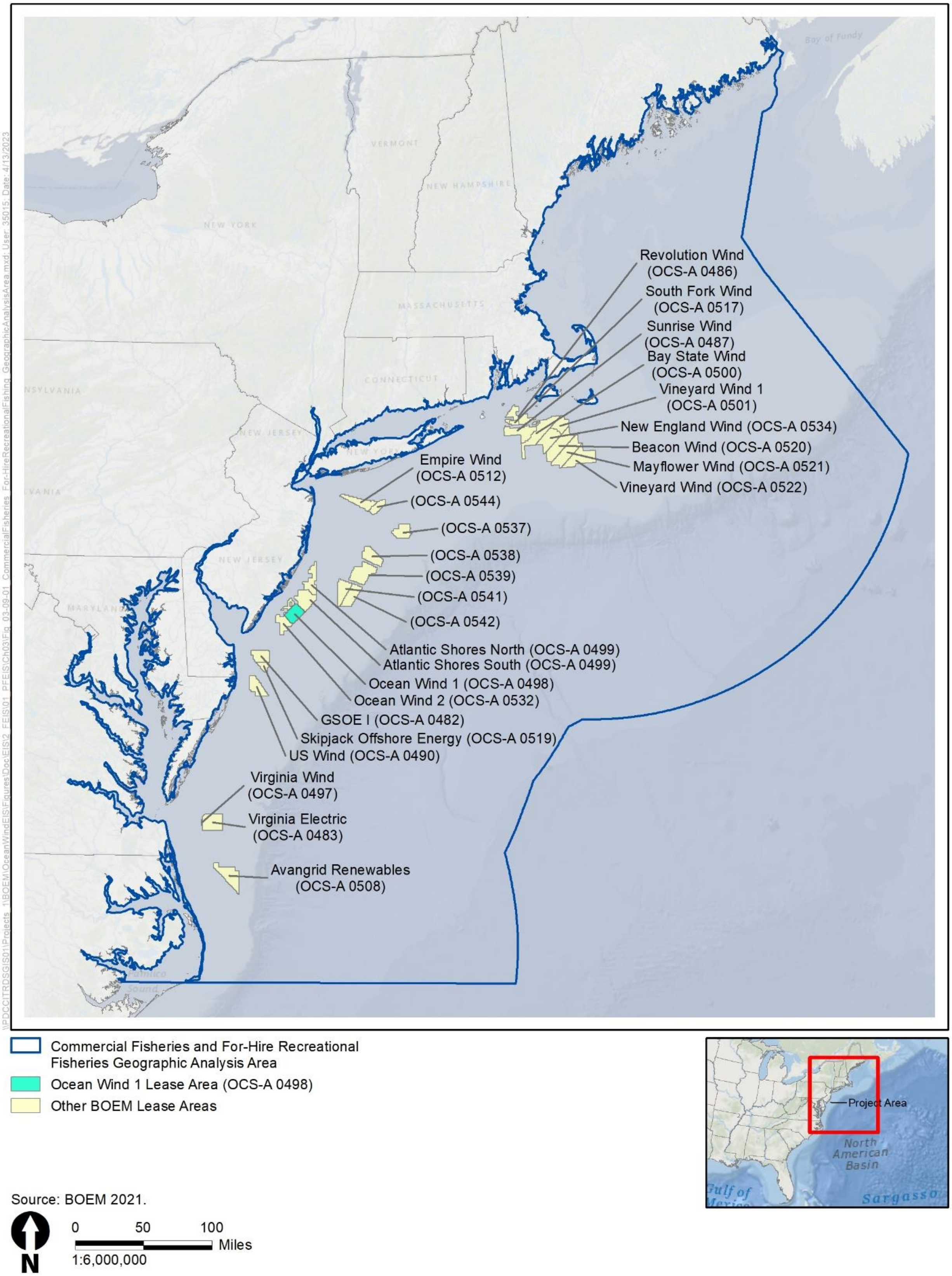


Figure 3.9-1 Commercial Fisheries and For-Hire Recreational Fishing Geographic Analysis Area

Regional Setting

Commercial fisheries operating in federal waters off the Mid-Atlantic and New England regions are known for large catches of a variety of species, including Atlantic herring (*Clupea harengus*), clams (Atlantic surfclam [*Spisula solidissima*] and ocean quahog [*Arctica islandica*]), squid (Decapodiformes), Atlantic sea scallops (*Placopecten magellanicus*), skates (Rajidae), summer flounder (*Paralichthys dentatus*), groundfish, monkfish (*Lophius americanus*), American lobster (*Homarus americanus*), and Jonah crab (*Cancer borealis*). These fishery resources are harvested with a broad assortment of fishing gear, specifically mobile gear (e.g., bottom trawl, dredge, midwater trawl) and fixed gear (e.g., gillnet, pot, bottom longline, seine, hand line). For example, dredging gear targets seafloor organisms such as surfclam, ocean quahog, and scallops; bottom trawl for monkfish and summer flounder; trawlers and purse seines for herring; and traps and pots for lobster and Jonah crab. The fishery resources are managed under several FMPs: the Northeast Multispecies (large-mesh and small-mesh) FMP,[1] Sea Scallop FMP, Monkfish FMP, Atlantic Herring FMP, Skate FMP, and Red Crab FMP under NEFMC (NEFMC 2021); the Summer Flounder/Scup/Black Sea Bass FMP, Spiny Dogfish FMP, Mackerel/Squid/Butterfish FMP, Bluefish FMP, Surfclam/Ocean Quahog FMP, and Golden and Blueline Tilefish FMP under MAFMC (MAFMC 2021); the Highly Migratory Species FMP under NMFS (NMFS 2006); and the Shad and River Herring FMP, Lobster FMP, and Jonah Crab FMP under the Atlantic States Marine Fisheries Commission (ASMFC) (ASMFC 2021). These FMP fisheries are referred to throughout this section; therefore, the author-date citations are provided only here. Commercial fisheries species managed in state waters include the American eel (*Anguilla rostrate*), Atlantic croaker (*Micropogonias undulatus*), Atlantic menhaden (*Brevoortia tyrannus*), American shad (*Alosa sapidissima*) and river herring (*Alosa*), red drum (*Sciaenops ocellatus*), horseshoe crab (*Limulus polyphemus*), and northern shrimp (*Pandalus borealis*). The American lobster, as well as Jonah crab, is managed under the authority of the Atlantic Coastal Fisheries Cooperative Management Act and is cooperatively managed by the states under the framework of ASMFC and NMFS in federal waters. American lobster is managed under Amendment 3 of the Interstate FMP and its Addenda (I–XXVI). There are three coastal migratory stocks for lobster: Gulf of Maine, Georges Bank, and Southern New England. The stocks are further divided into seven management areas. The Project area falls within the Inshore and Offshore Mid-Atlantic (Area 5) lobster area.

Within the New Jersey state waters of the Lease Area, commercial and recreational fisheries are further managed by state regulatory agencies under various ocean management plans developed at the state level or at the regional level (MAFMC). Each coastal state has its own structure of agencies and plans that govern fisheries resources. In New Jersey, NJDEP’s Bureau of Marine Fisheries administers all laws relating to marine fisheries (Part 7:25, Subchapter 18 – Marine Fisheries) and is responsible for the development and enforcement of state and federal regulations pertaining to marine fish and fisheries in New Jersey state waters, including the management of diadromous species (e.g., American eel, striped bass, river herring, sturgeon).

Regional Fisheries Economic Value and Landings

This section describes federally permitted fishing activity in both federal and state waters of the Mid-Atlantic and New England fisheries. It summarizes regional data on the average annual revenue of federally permitted vessels by FMP fishery and port of landing.

[1] The Northeast Multispecies large-mesh fishery is composed of the following species: Atlantic cod, haddock, pollock, yellowtail flounder, witch flounder, winter flounder, windowpane flounder, American plaice, Atlantic halibut, Acadian redfish, Atlantic wolffish, ocean pout, and white hake. The Northeast Multispecies small-mesh fishery is composed of five stocks of three species of hakes: northern silver hake and southern silver hake, northern red hake and southern red hake, and offshore hake. Southern silver hake and offshore hake are often grouped together and collectively referred to as “southern whiting.”

Commercial fishing contributes to the overall regional economy through direct employment, income, and gross revenues; products and services to maintain and operate fishing vessels; and seafood processors, wholesalers/distributors, and retailers. Table 3.9-1 shows the average annual revenue by FMP fishery for the Mid-Atlantic and New England fisheries from 2008 through 2021, the most recent period for which the data are available. Table 3.9-2 shows the average annual landings in pounds by species for the same period. During this period, the species with the highest average annual landed weight included Atlantic menhaden, which represented 34 percent of the average landed weight, Atlantic herring, American lobster, blue crab, sea scallop, and surfclam (Table 3.9-2). The most valuable species over this period were American lobster and sea scallop, which together represented 58 percent of the average annual revenue, followed by blue crab, eastern oyster, Atlantic menhaden, and northern quahog (Table 3.9-1).

Table 3.9-1 Commercial Fishing Revenue of the Top 20 Most Valuable Species within the Geographic Analysis Area (2008–2021)

Species[1]	FMP Fishery	Peak Annual Revenue (millions of dollars)	Average Annual Revenue (millions of dollars)	Percentage of Revenue in Geographic Analysis Area
American Lobster	American Lobster (ASMFC)	$924.7	$535.8	30.4%
Atlantic Sea Scallop	Sea Scallop	$670.6	$493.7	28.0%
Blue Crab	No federal FMP	$127.5	$94.0	5.3%
Eastern Oyster[2]	No federal FMP	$102.6	$64.8	3.7%
Atlantic Menhaden	Atlantic Menhaden	$140.5	$49.0	2.8%
Northern Quahog[2]	No federal FMP	$75.8	$44.7	2.5%
Loligo Squid	Mackerel/Squid/Butterfish	$50.1	$29.5	1.7%
Atlantic Surfclam	Surfclam/Ocean Quahog	$32.3	$27.6	1.6%
Soft-shell Clam	No federal FMP	$34.2	$24.2	1.4%
Summer Flounder	Summer Flounder/Scup/Black Sea Bass	$27.4	$22.2	1.3%
Atlantic Herring	Atlantic Herring	$31.8	$21.9	1.2%
Monkfish	Monkfish	$27.1	$18.8	1.1%
Striped Bass	No federal FMP	$22.0	$17.1	1.0%
Haddock	Northeast Multispecies (large-mesh)	$22.4	$14.7	0.8%
Atlantic Cod	Northeast Multispecies (large-mesh)	$32.6	$13.7	0.8%
American Eel	No federal FMP	$39.7	$13.6	0.8%
Ocean Quahog	Surfclam/Ocean Quahog	$22.8	$12.4	0.7%
Illex Squid	Mackerel/Squid/Butterfish	$27.3	$12.3	0.7%
Jonah Crab	Jonah Crab	$18.6	$10.8	0.6%
Silver Hake	Northeast Multispecies (small-mesh)	$11.2	$9.8	0.6%
All species[3]		**$2,476.4**	**$1,763.4**	**--**

Source: NMFS 2022a.
[1] Species are sorted by average annual revenue in descending order.
[2] Farmed.
[3] Includes 252 species and taxonomic groups (e.g., drums, skates) for which there were recorded landings.

Table 3.9-2 Commercial Fishing Landings (pounds) of the Top 20 Species by Landed Weight within the Geographic Analysis Area (2008–2021)

Species[1]	FMP Fishery	Peak Annual Landings (millions of lbs.)	Average Annual Landings (millions of lbs.)	Percentage of Landings in Geographic Analysis Area
Atlantic Menhaden	Atlantic Menhaden	504.8	423.8	33.8%
Atlantic Herring	Atlantic Herring	224.5	135.5	10.8%
American Lobster	American Lobster	159.4	132.5	10.6%
Blue Crab	No federal FMP	119.0	69.6	5.5%
Atlantic Sea Scallop	Sea Scallop	60.6	49.7	4.0%
Atlantic Surfclam	Surfclam/Ocean Quahog	50.4	36.7	2.9%
Skates	Skate	40.1	32.9	2.6%
Illex Squid	Mackerel/Squid/Butterfish	61.4	28.9	2.3%
Loligo Squid	Mackerel/Squid/Butterfish	40.1	24.4	1.9%
Monkfish	Monkfish	24.5	20.0	1.6%
Atlantic Mackerel	Mackerel/Squid/Butterfish	49.9	18.2	1.5%
Ocean Quahog	Surfclam/Ocean Quahog	31.7	16.7	1.3%
Spiny Dogfish	Spiny Dogfish	24.1	15.2	1.2%
Jonah Crab	Jonah Crab	20.2	13.9	1.1%
Silver Hake	Northeast Multispecies (small-mesh)	17.8	13.9	1.1%
Scup	Summer Flounder/Scup/Black Sea Bass	17.8	13.4	1.1%
Haddock	Northeast Multispecies (large-mesh)	22.4	13.4	1.1%
Pollock	Northeast Multispecies (large-mesh)	22.0	10.7	0.9%
Acadian Redfish	Northeast Multispecies (large-mesh)	12.9	8.4	0.7%
Summer Flounder	Summer Flounder/Scup/Black Sea Bass	13.0	8.1	0.6%
All species[2]		**1,454.0**	**1,255.4**	**--**

Source: NMFS 2022a.
[1] Species are sorted by average annual landings in descending order.
[2] Includes 252 species and taxonomic groups (e.g., drums, skates) for which there were recorded landings.

Commercial fishing fleets provide economic benefits to coastal communities in the Mid-Atlantic and New England regions. These fleets not only generate direct employment and income for vessel owners and crew, but also contribute indirectly to the employment and revenue generated through products and services necessary to maintain and operate fishing vessels, seafood processors, wholesalers/distributors, and retailers. On average, commercial fishing activity in New England and the Mid-Atlantic generated approximately $1.2 billion in annual ex-vessel revenue from 2010 through 2021. Table 3.9-3 summarizes the average annual revenue by port of landing from 2010 through 2021 for ports in the geographic analysis area. Landings in New Bedford, Massachusetts represented approximately 32 percent of the average annual commercial fishing revenue in the geographic analysis area. The ports with the next highest revenues—Cape May, New Jersey; Reedville, Virginia; and Hampton Roads area, Virginia—represented 7 percent, 6 percent, and 5 percent, respectively.

Table 3.9-3 Commercial Fishing Landings and Revenue for the Top 20 Highest Revenue Ports in the Geographic Analysis Area, 2010–2021

Port and State[1]	Peak Annual Landings (millions lbs.)	Average Annual Landings (millions lbs.)	Peak Annual Revenue (millions dollars)	Average Annual Revenue (millions dollars)	Percentage of Revenue in Geographic Analysis Area
New Bedford, Massachusetts	170.0	126.4	$569.7	$367.9	31.7%
Cape May, New Jersey	113.5	69.0	$147.7	$80.8	7.0%
Reedville, Virginia	426.1	349.0	$466.5	$65.4	5.6%
Hampton Roads Area, Virginia	19.3	15.1	$88.3	$60.8	5.2%
Gloucester, Massachusetts	122.3	72.5	$80.3	$54.1	4.7%
Stonington, Maine	25.4	17.7	$73.2	$50.4	4.3%
Point Judith, Rhode Island	57.3	45.6	$72.1	$49.2	4.2%
Vinalhaven, Maine	13.4	9.7	$55.8	$36.0	3.1%
Point Pleasant, New Jersey	43.3	25.2	$35.7	$28.7	2.5%
Portland, Maine	62.4	42.9	$38.1	$28.5	2.5%
Provincetown-Chatham, Massachusetts	26.5	18.7	$35.5	$28.3	2.4%
Barnegat Light, New Jersey	8.9	7.2	$33.8	$25.7	2.2%
Wanchese-Stumpy Point, North Carolina	25.6	18.7	$26.6	$22.4	1.9%
Friendship, Maine	9.1	6.2	$40.7	$22.0	1.9%
Beals Island, Maine	8.1	6.6	$35.6	$21.4	1.8%
Newington, New Hampshire	4.7	3.9	$30.0	$20.3	1.7%
Atlantic City, New Jersey	35.3	25.6	$24.1	$18.9	1.6%
Montauk, New York	14.8	11.7	$21.2	$16.8	1.4%
Boston, Massachusetts	20.2	14.8	$19.3	$16.3	1.4%
Spruce Head, Maine	6.3	4.4	$31.5	$16.1	1.4%
All Ports[2]	**1,073.7**	**998.1**	**$2,196.3**	**$1,160.1**	**--**

Source: NMFS 2022a.
[1] Ports are sorted by average annual revenue in descending order.
[2] Includes 58 ports within the New England and Mid-Atlantic region, which encompasses the geographic analysis area.

Commercial Fisheries in the Lease Area

The commercial fisheries active in the Lease Area encompass a wide range of FMP fisheries, gears, and landing ports, although NMFS VMS data[2] indicate that most FMP fisheries within the Lease Area do not have a high level of fishing effort compared to surrounding areas (see Figure 2.3.4-1 to Figure 2.3.4-7 in COP Volume II, Section 2.3.4.1.3; Ocean Wind 2023). Table 3.9-4 and Table 3.9-5 provide data on revenue and landings for 2008 through 2021 for commercial fisheries in the Lease Area for vessels that were issued federal fishing permits by the NMFS Greater Atlantic Region.

[2] VMS coverage is not universal for all fisheries. Non-VMS data have declared as out of fishery, meaning they have declared out of a fishery managed by days-at-sea effort controls (i.e., scallops, Northeast multispecies, and monkfish).

Table 3.9-4 Commercial Fishing Revenue of Federally Permitted Vessels in the Lease Area by FMP Fishery (2008–2021)

FMP Fishery	Average Annual Revenue	Total Annual Revenue	Average Annual Revenue as Percentage of Total Revenue from the Geographic Analysis Area	Average Annual Number of Vessels in the Lease Area	Average Annual Number of Vessel Trips in the Lease Area
Top Five FMPs					
Sea Scallop	$131,714	$1,844,000	0.03%	74	121
Surfclam, Ocean Quahog	$128,357	$1,797,000	0.15%	14	118
ASMFC FMP	$44,786	$627,000	<0.01%	29	182
No Federal FMP	$28,286	$396,000	0.01%	42	254
Summer Flounder, Scup, Black Sea Bass	$14,714	$206,000	0.04%	66	249
Total Top Five FMPs	**$347,857**	**$4,870,000**	**--**	**225**	**924**
Other FMP Fisheries					
Mackerel, Squid, and Butterfish	$11,857	$166,000	0.02%	43	112
Monkfish	$4,214	$59,000	0.02%	65	132
Skates	$1,786	$25,000	0.03%	11	74
Atlantic Herring	$500	$7,000	<0.01%	2	3
All Others[2]	$286	$4,000	<0.01%	NA	NA
Highly Migratory Species	$286	$4,000	<0.01%	12	22
Bluefish	$71	$1,000	<0.01%	28	46
Small-Mesh Multispecies	$71	$1,000	<0.01%	18	38
Northeast Multispecies	$71	$1,000	<0.01%	4	9
Southeast Regional Office FMP	$71	$1,000	0.02%	9	13
Spiny Dogfish	<$36	<$500	<0.01%	3	7
Tilefish	<$36	<$500	<0.01%	12	18
Total Other FMP Fisheries	**$19,214**	**$269,000**	--	**207**	**474**
All FMP Fisheries	**$367,071**	**$5,139,000**	**0.02%**	**432**	**1,398**

Source: Developed using data from NMFS 2022b.
Notes: Data are for vessels issued federal fishing permits by the NMFS Greater Atlantic Region. Numbers are in 2021 dollars and Total Revenue is rounded to nearest $1,000. NA indicates data not available to perform calculations. Differences in totals are due to rounding. Averages were calculated based upon total counts across years 2008–2021 then divided by 14 years.
[1] Regional comparison is relative to the individual species noted, not all species combined.
[2] All Others refers to FMP fisheries with fewer than three permits or dealers affected to protect data confidentially.

Table 3.9-5 Commercial Fishing Landings (pounds) of Federally Permitted Vessels in the Lease Area (2008–2021)

FMP Fishery	Average Annual Landings (Pounds)	Total Landings (Pounds)
Top Five Fisheries		
ASMFC FMP	339,214	4,749,000
Surfclam, Ocean Quahog	176,214	2,467,000
Sea Scallop	12,786	179,000
Summer Flounder, Scup, Black Sea Bass	5,571	78,000
No Federal FMP	4,929	69,000
Total	**5,571**	**7,542,000**
Other FMP Fisheries		
Mackerel, Squid, and Butterfish	17,929	251,000
Atlantic Herring	4,357	61,000
Skates	3,786	53,000
Monkfish	2,429	34,000
All Others	1,571	22,000
Highly Migratory Species	214	3,000
Spiny Dogfish	143	2,000
Bluefish	143	2,000
Small-Mesh Multispecies	143	2,000
Southeast Regional Office FMP	<36	<500
Northeast Multispecies	<36	<500
Tilefish	30,714	<500
Total	**569,429**	**430,000**
All FMP Fisheries	**17,929**	**7,972,000**

Source: NMFS 2022b.
Notes: Data are for vessels issued federal fishing permits by the NMFS Greater Atlantic Region. Total landings rounded to nearest 1,000. Differences in totals are due to rounding. Averages were calculated based upon total counts across years 2008–2021 then divided by 14 years.

The top fisheries by revenue in the Lease Area were Sea Scallop, Surfclam/Ocean Quahog, ASMFC FMP, the No Federal FMP,[3] and Summer Flounder/Scup/Black Sea Bass. The top FMP fisheries accounted for approximately 97 percent of total revenue generated commercially within the Lease Area from 2008 through 2021 and approximately 95 percent of all landings. While the Sea Scallop FMP fishery only accounted for roughly 2 percent of the total landings, it was the top revenue producer, accounting for approximately 36 percent of the total revenue produced within the Lease Area. Sea Scallop and Surfclam/Ocean Quahog together accounted for approximately 71 percent of the total revenue and 33 percent of the total landings within the Lease Area. In total, the Lease Area accounted for

[3] The No Federal FMP contains a variety of species that are managed under an FMP but are not federally regulated, such as the smooth and chain dogfish (*Mustelus canis* and *Scyliorhinus retifer*, respectively), whelk (Buccinidae), and menhaden. In total, there are approximately 88 species caught within the Lease Area that are not regulated under a federal FMP (NMFS 2022b).

approximately 0.02 percent of the total revenue across all FMP fisheries in the Mid-Atlantic and New England regions.

As noted, the No Federal FMP includes a variety of species that are managed under an FMP but are not federally regulated, including the menhaden, which is an important species to commercial fisheries operating in and around New Jersey. The Atlantic menhaden fishery is managed by ASMFC. The Atlantic menhaden commercial fishery consists of a reduction fishery (named because it "reduces" the whole fish into fish meal, fish oil, and fish solubles) and a bait fishery. Commercial landings overall in 2021 including reduction, bait, bycatch, and episodic event landings were 195,092 metric tons, which was a 6-percent increase from 2020 landings (ASMFC 2023). The current management quota allocations for Atlantic menhaden include 11 percent for New Jersey, which is second only to Virginia at 75 percent. Recent assessments indicate the stock is not overfished or experiencing overfishing and the total allowable catch for 2023 through 2025 includes an increase of approximately 20 percent from the total allowable catch from 2021–2022 (ASMFC 2023).

Table 3.9-6 and Table 3.9-7 provide the revenue (average annual and total) and landings in pounds (average annual and total) in the Lease Area by gear type for the 2008–2021 period. Together, dredge-scallop and dredge-clam accounted for approximately 71 percent of the total revenue generated by commercial fishing activity in the Lease Area, followed by pot-other and all others. When compared to the entire geographic analysis area, this only equated to 0.01 percent of average annual revenue. From an average annual landings perspective, the all others category generated the highest percentage of landings at over 59 percent, followed by dredge-clam at approximately 31 percent, and when compared to the geographic analysis area were 0.03 percent and 0.01 percent, respectively.

Table 3.9-6 Commercial Fishing Revenue of Federally Permitted Vessels in the Lease Area by Gear Type (2008–2021)

Gear Type	Average Annual Revenue	Total Revenue	Percentage of Annual Average Revenue in the Geographic Analysis Area [1]
Dredge-Scallop	$130,857	$1,832,000	0.01%
Dredge-Clam	$128,500	$1,799,000	0.01%
Pot-Other[1]	$42,357	$593,000	0.00%
All Others[3]	$38,857	$544,000	0.00%
Trawl-Bottom	$19,571	$274,000	0.00%
Gillnet-Sink	$4,857	$68,000	0.00%
Pot-Lobster	$1,143	$16,000	0.00%
Trawl-Midwater	$786	$11,000	0.00%
All Gear Types	**$367,000**	**$5,138,000**	**0.02%**

Source: Developed using data from NMFS 2022b.
Notes: Data are for vessels issued federal fishing permits by the NMFS Greater Atlantic Region. Revenue is in 2021 dollars, with total revenue rounded to nearest thousand. Differences in totals are due to rounding. Averages were calculated based upon total counts across years 2008–2021 then divided by 14 years.
[1] Calculated as the average annual revenue generated by gear type in the Lease Area divided by the total average revenue generated by all gear types in the geographic analysis area. A value of 0.00% means there is a value below 0.01%, but not zero.
[2] Pot-Other includes pot gear used in the Lobster FMP fishery.
[3] All Others includes Seine-Purse.

Table 3.9-7 Commercial Fishing Landings (pounds) of Federally Permitted Vessels in the Lease Area by Gear Type (2008–2021)

Gear Type	Average Annual Landings (Pounds)	Total Landings (Pounds)	Percentage of Annual Average Landings in the Geographic Analysis Area [1]
All Others[2]	336,643	4,713,000	0.03%
Dredge-Clam	176,286	2,468,000	0.01%
Trawl-Bottom	22,429	314,000	0.00%
Dredge-Scallop	12,786	179,000	0.00%
Pot-Other[3]	10,143	142,000	0.00%
Trawl-Midwater	6,714	94,000	0.00%
Gillnet-Sink	4,143	58,000	0.00%
Pot-Lobster	286	4,000	0.00%
All Gear Types	**569,429**	**7,972,000**	**0.05%**

Source: NMFS 2022b.

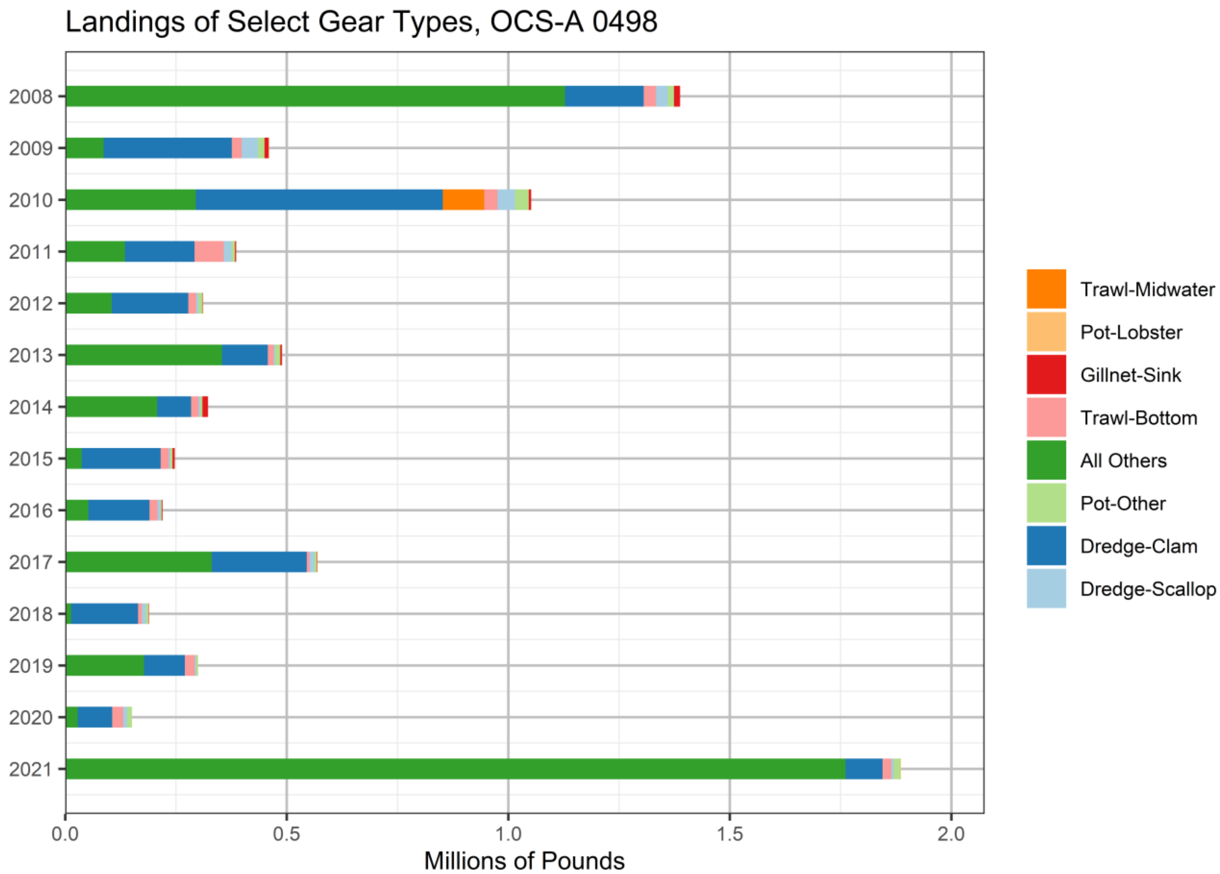
Note: Data are for vessels issued federal fishing permits by the NMFS Greater Atlantic Region. Differences in totals are due to rounding. Averages were calculated based upon total counts across years 2008–2021 then divided by 14 years.

[1] Calculated as the annual average landings by gear type in the Lease Area divided by the total average landings generated by all gear types in the geographic analysis area. A value of 0.00% means there is a value below 0.01%, but not zero.

[2] All Others includes Seine-Purse.

[3] Pot-Other includes pot gear used in the Lobster FMP fishery.

From 2008 through 2020, landings within the Lease Area had generally decreased across all gear types; however, in 2021 there was a substantial increase specifically for the All Others category (see Figure 3.9-2).



Source: NMFS 2022b

Figure 3.9-2 Summary of Landings (pounds) by Gear Type in Lease Area

It is widely acknowledged that there are a number of attributes and variables that are important data points to incorporate into the development of social indicators. Fisheries are part of social-ecological systems that take into account inter-relationships between ecological functions and human communities that depend on ecosystem services for their well-being. Research and resources are available that attempt to capture this relationship and potential impact. For example, the Social Wellbeing in Fisheries Tool can be used to understand social aspects of fisheries performance, including security, flexibility, and viability at the individual, community, and system levels. Well-being objectives to consider according to the article include impacts on income and employment, infrastructure investment, equitable distribution of fisheries benefits, maintaining fishing opportunities for small-scale operators, promoting food security, and maintaining cultural importance of fishing to the community (Van Holt et al. 2016).

Incorporation of social sciences, including social indicators that can be scaled to various geographic study areas and provide a mechanism to track progress toward sustainability goals, is important (Clay and Colburn 2020; Hicks et al. 2016). Social vulnerability indicators and gentrification pressure indicators are important data sources and information to consider, including the impact on traditional values and historical significance of fishing areas in the region. In addition, consideration of the demographics, well-being indicators, and job satisfaction of those working in the commercial fisheries and for-hire recreational fishing industries is important.

As found in the literature, established fishing communities are oftentimes forced to adapt to new social, economic, and environmental conditions and as a result many fishing communities in the Northeast have been supplemented with technology-based industries and tourism or are heavily affected by coastal development, gentrification, and the emergence of retirement communities (Claesson et al. 2006). Increased tourism and recreational boating and fishing infrastructure as a result of gentrification has also resulted in space-use conflicts both onshore and offshore between commercial and recreational fishing (Jepson and Colburn 2013; Thompson et al. 2016; Hall-Arber et al. 2001) that could be exacerbated by offshore wind development.

As such, social vulnerability indicators (i.e., personal disruption, population consumption, and poverty) and gentrification pressure indicators (i.e., retiree migration and urban sprawl) along with other selected socioeconomic characteristics of communities with fishing ports that could be affected by the Project are also presented in Section 3.11 (*Demographics, Employment, and Economics*) and Section 3.12 (*Environmental Justice*).

Table 3.9-8 shows the average number of vessel trips and average number of vessels fishing in the Lease Area by port for 2008 through 2021. The Lease Area is predominantly utilized by vessels whose home ports are in the Mid-Atlantic. Of the 676 average annual trips, the Mid-Atlantic has taken 604 trips. Of the 150 average annual vessels, the Mid-Atlantic region effort consists of 109 vessels. Table 3.9-9 provides a ranking of ports by revenue of fishing vessels in the Lease Area from 2008 through 2021, as well as the level of commercial fishing engagement and reliance of the community in which the port is located. As noted earlier, these rankings portray the level of dependence of the community on commercial fishing and are compiled by NMFS (NOAA Fisheries Office of Science and Technology 2021). Seventy-five percent of the trips of fishing vessels that operate within the Lease Area originate from the Atlantic City, Cape May, and Sea Isle City ports in New Jersey. Atlantic City and Cape May receive the highest value of landings of any ports, with respective totals of $1.665 million and $1.150 million for 2008 through 2021. These ports contribute just over 64 percent of the total revenue for the Lease Area. As shown in the table, the commercial fishing engagement and reliance differ across communities that engage in commercial fishing within the Lease Area. For example, while Cape May ranks high in both commercial fishing engagement and reliance, Atlantic City, which generates the most revenue from the Lease Area, ranks high in fishing engagement but low in the community’s reliance on commercial fishing. Information regarding the ranking determinations for each community is provided in the community profiles available from NMFS (NMFS 2021d). These profiles present the most recent data available for these key indicators of New England and Mid-Atlantic fishing communities related to dependence on fisheries and other economic and demographic characteristics.

Table 3.9-8 Commercial Fishing Trips and Vessels in the Lease Area by Port (2008–2021)

Port and State	Average Annual Trips[1,2]	Average Annual Vessels[2]
Atlantic City, New Jersey	247	18
Barnegat, New Jersey	34	7
Beaufort, North Carolina	5	4
Cape May, New Jersey	143	46
Chincoteague, Virginia	1	1
Davisville, Rhode Island	3	1
Fairhaven, Massachusetts	0	0
Hampton, Virginia	14	8
Montauk, New York	1	0
Long Beach, New Jersey	5	1
New Bedford, Massachusetts	34	23

Port and State	Average Annual Trips[1,2]	Average Annual Vessels[2]
New London, Connecticut	1	1
Newport News, Virginia	22	15
North Kingstown, Rhode Island	8	1
Ocean City, Maryland	12	6
Oriental, North Carolina	1	1
Point Judith, Rhode Island	17	8
Point Pleasant, New Jersey	2	2
Sea Isle City, New Jersey	120	5
Shinnecock, New York	0	0
Wanchese, North Carolina	4	3
Wildwood, New Jersey	2	0
Total	**676**	**150**

Source: Developed using data from NMFS 2022b.
Note: Data are for vessels issued federal fishing permits by the NMFS Greater Atlantic Region. Differences in totals are due to rounding. Averages were calculated based upon total counts across years 2008–2021 then divided by 14 years.
[1] Trips were not necessarily made in every year, but all ports had at least one or more years where trips were made. Ports with only one year where trips to the Lease Area were made include Fairhaven, Massachusetts (2010); Montauk, New York (2009); Long Beach, New Jersey (2008); and Shinnecock, New York (2009).
[2] Zeros are due to rounding.

Table 3.9-9 Commercial Fishing Revenue of Federally Permitted Vessels in the Lease Area by Port (2008–2021)

Port and State	Average Annual Revenue	Total Revenue for the 12-Year Period	Commercial Fishing Engagement Categorical Ranking[1]	Commercial Fishing Reliance Categorical Ranking[2]
Atlantic City, New Jersey	$118,946	$1,665,000	High	Low
Cape May, New Jersey	$82,156	$1,150,000	High	High
New Bedford, Massachusetts	$26,005	$364,000	High	Medium
Newport News, Virginia	$19,658	$275,000	High	Low
Sea Isle City, New Jersey	$16,503	$231,000	Medium	Medium
Barnegat, New Jersey	$6,483	$91,000	Low	Low
Wildwood, New Jersey	$3,786	$53,000	Medium	Low
Hampton, Virginia	$3,104	$43,000	High	Low
Ocean City, Maryland	$2,537	$36,000	High	Medium
Long Beach, New Jersey	$1,112	$16,000	Low	Low
Beaufort, North Carolina	$1,088	$15,000	High	Medium
Point Judith, Rhode Island	$637	$9,000	High	Medium
North Kingstown, Rhode Island	$445	$6,000	High	Low
Point Pleasant, New Jersey	$433	$6,000	High	Medium
Wanchese, North Carolina	$260	$4,000	High	Medium
New London, Connecticut	$215	$3,000	Medium-High	Low

Port and State	Average Annual Revenue	Total Revenue for the 12-Year Period	Commercial Fishing Engagement Categorical Ranking[1]	Commercial Fishing Reliance Categorical Ranking[2]
Davisville, Rhode Island	$206	$3,000	High	Low
Chincoteague, Virginia	$57	$1,000	Medium	Medium
Oriental, North Carolina	$43	$1,000	Medium	Medium
Montauk, New York	$21	<$1,000	High	Medium
Shinnecock, New York	$8	<$1,000	High	Low
All Others	$28,905	$405,000	NA	NA

Source: Developed using data from NMFS 2022b; NOAA Fisheries Office of Science and Technology 2021.
Notes: Data are for vessels issued federal fishing permits by the NMFS Greater Atlantic Region. Revenue is in 2021 dollars with total revenue rounded to nearest thousand. Averages were calculated based upon total counts across years 2008–2021 then divided by 14 years.
[1] Commercial fishing engagement measures the presence of commercial fishing through fishing activity as shown through permits, fish dealers, and vessel landings. A high rank indicates more engagement. Rankings are for 2019, the latest year data are available.
[2] Commercial fishing reliance measures the presence of commercial fishing in relation to the population size of a community through fishing activity. A high rank indicates more reliance. Rankings are for 2019, the latest year data are available.
NA = not applicable

Annual average commercial fishing landings and revenue within the Lease Area from 2008–2021 are summarized by fishing port in Table 3.9-10 and by state in Table 3.9-11. The fishing ports with the highest landed weight were Atlantic City, New Jersey and Cape May, New Jersey, which combined for over 83 percent of the total annual average landings from the Lease Area, and 0.01 percent and 0.02 percent of the geographic analysis area, respectively. No other fishing port landed more than an average of 10,000 pounds per year, except the all others category. From an average annual revenue perspective, Atlantic City, New Jersey and Cape May, New Jersey accounted for over 64 percent of the average annual revenue generated within the Lease Area, and 0.01 percent of the geographic analysis area, each. No other fishing ports had above 0.01 percent of the geographic analysis area average annual revenue.

When looking at average annual landings and revenue generated by state, Table 3.9-11 shows that ports in New Jersey generated over 86 percent of the average landings and, compared to the geographic analysis area, this equated to 0.04 percent. No other states reached 0.01 percent of the geographic analysis area in average annual landings from the Lease Area.

In general, fishing ports and states that derive higher percentages of landings and revenue from the Lease Area are expected to experience greater impacts from the Proposed Action. However, this should also be considered relative to the overall commercial fishing engagement and reliance of ports, as outlined in Table 3.9-9. For instance, the two ports with the highest percentage of annual average revenue generated within the Lease Area are the New Jersey ports of Atlantic City and Cape May. Both have a “high” commercial fishing engagement ranking, but Atlantic City has a “low” commercial fishing reliance rank and Cape May has a “high” commercial fishing reliance rank.

Table 3.9-10 Annual Average Commercial Fishing Landings and Revenue Exposed to the Wind Farm Area by Port Based on Annual Average Revenue 2008–2021

Port	Lease Area Landings (pounds)	Percentage of Landings in the Geographic Analysis Area[1]	Lease Area Average Annual Revenue (2020 dollars)	Percentage of Revenue in the Geographic Analysis Area[2]
Atlantic City, New Jersey	173,674	0.01%	$134,370	0.01%
Cape May, New Jersey	304,731	0.02%	$89,625	0.01%
New Bedford, Massachusetts	5,001	0.00%	$28,865	0.00%
Newport News, Virginia	2,932	0.00%	$22,982	0.00%
Sea Isle City, New Jersey	5,523	0.00%	$17,960	0.00%
Barnegat, New Jersey	2,840	0.00%	$7,089	0.00%
Hampton, Virginia	774	0.00%	$3,587	0.00%
Wildwood, New Jersey	3,582	0.00%	$3,584	0.00%
Ocean City, Maryland	1,971	0.00%	$2,780	0.00%
Long Beach, New Jersey	993	0.00%	$1,343	0.00%
Beaufort, North Carolina	182	0.00%	$1,071	0.00%
Point Judith, Rhode Island	601	0.00%	$691	0.00%
North Kingstown, Rhode Island	1,166	0.00%	$527	0.00%
Point Pleasant, New Jersey	185	0.00%	$500	0.00%
Wanchese, North Carolina	179	0.00%	$305	0.00%
New London, Connecticut	32	0.00%	$258	0.00%
Davisville, Rhode Island	413	0.00%	$229	0.00%
Chincoteague, Virginia	35	0.00%	$65	0.00%
Oriental, North Carolina	35	0.00%	$52	0.00%
Montauk, New York	27	0.00%	$25	0.00%
Shinnecock, New York	9	0.00%	$10	0.00%
All Others[3]	67,136	0.01%	$32,466	0.00%
All Ports	**572,021**	**0.05%**	**$348,384**	**0.02%**

Sources: Developed using data from NMFS (2022b).
Notes: Revenue values have been adjusted to real 2020 dollars and are estimated based on the annual average revenue by port from 2008 through 2021. Ports were then sorted by revenue in descending order, with All Others listed last, as it is not attributable to a specific port.
[1] Calculated as the landed weight at a port from the Lease Area divided by the total landed weight across all ports from the geographic analysis area. A value of 0.00% means there is a value below 0.01%, but not zero.
[2] Calculated as the revenue at a port from the Lease Area divided by the total revenue across all ports from the geographic analysis area. A value of 0.00% means there is a value below 0.01%, but not zero.
[3] “All Others” is for data that have been aggregated for confidentiality purposes.

Table 3.9-11 Annual Average Commercial Fishing Revenue Exposed to the Wind Farm Area by State Based on Annual Average Revenue 2008–2021

State	Lease Area Landings (pounds)	Percentage of Landings in the Geographic Analysis Area[1]	Lease Area Average Annual Revenue (2020 dollars)	Percentage of Revenue in the Geographic Analysis Area[2]
New Jersey	493,329	0.04%	$261,367	0.01%
Virginia	5,199	0.00%	$38,600	0.00%
Massachusetts	60,883	0.00%	$35,911	0.00%
Rhode Island	9,015	0.00%	$6,387	0.00%
Maryland	1,895	0.00%	$2,583	0.00%
North Carolina	668	0.00%	$2,064	0.00%
Connecticut	71	0.00%	$550	0.00%
New York	50	0.00%	$53	0.00%
Delaware	3	0.00%	$9	0.00%
All Others[3]	910	0.00%	$862	0.00%
All States	**572,023**	0.05%	**$348,386**	0.02%

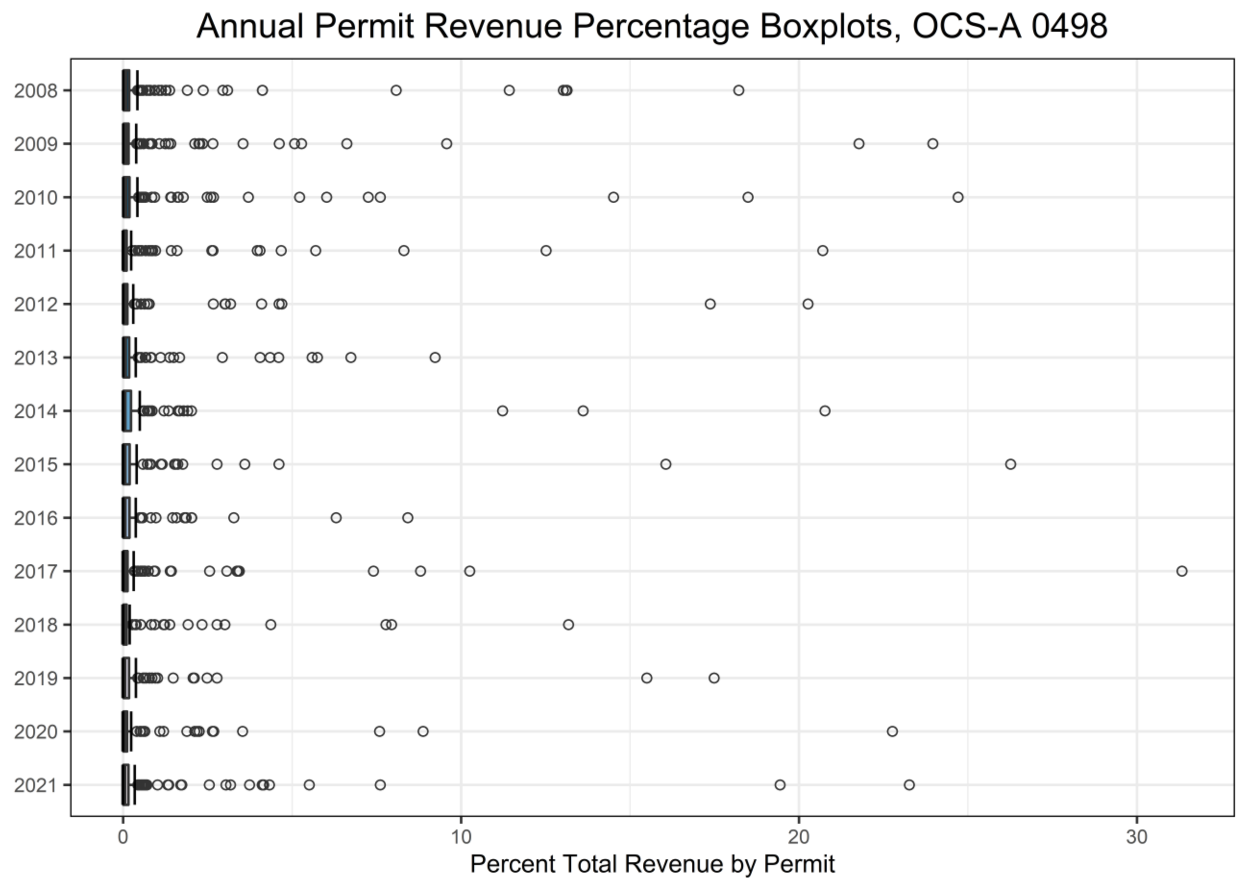
Sources: Developed using data from NMFS (2022b).
Notes: Revenue values have been adjusted to real 2020 dollars and are estimated based on the annual average revenue by state from 2008 through 2021. They were then sorted by highest average annual revenue, with All Others listed last, as it is not attributable to a specific state.
[1] Calculated as the landed weight at a port from the Lease Area divided by the total landed weight across all ports from the geographic analysis area. A value of 0.00% means there is a value below 0.01%, but not zero.
[2] Calculated as the revenue at a port from the Lease Area divided by the total revenue across all ports from the geographic analysis area. A value of 0.00% means there is a value below 0.01%, but not zero.
[3] "All Others" is for data that have been aggregated for confidentiality purposes.

To analyze differences in the economic importance of fishing grounds in the Lease Area across the commercial fishing fleet, NMFS analyzed the percentage of each permit's total commercial fishing revenue attributed to catch within the Lease Area during 2008 through 2021 (NMFS 2022b).

The vessel-level annual revenue percentages were divided into quartiles, which were created by ordering the data from lowest to highest percentage value and then dividing the data into four groups of equal size. The first quartile represents the lowest 25 percent of ranked percentages, while the fourth quartile represents the highest 25 percent.

The distribution of the vessel-level annual revenue percentages for the Lease Area is provided in the boxplot on Figure 3.9-3. The boxplot begins at the first quartile, or the value beneath which 25 percent of all vessel-level revenue percentages fall. A thick line within the box identifies the median, the observation that 50 percent of vessel-level revenue percentages are above or beneath. The box ends at the third quartile, or the vessel-level revenue percentage beneath which 75 percent of observations fall. Nonparametric estimates of the minimum and maximum values are also indicated by the "whiskers" (dashed line terminating in a vertical line) that jut out from each side of the box. Any points outside of these whiskers are vessel-level revenue percentages that are considered outliers. In the context of this analysis, an outlier is a vessel that derived an exceptionally high proportion of its annual revenue from the Lease Area in comparison to other vessels that fished in the area.[4]

[4] Technically, an outlier in a boxplot distribution is an observation that is more than 1.5 times the length of the box away from either the first quartile (Q1) or third quartile (Q3). Specifically, if an observation is less than Q1 – (1.5 × IQR) or greater than Q3 + (1.5 × IQR), it is an outlier; where IQR = interquartile range = Q3 – Q1.



Source: NMFS 2022b.

Figure 3.9-3 Percentage of Total Commercial Fishing Revenue of Federally Permitted Vessels Derived from the Lease Area by Vessel (2008–2021)

Table 3.9-12 presents the minimum, first quartile, median, third quartile, and maximum values for the Lease Area from 2008 through 2021. Table 3.9-13 presents the number of outliers by year.

Table 3.9-12 Analysis of 14-Year Permit Revenue Boxplots for the Lease Area (2008–2021)

Minimum Revenue Percentage Value	First Quartile	Median	Third Quartile	Maximum Revenue Percentage Value[1]
0	0	0.04	0.16	31

Source: Developed using data from NMFS 2022b.
Note: Data are for vessels issued federal fishing permits by the NMFS Greater Atlantic Region.
[1] Maximum value is inclusive of outliers.

Table 3.9-13 Number of Federally Permitted Vessels in the Lease Area (2008–2021)

Year	Number of Vessels	Number of Outliers	Number of Outliers as a Percentage of Total Vessels
2021	139	28	20.1%
2020	111	18	16.2%

Year	Number of Vessels	Number of Outliers	Number of Outliers as a Percentage of Total Vessels
2019	115	19	16.5%
2018	131	18	13.7%
2017	139	25	18.0%
2016	123	14	11.4%
2015	108	15	13.9%
2014	126	19	15.1%
2013	132	20	15.2%
2012	139	18	12.9%
2011	180	28	15.6%
2010	268	33	12.3%
2009	282	31	11.0%
2008	260	33	12.7%
Average	**161**	**23**	**14.2%**

Source: Developed using data from NMFS 2022b.
Note: Data are for vessels issued federal fishing permits by the NMFS Greater Atlantic Region.

A total of 75 percent of the permitted vessels that fished in the Lease Area derived less than 0.16 percent of their total annual revenue from the area (NMFS 2022b). The highest percentage of total annual revenue attributed to catch within the Lease Area was 31 percent in 2017, but varied from year to year. Although outliers derived a high proportion of their annual revenue from the Lease Area in comparison to other vessels that fished in the area, Figure 3.9-3 shows that, in any given year, the revenue percentage for the majority of outliers was below 5 percent. As such, while some vessels depended heavily on the Lease Area for their commercial fishing revenue, most derived a small percentage of their total annual revenue from the area.

Another aspect of commercial fishing within the Lease Area is the proportion of small business operations compared to large businesses. To characterize the amount of fishing revenue from the Lease Area that is generated by small businesses, NMFS conducted a small business analysis. The analysis defined a small business as a business that is independently owned and operated, is not dominant in its field of operation (including its affiliates), and has combined annual receipts not in excess of $11 million for all its affiliated operations worldwide. The analysis was conducted upon unique business interests, which can represent multiple vessel permits. Both within the Northeast region as well as the Ocean Wind Lease Area, there are more small businesses operating than large businesses. The number of small and large businesses engaged in federally managed fishing and the revenue of those businesses from 2019 through 2021 are summarized for the geographic analysis area in Table 3.9-14 and for the Lease Area in Table 3.9-15. During this 3-year time period, an annual average of 1,166 businesses fished in the geographic analysis area, of which 1,155 (99 percent) were small businesses and 11 (1 percent) were large businesses. Businesses engaged in fishing in the geographic analysis area generated an annual average revenue of more than $1 billion, of which over $777 million (77 percent) was attributed to small businesses and $232 million (23 percent) was attributed to large businesses. During this same time period, an annual average of 89 businesses fishing in the Lease Area, of which 81 (91 percent) were small businesses and 8 (9 percent) were large businesses. Businesses generated an annual average revenue of $272,000 in the Lease Area, of which $239,000 (88 percent) was attributed to small businesses and $33,000 (12 percent) was attributed to large businesses. Small businesses that fished inside the Lease Area generated 0.118 percent of their total revenue from the Lease Area, while large businesses that fished inside the Lease Area generated 0.020 percent of their total revenue from the Lease Area, demonstrating that small businesses were more reliant on revenue generated from the Lease Area.

Table 3.9-14 Number and Revenue of Small and Large Businesses Engaged in Federally Managed Fishing within the Geographic Analysis Area, 2019–2021

Year	Business Type	Number of Entities	Revenue (thousands of dollars)[1]
2019	Large business	11	$247,928
	Small business	1,130	$799,249
2020	Large business	11	$200,342
	Small business	1,144	$684,526
2021	Large business	11	$248,437
	Small business	1,190	$849,039
Annual Average	**Large business**	**11**	**$232,236**
	Small business	**1,155**	**$777,605**

Source: Developed using data from NMFS 2022b.
[1] Revenue values have been delated to 2021 dollars and rounded to the nearest thousand.

Table 3.9-15 Number and Revenue of Small and Large Businesses Inside the Lease Area Compared to the Total Revenue of those Businesses, 2019–2021

Year	Business Type	Number of Entities	Revenue from Lease Area (thousands of dollars)[1]	Total Revenue (thousands of dollars)[1]	Percentage of Revenue from Lease Area
2019	Large business	8	$40	$181,251	0.022%
	Small business	70	$129	$178,269	0.072%
2020	Large business	9	$32	$167,555	0.019%
	Small business	70	$174	$153,437	0.113%
2021	Large business	7	$27	$158,163	0.017%
	Small business	102	$413	$274,758	0.150%
Annual Average	**Large business**	**8**	**$33**	**$168,990**	**0.020%**
	Small business	**81**	**$239**	**$202,155**	**0.118%**

Source: Developed using data from NMFS 2022b.
[1] Revenue values have been delated to 2021 dollars and rounded to the nearest thousand.

Commercial fishing regulations include requirements for VMS. A VMS is a satellite surveillance system that monitors the location and movement of commercial fishing vessels; therefore, it is a good data source for understanding the spatial distribution of fishing vessels engaged in FMP fisheries in the Northeast region. However, VMS coverage is not universal for all fisheries, with some fisheries (summer flounder, scup, black sea bass, bluefish, American lobster, spiny dogfish, skate, whiting, and tilefish) not covered at all by VMS (for a greater description of the limitations of VMS data see Appendix D, Section D1.6). In 2018 there were 912 VMS-enabled vessels operating in the Northeast across all fisheries. These 912 vessels represented a substantial portion (71–87 percent) of summer flounder, scup, black sea bass, and skate landings, and greater than 90 percent of landings for scallops, squid, monkfish, herring, mackerel, large mesh multispecies, whiting, surfclams, and ocean quahogs. VMS vessels represented less than

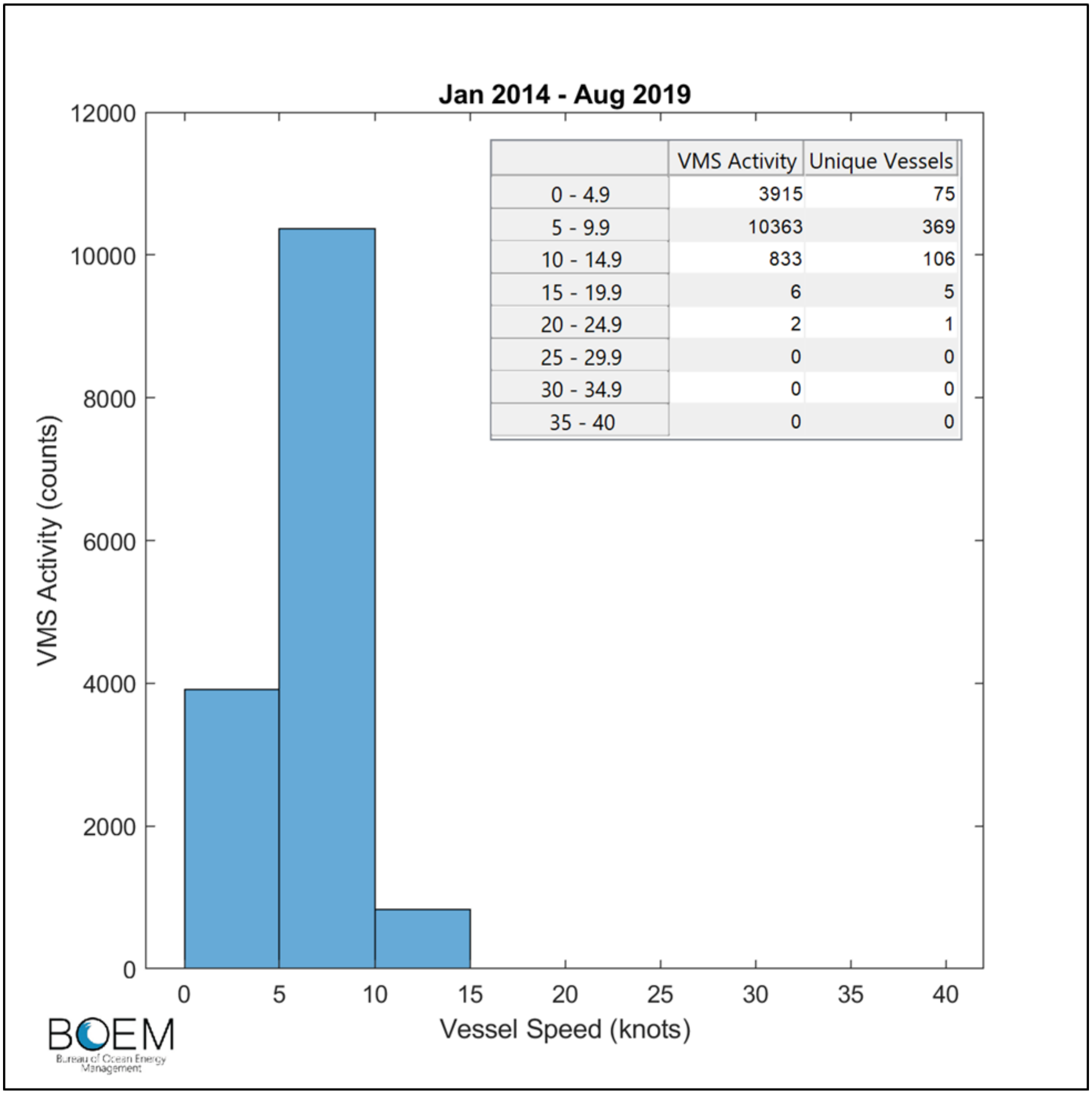
20 percent of highly migratory species and 10 percent of lobster/Jonah crab landings (NMFS pers. comm. 2020).

Using VMS data conveyed in individual position reports (pings) from January 2014 to August 2019, BOEM compiled information about fishing activities within the Lease Area (NMFS 2019). From the VMS data, it is interpreted that vessels with speeds less than 5 knots (2.6 m/s) are actively engaged in fishing, although vessels may also be using slower speeds to transit or be engaged in other activities such as processing at sea. Vessels traveling faster than 5 knots (2.6 m/s) are generally interpreted to be transiting. Figure 3.9-4 indicates that only about 13 percent of the 556 unique vessels identified operating in the Lease Area during the above-referenced period were actively fishing. BOEM also developed polar histograms using the VMS data that show the directionality of VMS-enabled vessels operating in the Project area and the targeted FMP fishery (Figure 3.9-5 through Figure 3.9-9). The larger bars in the polar histograms represent a greater number of position reports showing fishing vessels moving in a certain direction within the Project area. The polar histograms differ with respect to their scales.

Figure 3.9-5 shows that for all activities (transiting and fishing combined), most of the 377 unique vessels participating in a VMS fishery generally operated in a southwest-northeast pattern with a secondary pattern of northwest-southeast, while most of the 201 unique vessels participating in a non-VMS fishery[5] generally operated in a southwest-northeast pattern. Figure 3.9-6 shows that VMS fishery vessels transiting the Lease Area followed primarily a southwest-northeast pattern with a secondary pattern of northwest-southeast and non-VMS fishery vessels generally transited in a southwest-northeast pattern. Figure 3.9-7 show that most of the unique VMS fishery vessels fishing in the Lease Area followed a slightly northeast-southwest fishing pattern while the orientation for those non-VMS fishery vessels actively fishing in the Lease Area varied, but had a slightly southwest pattern.

For individual FMP fisheries, Figure 3.9-8 shows that the orientation of vessels transiting the Lease Area generally followed a northeast-southwest pattern except for those in the Surfclam/Ocean Quahog FMP fishery, which followed a northwest-southeast pattern. Figure 3.9-9 shows that the orientation of vessels actively fishing within the Lease Area varied by FMP fishery.

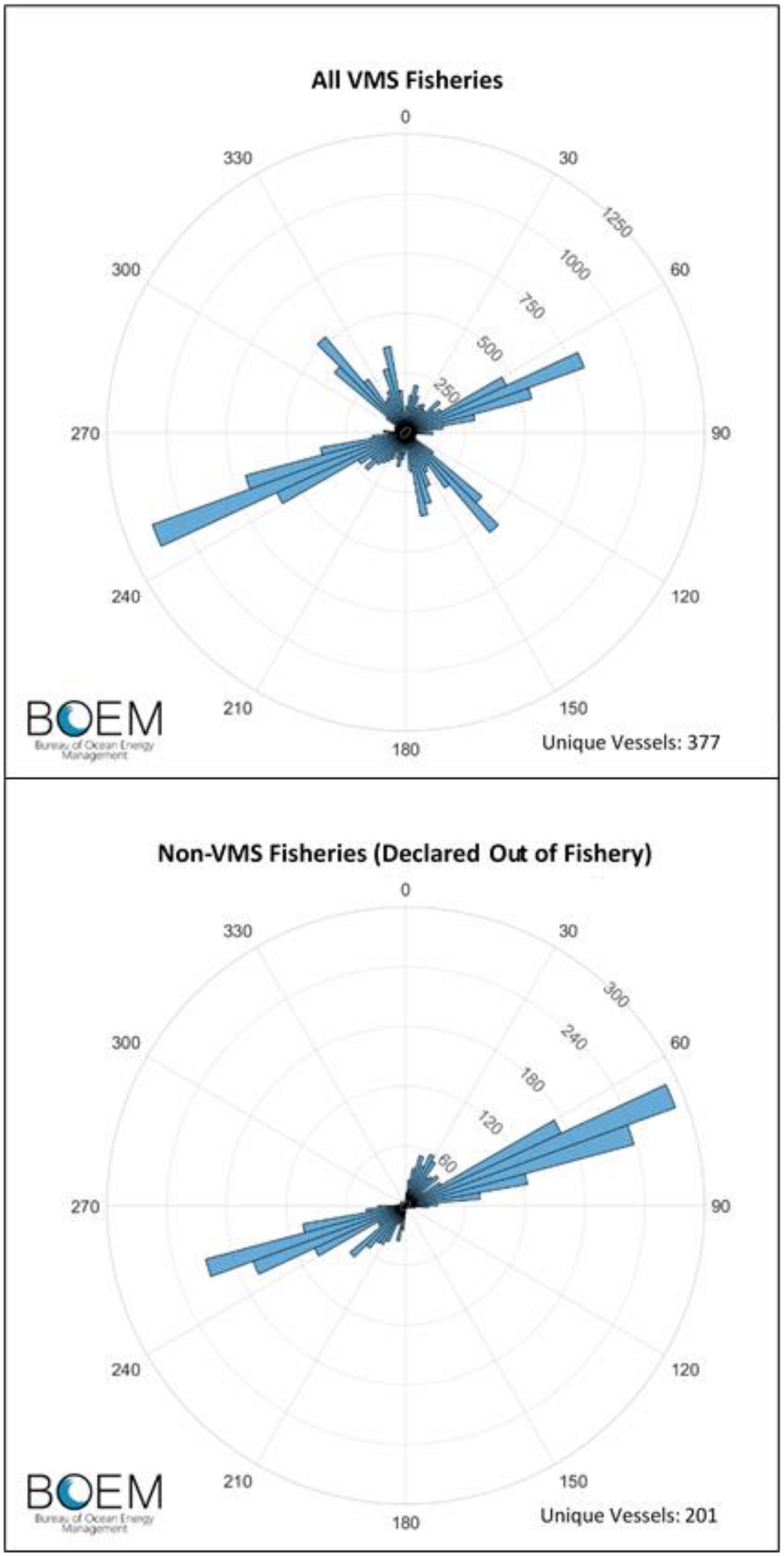
[5] Vessels that are considered non-VMS Fisheries have declared as out of fishery, meaning they have declared out of a fishery managed by days-at-sea effort controls (i.e., scallops, Northeast multispecies, and monkfish).



	VMS Activity	Unique Vessels
0 - 4.9	3915	75
5 - 9.9	10363	369
10 - 14.9	833	106
15 - 19.9	6	5
20 - 24.9	2	1
25 - 29.9	0	0
30 - 34.9	0	0
35 - 40	0	0

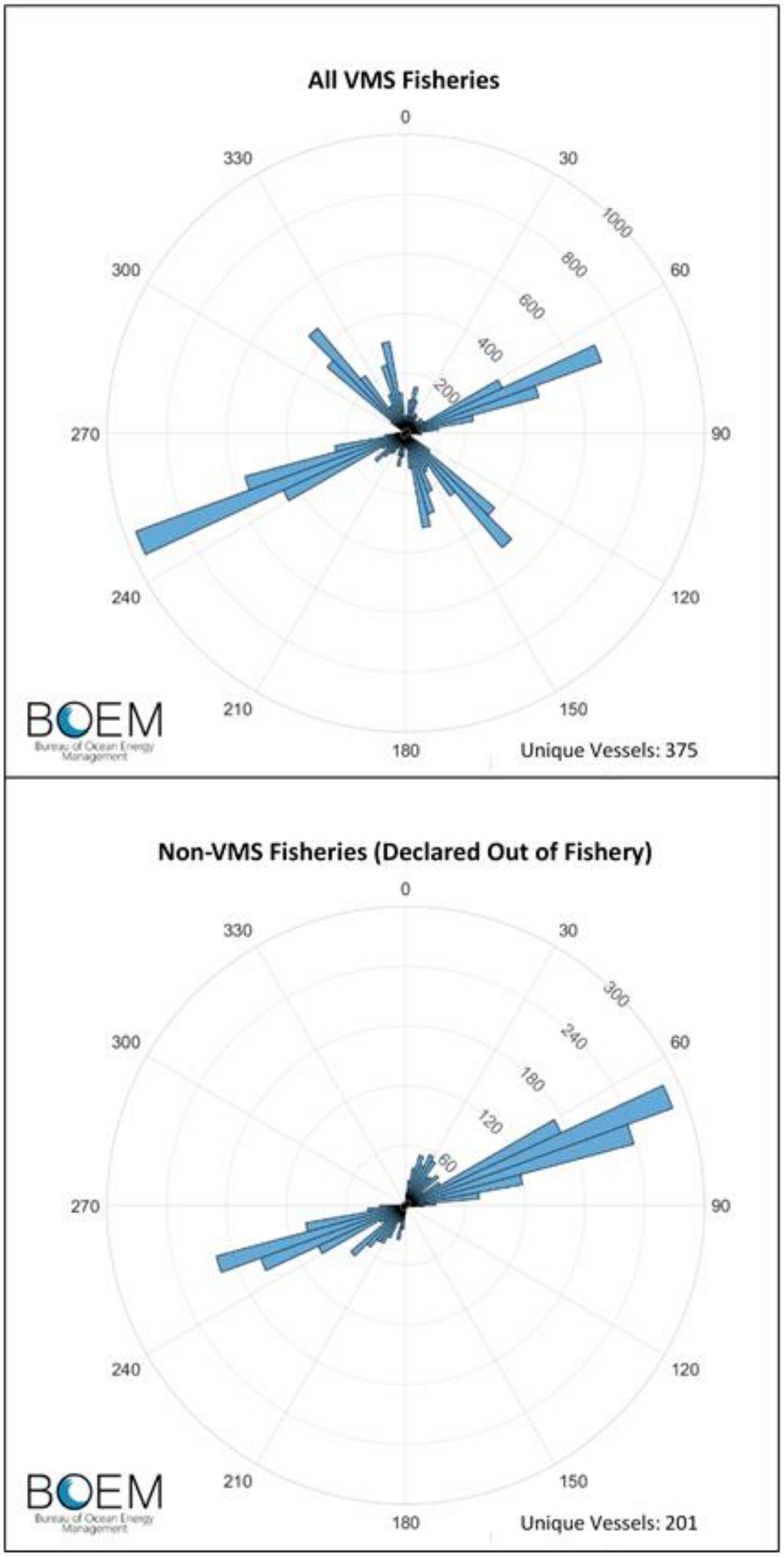
Source: Developed by BOEM using VMS data provided by NMFS (2019).

Figure 3.9-4 VMS Activity and Unique Vessels Operating in the Lease Area, January 2014–August 2019



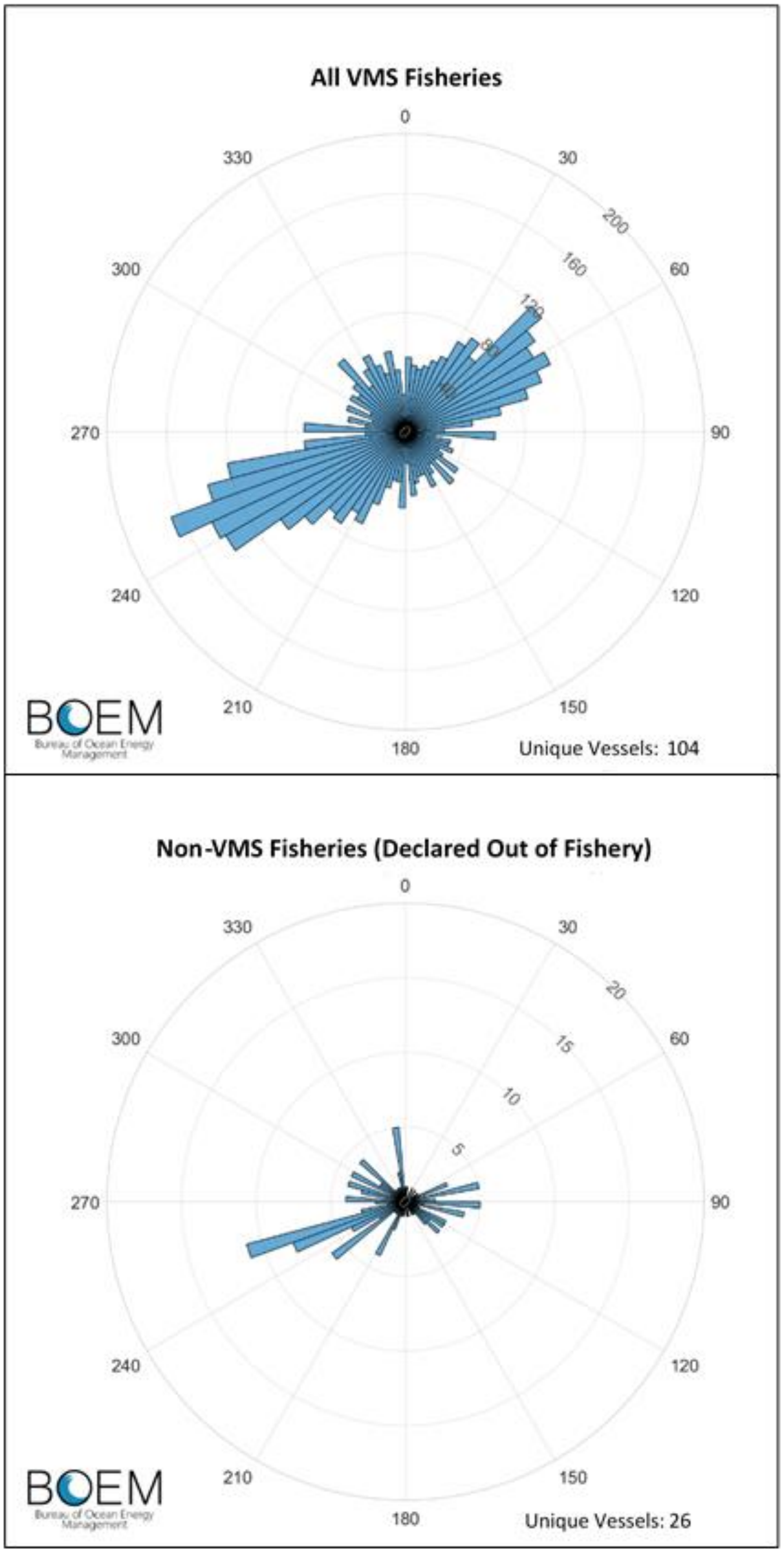
Source: Developed by BOEM using VMS data provided by NMFS (2019).

Figure 3.9-5 VMS Bearings for All Activity of VMS and Non-VMS Fisheries within the Lease Area, January 2014–August 2019



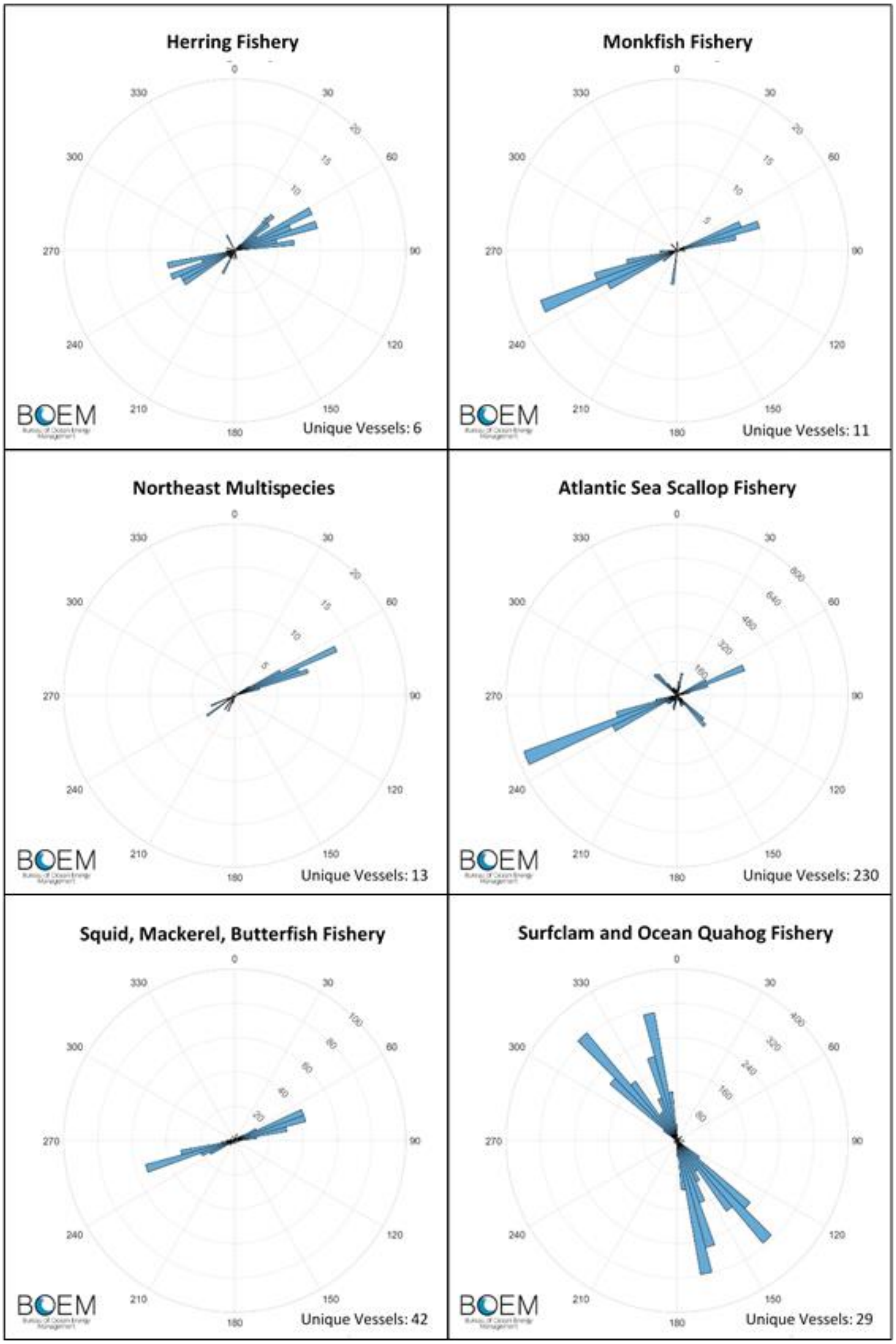
Source: Developed by BOEM using VMS data provided by NMFS (2019).

Figure 3.9-6 VMS Bearings for Transiting VMS and Non-VMS Fishery Vessels within the Lease Area, January 2014–August 2019



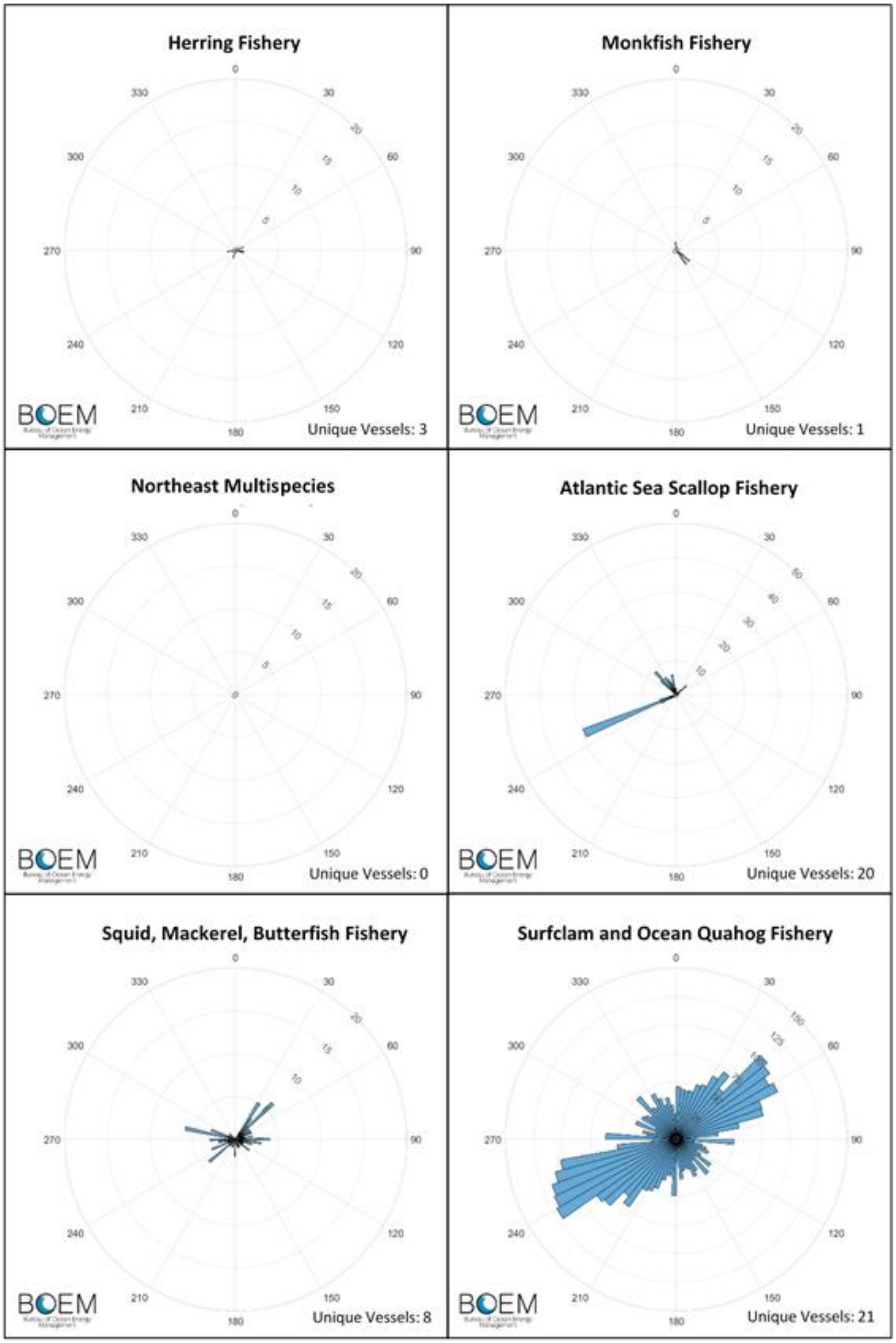
Source: Developed by BOEM using VMS data provided by NMFS (2019).

Figure 3.9-7 VMS Bearings for Fishing Activity by VMS and Non-VMS Fishery Vessels within the Lease Area, January 2014–August 2019



Source: Developed by BOEM using VMS data provided by NMFS (2019).

Figure 3.9-8 VMS Bearings of Vessels Transiting the Lease Area by FMP Fishery, January 2014–August 2019



Source: Developed by BOEM using VMS data provided by NMFS (2019).

Figure 3.9-9 VMS Bearings of Vessels Actively Fishing in the Lease Area by FMP Fishery, January 2014–August 2019

For-Hire Recreational Fishing

As with the commercial fishing industry, the for-hire recreational fishing fleets contribute to the economy through direct employment, income, and gross revenues of the for-hire businesses, as well as through spending on products and services to maintain and operate their vessels, triggering further indirect multiplier effects that are dependent upon the initial demands of the for-hire fleet (Steinback and Brinson 2013). For-hire recreational fishing boats are operated by licensed captains for businesses that sell recreational fishing trips to anglers. These boats include both party (head) boats, defined as boats on which fishing space and privileges are provided for a fee, and charter boats, defined as boats operating under charter for a price, time, etc., whose participants are part of a preformed group of anglers (NMFS 2021c). New Jersey's recreational fleet consists of approximately 100 party and 300 charter boats, which are docked near all major inlets and bays (NJDEP 2010).

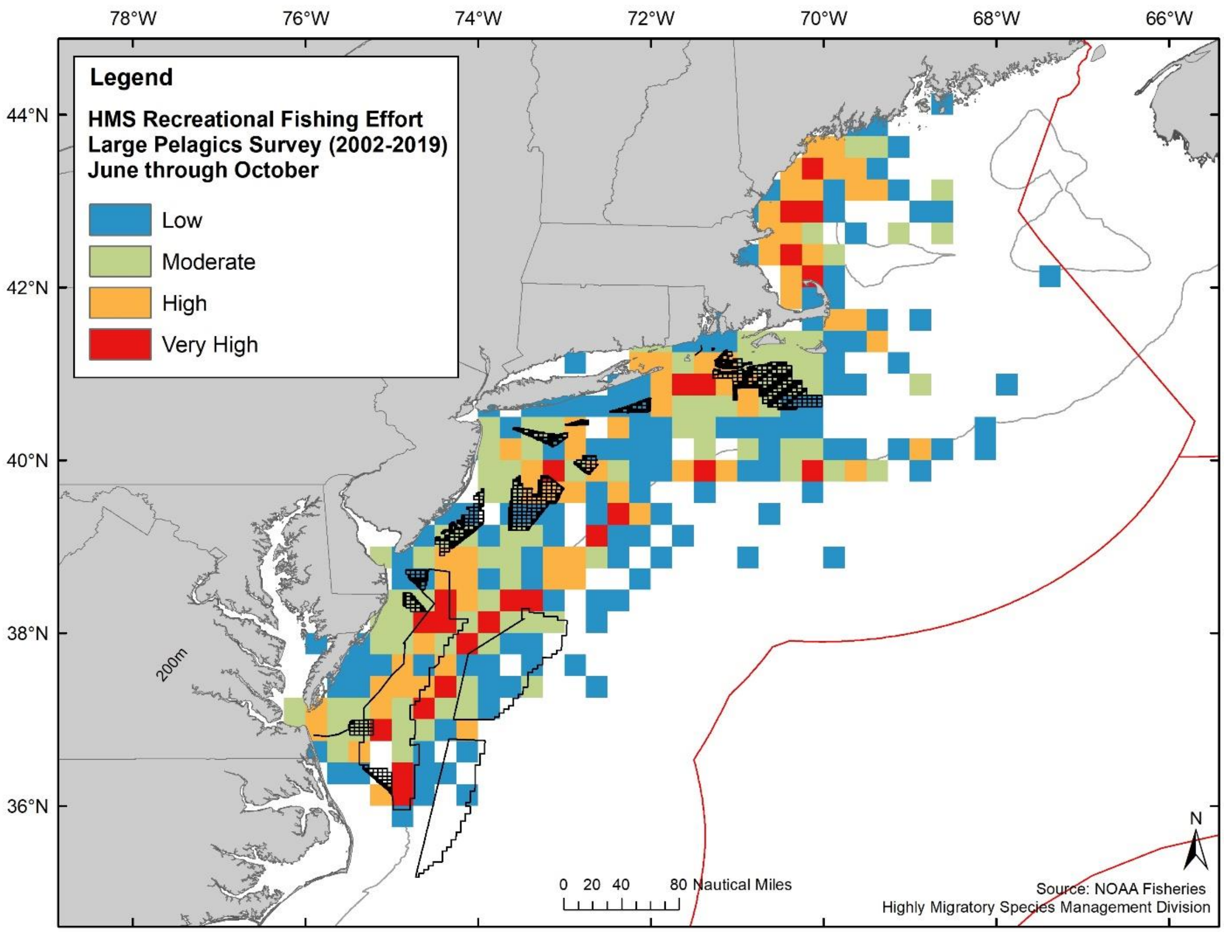
New Jersey has compiled information from charter boat, party boat, and private boat captains to identify the areas they consider recreationally significant fishing areas or prime fishing areas (see Figure 2.3.4-9 in COP Volume II, Section 2.3.4.1.4; Ocean Wind 2023). These specific areas are described as those that consistently produce good catches of fish, most likely because the physical characteristics of those locations provide optimum fish habitat. Historically productive fishing grounds, for example, often occur around rock piles, shallow ridges, artificial and natural reefs, deep sloughs, and bay inlets.

NOAA works with state and local partners to monitor the recreational fishery catch and effort through the Marine Recreational Information Program (COP Volume II, Section 2.3.4.1.4; Ocean Wind 2023 citing NOAA Fisheries n.d.). The for-hire recreational fishing data reported for New Jersey (March to December) include fish discarded, landed, and used as bait. Approximately 1.8 million fish were reported caught in New Jersey in 2017. A wide variety of species/groups were reported, with the highest numbers and diversity of species in offshore areas. Striped bass (*Morone saxatilis*) was the primary species caught in inland waters in March/April and November/December. Summer flounder dominated the inland catch from May to October with sea robins (Triglidae) co-dominating during summer months. The highest catch numbers reported caught in state waters offshore New Jersey occurred from July/August and September/October, with approximately 200,000 fish caught during each interval. The reported catch was dominated primarily by black sea bass, followed by scup (*Stenotomus chrysops*), summer flounder, sea robin, striped bass, and skates/rays. Other species reported in higher numbers consist of cunner (*Tautogolabrus adspersus*), tautog (*Tautoga onitis*), dogfish sharks, Atlantic cod (*Gadus morhua*), and bluefish. The highest reported catch numbers occurred in federal waters, ranging from more than 25,000 reported in March/April to nearly 675,000 for July/August. The species composition for federal waters was similar to that of state waters, with additional species of tunas/mackerels. Large numbers of black sea bass, nearly 300,000, were reported in November/December (COP Volume II, Section 2.3.4.1.4; Ocean Wind 2023 citing NOAA Fisheries n.d.).

The blue crab fishery is not included in the Marine Recreational Information Program. Blue crabs are abundant all along the New Jersey coast, in tidal creeks and rivers, and in shallow, saltwater bays, from the Hudson River to Delaware Bay. Recreational fishing effort in New Jersey is greater for blue crab than any other single species (COP Volume II, Section 2.3.4.1.4; Ocean Wind 2023 citing NJDFW n.d.). Recreational crabbing is done by small boats, shoreline bank, bulkhead, bridge, or pier-bordering tidal waters and not by for-hire party boats or charters. Adult blue crabs may use benthic habitat for spawning; dredging impacts could include increased local total suspended solids, loss of larvae due to suction dredging, or short-term displacement of individual crabs. However, these impacts are either short term, limited in spatial extent, or insignificant to the success of the species.

Recreational fishing for highly migratory species also occurs in and around the Lease Area and along the export cable corridor. Based on the NMFS Large Pelagics Survey, an intercept survey that includes both for-hire and private fishing, the level of recreational fishing effort for highly migratory species from

2002–2019 ranged from low to moderate in the Project area (Figure 3.9-10). The Large Pelagics Survey data metric is intercepts, meaning a fisherman intercepted by a dockside monitor reported fishing for highly migratory species in that block on the intercepted trip (i.e., a positive fishing effort for highly migratory species); therefore, it is not a census of all trips, but a sample of trips based upon dockside coverage in ports (Curtis 2023).



Note: Data are based on intercept surveys and include both for-hire and private fishing for highly migratory species. Leasing and planning areas are as of approximately 2020.

Figure 3.9-10 Fishing Effort for Highly Migratory Species in the Greater Atlantic

As shown in Table 3.9-16, from 2008 to 2021, the annual revenue from the for-hire recreational fishery operating in the Lease Area varied considerably, ranging from a low of $5,000 (rounded to the nearest thousand dollars) in 2008 to a high of $82,000 in 2012, while totaling $293,000 during the entire period and averaging $20,929.

Table 3.9-16 Total For-Hire Recreational Fishing Revenue by Year for Lease Area, 2008–2021

Year	Annual Revenue
2008	$5,000
2009	$11,000
2010	$6,000

Year	Annual Revenue
2011	17,000
2012	$82,000
2013	$5,000
2014	$12,000
2015	$16,000
2016	$19,000
2017	$16,000
2018	$44,000
2019	$22,000
2020	$31,000
2021	$7,000
Total	**$293,000**
Average	**$20,929**

Source: NMFS 2022b.
Notes: Escalated to 2021 dollars and rounded to nearest $1,000.

Table 3.9-17 and Table 3.9-18 show the total number of trips to the Lease Area by year and port for party/charter boats and angler trips, respectively.

Table 3.9-17 Total Number of Party/Charter Boat Trips by Port and Year for Lease Area, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Other Ports, NJ[1]	9	14	9	11	31	10	10	10	35	36	25	23	13	6
Atlantic City, NJ	0	0	0	4	0	0	8	7	0	0	0	0	0	0
Other Ports, MD	0	0	0	0	0	0	0	3	0	0	0	0	0	0
No Port Data	0	0	0	0	0	0	0	0	0	0	2	1	0	3
Sea Isle City, NJ	0	0	0	0	0	0	0	0	0	0	19	0	0	0

Source: NMFS 2022b.
[1] The "Other Ports" category refers to ports with fewer than three permits to protect data confidentiality.

Table 3.9-18 Total Number of Angler Trips by Port and Year for Lease Area, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Other Ports, NJ[1]	71	143	78	153	953	57	80	79	204	171	334	231	336	80
Atlantic City, NJ	0	0	0	46	0	0	49	45	0	0	0	0	0	0
Other Ports, MD	0	0	0	0	0	0	0	47	0	0	0	0	0	0
No Port Data	0	0	0	0	0	0	0	0	0	0	20	29	0	14
Sea Isle City, NJ	0	0	0	0	0	0	0	0	0	0	142	0	0	0

Source: NMFS 2022b.
[1] The "Other Ports" category refers to ports with fewer than three permits to protect data confidentiality.

To understand the relative importance of the Lease Area to the regional for-hire recreational fishing industry, Table 3.9-19 compares the landings reported in the Lease Area for the top five species to the entire Northeast region by year during the 2008–2021 period. Table 3.9-20 provides the 14-year fish count and percentage of the total for the Northeast region for the top five species.

Table 3.9-19 Annual Party Vessel Trips, Angler Trips, and Number of Vessels in the Lease Area as a Percentage of the Geographic Analysis Area, 2008–2021

Year	Vessel Trips as % of Total	Angler Trips as % of Total	Number of Vessels as % of Total
2008	0.03%	2.12%	1.08%
2009	0.05%	6.38%	1.08%
2010	0.03%	1.47%	0.74%
2011	0.05%	1.96%	1.64%
2012	0.10%	10.83%	1.21%
2013	0.03%	4.51%	0.55%
2014	0.07%	1.55%	1.54%
2015	0.08%	6.57%	1.61%
2016	0.14%	11.30%	1.37%
2017	0.15%	14.16%	1.20%
2018	0.22%	15.90%	2.24%
2019	0.12%	28.11%	0.74%
2020	0.06%	11.08%	0.73%
2021	0.04%	6.88%	0.66%

Source: NMFS 2022b.

Table 3.9-20 14-Year Fish Count for Top Six Fish Species Landed by For-Hire Recreational Fishing in the Lease Area as a Percentage of the Geographic Analysis Area, 2008–2021

Species	Fish Count as % of Total
Triggerfish	0.08%
Summer Flounder	0.06%
Black Sea Bass	0.05%
Tautog	0.03%
Sea Robins	0.02%
Bluefish	0.01%

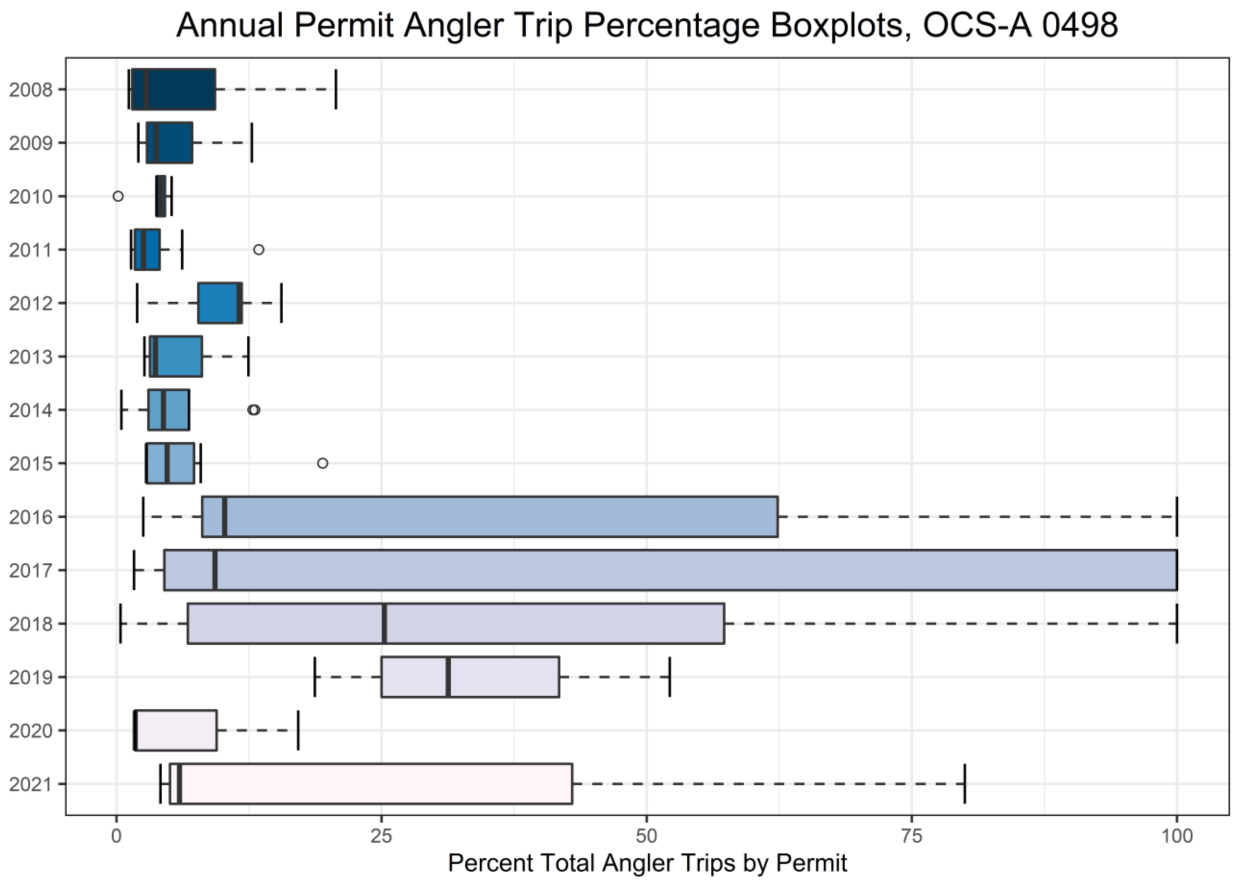
Source: NMFS 2022b.
[1] "All Others" refers to species with fewer than three permits to protect data confidentiality.

To analyze differences in the importance of fishing grounds in the Lease Area for the for-hire recreational fishery, NMFS analyzed the percentage of each permit's total angler trips in the Lease Area from 2008 through 2021 (NMFS 2022b). Results are presented on Figure 3.9-11, which displays the data in a boxplot. A description of the meaning of the quartiles and other information for the boxplot can be found in Section 3.9.1, in the text associated with Figure 3.9-3. Table 3.9-21 presents the minimum, first quartile, median, third quartile, and maximum values for the Lease Area from 2008 through 2021.

Table 3.9-21 Analysis of 14-Year Summary of Permit Angler Trip Percent Boxplots for the Lease Area (2008–2021)

Minimum	1st Quartile	Median	3rd Quartile	Maximum Revenue Percentage Value[1]
0.16%	3%	5%	13%	100%

Source: Developed using data from NMFS 2022b.
[1] Maximum value is inclusive of outliers.



Source: NMFS 2022b.

Figure 3.9-11 Annual Permit Angler Trip Percentage Boxplots for the Lease Area, 2008–2021

A total of 75 percent of the permitted vessels that fished in the Lease Area derived less than 13 percent of their total annual revenue from the area (NMFS 2022b). The highest percentage of total annual angler trips attributed to the Lease Area was 100 percent in 2016, 2017, and 2018, but varied from year to year. There was a change in the percentage of annual angler trips to the Lease Area from 2008 to 2015 compared to after 2016 where there was an increase in the percentage of angler trips to the Lease Area (Figure 3.9-11).

Data show that essentially all for-hire recreation fishing entities both in the Northeast Region as well as within the Ocean Wind Lease Area are considered small businesses. At the regional level, from 2019 to 2021, there were between 289 and 402 entities operating that generated between $1.8 and 4.7 million in the for-hire recreational fishing category. Within the Lease Area, data available for 2021 show three small business entities operating and no large business entities (NMFS 2022b).

3.9.2 Environmental Consequences

3.9.2.1. Impact Level Definitions for Commercial Fisheries and For-Hire Recreational Fishing

Definitions of impact levels are provided in Table 3.9-22.

Table 3.9-22 Impact Level Definitions for Commercial Fisheries and For-Hire Recreational Fishing

Impact Level	Impact Type	Definition
Negligible	Adverse	No impacts would occur, or impacts would be so small as to be unmeasurable.
	Beneficial	No effect or no measurable effect.
Minor	Adverse	Impacts on the affected activity or community would be avoided and would not disrupt the normal or routine functions of the affected activity or community. Once the affecting agent is eliminated, the affected activity or community would return to a condition with no measurable effects.
	Beneficial	Small or measurable effects that would result in an economic improvement.
Moderate	Adverse	Impacts on the affected activity or community are unavoidable. The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the Project or, once the affecting agent is eliminated, the affected activity or community would return to a condition with no measurable effects if appropriate remedial action is taken.
	Beneficial	Notable and measurable effects that would result in an economic improvement.
Major	Adverse	The affected activity or community would experience substantial disruptions and, once the affecting agent is eliminated, the affected activity or community could retain measurable effects indefinitely, even if remedial action is taken.
	Beneficial	Large local or notable regional effects that would result in an economic improvement.

3.9.3 Impacts of the No Action Alternative on Commercial Fisheries and For-Hire Recreational Fishing

When analyzing the impacts of the No Action Alternative on commercial fisheries and for-hire recreational fishing, BOEM considered the impacts of activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for commercial fisheries and for-hire recreational fishing. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*.

3.9.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for commercial fisheries and for-hire recreational fishing described in Section 3.9.1, *Description of the Affected Environment for Commercial Fisheries and For-Hire Recreational Fishing*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities (see Section F.2 in Appendix F for a description of ongoing and planned activities).

Ongoing non-offshore wind activities within the geographic analysis area that have impacts on commercial and for-hire recreational fisheries are generally associated with climate change and fisheries use and management. Ongoing impacts of climate change include increased magnitude or frequency of storms, shoreline changes, ocean acidification, and water temperature changes. Risks to fisheries associated with these events include the ability to safely conduct fishing operations (e.g., because of storms) and climate-related habitat or distribution shifts in targeted species. Fish and shellfish species are expected to exhibit variation in their responses to climate change, with some species benefiting from climate change and others being adversely affected (Hare et al. 2016). To the extent that impacts of climate change on targeted species result in a decrease in catch or increase in fishing costs, the profitability of businesses engaged in commercial fisheries and for-hire recreational fishing would be adversely affected. Ongoing activities of NMFS and fishery management councils affect commercial and for-hire recreational fisheries through stock assessments, setting quotas, and implementing FMPs to ensure the continued existence of species at levels that will allow commercial and for-hire recreational fisheries to occur. Fishery management measures affect fishing operations differently for each fishery and are intended to achieve long-term, sustainable fisheries populations, which should have long-term benefits to fisheries and fishing communities.

Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on commercial fisheries and for-hire recreational fishing include:

- Continued O&M of the Block Island project (five WTGs) installed in state waters;
- Continued O&M of the Coastal Virginia Offshore Wind project (two WTGs) installed in OCS-A 0497; and
- Ongoing construction of two offshore wind projects, the Vineyard Wind 1 project (62 WTGs and 1 OSS) in OCS-A 0501 and the South Fork Wind project (12 WTGs and 1 OSS) in OCS-A 0517.

The effects of approved projects have been evaluated through previous NEPA review and are incorporated by reference. Ongoing O&M of the Block Island and Coastal Virginia Offshore Wind projects and ongoing construction of the Vineyard Wind 1 and South Fork projects would affect commercial fisheries and for-hire recreational fishing through the primary IPFs of anchoring, noise, port utilization, vessel traffic, presence of structures, and cable emplacement and maintenance. Ongoing offshore wind activities would have the same type of impacts from anchoring, noise, port utilization, vessel traffic, presence of structures, and cable emplacement and maintenance that are described in detail in Section 3.9.3.2 for planned offshore wind activities but the impacts would be of lower intensity.

3.9.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with other planned non-offshore wind activities and planned offshore wind activities (without the Proposed Action).

Planned non-offshore wind activities within the geographic analysis area that contribute to cumulative impacts on commercial fisheries and for-hire recreational fishing include new submarine cables and pipelines, oil and gas activities, marine minerals extraction, port expansions, and future marine transportation and fisheries use. Some of these activities may result in disruptions to fishing vessel traffic, bottom disturbance or habitat conversion, and injury or mortality of fish and shellfish that are targeted in fisheries.

Fishery management measures likely to be implemented in the future include measures to reduce the risk of interactions between fishing gear and the North Atlantic right whale (NARW) by 60 percent (McCreary and Brooks 2019). This measure would likely have an adverse impact on fishing effort in the lobster and Jonah crab fisheries in the geographic analysis area. See Table F1-7 for a summary of potential impacts associated with ongoing and planned non-offshore wind activities by IPF for commercial and for-hire recreational fisheries.

Planned offshore wind activities include offshore wind energy development activities on the Atlantic OCS other than the Proposed Action determined by BOEM to be reasonably foreseeable (see Section F.2 and Attachment 2 in Appendix F for a complete description of planned offshore wind activities). BOEM expects planned offshore wind activities to affect commercial and for-hire recreational fisheries through the following primary IPFs.

Anchoring: Excluding the Proposed Action, BOEM estimates that approximately 3,058 acres (12.3 km^2) of seabed would be disturbed by anchoring associated with all other offshore wind activities. Anchoring vessels used in the construction of offshore wind energy projects would pose a navigational hazard to fishing vessels. All impacts would be localized (within a few hundred meters of anchored vessel) and temporary (hours to days in duration). Although anchoring impacts would occur primarily during project construction, some impacts could also occur during O&M and conceptual decommissioning. Therefore, the adverse effects of offshore wind energy–related anchoring on commercial fisheries and for-hire recreational fishing are expected to be long term and minor, though periodic in nature.

Noise: Noise impacts caused by offshore construction, including pile driving, trenching for cable placement, O&M activities, G&G investigations, and vessels, could cause indirect impacts on commercial and for-hire recreational fisheries through their direct impacts on species targeted by commercial and for-hire recreational fisheries. Noise impacts would also occur during decommissioning activities.

G&G surveys would be conducted for site assessment and characterization activities associated with offshore wind facilities and are expected to occur intermittently over a 2- to 10-year period at locations throughout the geographic analysis area. Site characterization surveys for offshore wind farms typically use sub-bottom profiler technologies that generate sound waves that are similar to common deep-water echosounders. These survey methods produce less-intense sound waves compared to seismic surveys used in oil and gas exploration. Noise from G&G surveys may cause localized and temporary behavioral changes in some fish species, which could affect the catch efficiency of some fishing gears (e.g., hook and line). However, the noise from G&G surveys is not anticipated to affect reproduction and recruitment of fish stocks. Although schedules for many planned offshore wind activities are still being developed, noise impacts on fish and shellfish might be minimized by sequentially scheduling site assessment and characterization surveys to avoid overlapping noise from different surveys.

Planned offshore wind activities will generate impulsive pile-driving noise during foundation installation. One or more projects may install more than one foundation per day, either concurrently or sequentially over the 6- to 10-year construction period. Noise transmitted through water and the seabed can cause injury to or mortality of fish over a small area around each pile and can cause temporary stress and behavioral changes over a larger area. Because of the relatively small footprint of injurious sound and the ability for most fish to swim away from noise sources, injurious noise from pile driving is not expected to cause stock-level changes that would adversely affect fisheries. High-intensity pile-driving noise may influence fish behavior by causing auditory masking and alteration of foraging patterns, social behavior, and metabolism (McCauley et al. 2000; Wahlberg and Westerberg 2005; Madsen et al. 2006; Slabbekoorn et al. 2010, as cited in Siddagangaiah et al. 2021). It is expected that behavioral responses to noise may cause some displacement of fish, thereby temporarily reducing the quality of fishing in affected areas and causing fishers to seek alternative fishing areas (Skalski et al. 1992). Behavioral responses from pile driving may occur at distances of 11 kilometers or greater, such that construction activities in adjacent projects could affect fish and fisheries beyond the boundaries of an individual project. While most finfish species are expected to avoid the noise-affected areas, invertebrates may exhibit stress and behavioral changes, such as discontinuation of feeding activities (Roberts and Elliott 2017). Behavioral responses to pile-driving noise may cause displacement of fishing activity and resulting increased conflict among fishers, increased operating costs for vessels, and lower revenue. Furthermore, pile-driving noise may cause spawning behavior changes. To the extent that changes in spawning behavior result in reduced reproductive success and subsequent recruitment, this could potentially result in long-term effects on populations and harvest levels. However, the risk of reduced recruitment from pile-driving noise is low because the behavioral impacts would only occur over the duration of noise. Behavioral impacts would be localized to the ensonified area and temporary, as fish behavior is expected to return to pre-construction levels following the completion of pile driving (Jones et al. 2020; Shelledy et al. 2018).

Several activities associated with cable laying would produce noise, including route identification surveys, trenching, jet plowing, backfilling, and installation of cable protection. Modeling based on noise data collected during cable laying for European wind farms has estimated that underwater noise levels would exceed 120 dB in a 98,842-acre area surrounding the source (Bald et al. 2015; Nedwell and Howell 2004; Taormina et al. 2018), which is well below the 150-dB threshold for behavioral responses in fish (Andersson et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007). As was described for pile-driving noise above, fish that are exposed to cable-laying noise may experience temporary stress and behavioral changes, which could indirectly cause displacement of fishing activity. However, because the cable-laying vessel and equipment would be continually moving and the ensonified area would move with it, a given area would not be ensonified for more than a few hours. Therefore, any behavioral responses to cable-laying noise are expected to be temporary and localized and are not expected to result in fishery-level impacts.

Vessels generate low-frequency, non-impulsive noise that could cause temporary stress or behavioral responses in fish. Vessel activity from planned offshore wind activities is expected to peak in 2024 when up to 379 vessels could be involved in construction of offshore wind facilities (BOEM 2019). This increase in vessel activity could cause repeated, intermittent behavioral responses in fish, which could indirectly cause displacement of fishing activity. Because behavioral responses to vessel noise would be localized and temporary, dissipating once the vessel leaves the area, they are not expected to result in fishery-level impacts.

Operating WTGs generate non-impulsive underwater noise that is audible to some fish. However, operating WTGs are expected to produce noise levels that are below recommended thresholds for fish injury and behavioral effects, and noise levels are expected to reach ambient levels within a short distance of turbine foundations. Therefore, noise from operating WTGs is not expected to result in fishery-level impacts.

Consequently, BOEM expects that underwater noise associated with planned offshore wind activities will cause long-term, moderate impacts on commercial and for-hire recreational fisheries, depending on the timing and overlap of construction activities. Impacts are expected to primarily result from pile-driving noise during the installation of foundations for WTGs and OSS. See Section 3.13.3.2 for a full description of noise impacts on fish and invertebrates.

Port utilization: Construction and decommissioning of offshore wind energy projects would require port facilities for staging and installation/decommissioning vessels, including crew transfer, dredging, cable lay, pile driving, survey vessels, and, potentially, feeder lift barges and heavy lift barges. All of these activities would add vessel traffic to port facilities and would require berthing. The additional vessel volume in construction ports could cause vessel traffic congestion, difficulties with navigating, and an increased risk for collisions, together with reduced access to high-demand port services (e.g., fueling and provisioning) by existing port users, including commercial fishing vessels. The impacts would be spread across the entire geographic analysis area throughout the duration of the construction period for offshore wind projects from 2023 to 2030, as well as beyond 2030 when projects go through decommissioning. These potential adverse impacts could cause some commercial and for-hire recreational vessel operators to change routes or use an alternative port. However, none of the New Jersey ports that may be used for the Project (and for which there is potential for cumulative effects with other offshore wind activities) are in areas with high levels of commercial fishing engagement, reducing the potential for space-use conflicts and competition between fishing vessels and vessels used for offshore wind for berths at ports. Areas adjacent to Charleston Harbor have medium to medium-high levels of commercial fishing engagement, while Norfolk, Virginia, supports a medium level of commercial fishing engagement. Impacts would be expected to be negligible to minor and temporary in nature, lasting the duration of the construction and decommissioning of the projects.

Traffic: The installation and decommissioning of offshore components for offshore wind energy projects and the presence of construction vessels could temporarily restrict fishing vessel movement and thus transit and harvesting activities within offshore wind lease areas and along the cable routing areas. To safeguard mariners from the hazards associated with installation and decommissioning of these offshore components, it is expected that most, if not all, offshore wind energy projects would create safety zones around construction areas. For example, for the Block Island Wind Farm, a 500-yard (457-meter) safety zone around the individual wind turbine locations was implemented during construction (BOEM 2018). When safety zones are in effect, fishing vessels could either forfeit fishing revenue or relocate to other fishing locations and continue to earn revenue. However, vessels that chose to relocate could incur increased operating costs such as increased fuel costs due to longer transit times to and from more distant fishing grounds, increased equipment maintenance/repair, and additional crew compensation due to more days at sea, among other factors. Commercial and for-hire recreational vessel operators could also experience lower revenue due to fishing potentially less-productive fishing grounds, potentially having to switch to less-valuable species, and potentially encountering more competition for a given resource. In addition, the increased steaming time may result in product spoilage for fisheries such as surfclams that must be processed shortly after harvest.

Once offshore wind projects are completed, some commercial fishermen may avoid the offshore wind lease areas if large numbers of recreational fishermen are drawn to the areas by the prospect of higher catches. WTG foundations and associated scour protection may produce an artificial reef effect, potentially increasing fish and invertebrate abundance within a facility’s footprint (see Section 3.13, *Finfish, Invertebrates, and Essential Fish Habitat*). According to ten Brink and Dalton (2018), the influx of recreational fishermen into the Block Island Wind Farm caused some commercial fishermen to cease fishing in the area because of vessel congestion and gear conflict concerns. If these concerns cause commercial fishermen to shift their fishing effort to areas not routinely fished, conflict with existing users could increase as other areas are encroached. In general, the potential for conflict among commercial fishermen due to fishing displacement may be higher for fishermen engaged in fisheries that have regulations that constrain where fishermen can fish, such as the lobster fishery. However, the potential for vessel congestion and gear conflict may also increase if mobile species targeted by commercial fishermen, such as Atlantic herring, Atlantic mackerel, squid, tuna, and groundfish, are attracted to offshore wind energy facilities by the artificial reef effect, and fishermen targeting these species concentrate their fishing effort in offshore wind lease areas as a result. Overall, the adverse impacts from vessel traffic would be long term and moderate.

Presence of structures: The presence of structures can lead to impacts on commercial fisheries and for-hire recreational fishing through allisions, entanglement or gear loss/damage, fish aggregation, and habitat conversion. It can also create navigational hazards (including transmission cable infrastructure) and space-use conflicts, which in turn could lead to vessel collisions. These impacts may arise from buoys, meteorological towers, foundations, scour/cable protection, and transmission cable infrastructure. Using the assumptions in Table F2-1 and Table F2-2 in Appendix F, offshore wind energy projects under the No Action Alternative would include 81 WTGs, 1,145 acres (4.3 km^2) of seabed disturbance due to foundation and scour protection, and 97 acres (0.4 km^2) of new hard protection atop cables. Projects may also install more buoys and meteorological towers. BOEM anticipates that structures would be added intermittently over an assumed 10-year period and that they would remain until conceptual decommissioning of each facility is complete.

The presence of the WTG foundations and associated scour protection would convert existing sand or sand with mobile gravel habitat to hard bottom, which, in turn, would reduce the habitat for target species that prefer soft-bottom habitat (e.g., surfclams, sea scallops, squid, summer flounder) and increase the habitat for target species that prefer hard-bottom habitat (e.g., lobster, striped bass, black sea bass, cod). Where WTG foundations and associated scour protection produce an artificial reef effect and attract finfish and invertebrates, the aggregation of species could increase the catchability of target species (Kirkpatrick et al. 2017). Although species that rely on soft-bottom habitat would experience a reduction in favorable conditions, the impacts from structures are not expected to result in population-level impacts (see Section 3.13, *Finfish, Invertebrates, and Essential Fish Habitat*). Decommissioning of each wind farm would then have the opposite impact, wherein the species dependent on hard-bottom or reef habitat would experience a reduction in favorable conditions, although some hard-bottom protection measures would remain, while removal of WTGs and their foundations would favor the increase of targeted species that prefer soft-bottom habitat.

USCG has stated that it does not plan to create exclusionary zones around offshore wind facilities during their operation (BOEM 2018). However, because of the height of wind turbines above the ocean surface, they would be visually detectable at a considerable distance during the day and easily detected by vessels equipped with radar regardless of the time of day. To further ensure navigational safety, all structures would have appropriate markings and lighting in accordance with USCG, BOEM, and IALA guidelines, and NOAA would chart wind turbine locations and could include a physical or virtual Automatic Identification System (AIS) at each turbine. Some fishing vessels operating in or near offshore wind facilities may experience radar clutter and shadowing. Most instances of interference can be mitigated through the proper use of radar gain controls (DNV-GL 2021). See also Section 3.16, *Navigation and Vessel Traffic*.

Notwithstanding these safety measures, some fishermen have commented that, because of safety considerations, they would not enter an offshore wind array during inclement weather, especially during low-visibility events (Kirkpatrick et al. 2017); during interviews with commercial fishermen, ten Brink and Dalton (2018) found that fishermen had concerns that low visibility, wind, or crew exhaustion could lead to vessels alliding with WTGs. Moreover, mechanical problems, such as loss of steerage, could result in an allision with a WTG as the vessel drifts during repair (DNV-GL 2021).

In addition, a potential effect of the presence of the offshore cables and wind turbines associated with offshore wind energy development is the entanglement and damage or loss of commercial and recreational fishing gear. Economic impacts on fishing operations associated with gear damage or loss include the costs of gear repair or replacement, together with the fishing revenue lost while gear is being repaired or replaced. In addition, comments from the fishing industry have included concerns that fishing vessel insurance companies may not cover claims for incidents within a WEA resulting in gear damage or loss, or they may increase premiums for vessels that operate within these areas. Given that mobile fishing gear is actively pulled by a vessel over the seafloor, the chance of snagging this gear type on project infrastructure is much greater than if—as in the case of fixed gear—the gear was set on the infrastructure or waves or currents pushed the gear into the infrastructure. The risk of damage or loss of deployed gear as a result of offshore wind development could affect mobile and fixed-gear commercial fisheries and for-hire recreational fishing. While the depth to which offshore power cables are buried is specific to individual projects, standard commercial practice is to bury cables 3 to 10 feet (0.9 to 3.0 meters) deep in waters shallower than 6,562 feet (2,000 meters) to protect them from external hazards such as fishing gear and anchors (BOEM 2018), and fishing gear does not typically penetrate that deep into the sediment and would normally not snag or become entangled in the cable. In a study of seabed depletion and recovery from bottom-trawl disturbance, Hiddink et al. (2017) found that hydraulic dredges, at 6.3 inches (16.1 centimeters), penetrated the ocean floor the deepest of any bottom-trawl gear. Therefore, even with the common practice of dredge vessels fishing the same or similar tow paths on multiple occasions during the same trip, it is unlikely that fishing gear would penetrate deep enough to snag or become tangled in the cable. However, due to underlying geology, cables may not be able to be buried to the minimum target depth along their entire distance. BOEM assumes less than 10 percent of the cables may not achieve the target burial depth and would require cable protection in the form of rock placement, concrete mattresses, or half-shell (BOEM 2021a). While cables are typically marked on nautical charts to aid in avoidance, mobile bottom-tending gear (trawl and dredge gear) could get snagged on these cable protection measures and cause damage or gear loss. Economic impacts on fishing operations associated with gear damage or loss include the costs of gear repair or replacement plus the fishing revenue lost while gear is being repaired or replaced, although the cost of these impacts would vary depending on the extent of damage to the fishing gear. To avoid these economic impacts, some vessel operators may not trawl or dredge over inter-array or export cables, but this could result in increased operating costs (e.g., additional fuel to arrive at more distant locations; additional crew compensation due to more days at sea) or lower revenue (e.g., fishing in a less-productive area or for a less-valuable species).

With respect to fishing vessel maneuverability restrictions (including risk of allisions and collisions with other vessels) within offshore wind lease areas, fishermen have expressed concerns about fishing vessels operating trawl gear that may not be able to safely deploy and operate in an offshore wind lease area given the size of the gear, the spacing between the WTGs, and the space required to safely navigate, especially with other vessels present and during poor weather conditions. Trawl and dredge vessel operators have commented that less than 1-nm (1.9-kilometer) spacing between WTGs may not be enough to operate safely due to maneuverability of fishing gear and gear not directly following in line with vessel orientation. Clam industry representatives (Atlantic surfclam and ocean quahog fisheries) state that their operations require a minimum distance of 2 nm (3.7 kilometers) between WTGs, in alignment with the bottom contours, for safe operations (BOEM 2021b; RODA 2021). Navigating through the offshore wind lease areas would not be as problematic for for-hire recreational fishing vessels, which tend to be smaller than commercial vessels and do not use large external fishing gear (other than hook and line) that makes maneuverability difficult. However, trolling for highly migratory species (e.g., bluefin tuna [*Thunnus thynnus*], swordfish [*Xiphias gladius*]) may involve deploying many feet of lines and hooks behind a vessel and then following large pelagic fish once they are hooked, which poses additional navigational and maneuverability challenges around WTGs (BOEM 2021b).

Some fishers that are displaced from traditional fishing grounds may find suitable alternative fishing grounds and continue to earn revenue, while others may switch the species they target or the gear they use, and others may leave the fishery altogether (O’Farrell et al. 2019). These behaviors are like those of fishers experiencing reduced access to fisheries resulting from fishing regulations and shifting species composition resulting from climate change (Papaioannou et al. 2021). Each of these scenarios requires adaptive behavior and risk tolerance, traits that are not universally shared by all fishers. For example, O’Farrell et al (2019) observed that some fishers have low vessel mobility and less explorative behavior, are risk averse, and take shorter trips, whereas other fishers have high mobility and a greater explorative behavior, are tolerant of risk, and conduct longer trips. Similarly, Papaioannou et al. (2021) observed that smaller trawlers had a higher affinity for their fishing grounds and were less likely to switch fishing grounds than larger trawlers. Fishers willing to seek alternate fishing grounds may experience increased operating costs (e.g., additional fuel to arrive at more distant locations; additional crew compensation due to more days at sea), lower revenue (e.g., fishing in a less-productive area, fishing for a less-valuable species, or increased competition for the same resource), or both. Fishers that switch target species or gear types used may also lose revenue from targeting a less-valuable species and increased costs from switching gear type. Switching species could also cause fishers to land their catch in different ports (Papaioannou et al. 2021), which could result in increased operational costs depending on where the port is located.

It is acknowledged that proposing fishers find alternative fishing grounds to earn revenue is a complex issue with many factors. Fishing communities may have a difficult time with climate adaptation. Historically, warming (and cooling) events have affected the abundance of species targeted, prevalence of invasives, and physical access to target species. Fishing communities historically viewed cooling waters twice as negatively as warming waters, as they were associated with a decrease in fishing opportunity due to storms, while warmer waters were associated with the potential for new fisheries. However, recent warming trends were viewed as strongly negative, associated with disease, reductions in target species, and shifts of fish distributions across jurisdictional lines (McClenachan et al. 2019).

The increased use of ocean space by offshore wind farms will likely result in increased travel time to landing ports, which may cause some fishers to use different landing ports, thereby resulting in economic loss to certain ports and communities, especially in small ports. Many fishing vessels use landing ports that differ from their primary port (i.e., the port where the vessel is docked or moored), and these vessels are likely to be particularly vulnerable to reductions in unobstructed ocean space. Silva et al. (2021) conducted an intercept survey from Maine to North Carolina and observed that 20 percent (n=479) of the fishing industry participants reported different primary and landing ports from the intercept port. Among those reporting differences, the primary and landing ports were generally in different states. The ports where differences were most reported included Newport News, Virginia; Cape May and Point Pleasant, New Jersey; New Bedford, Massachusetts; and Point Judith, Rhode Island. Surfclam vessels often travel between Atlantic City, New Jersey and New Bedford, Massachusetts. The increased travel time would also result in increased fuel costs and potential wear and tear on equipment.

In addition, as also discussed within Section 3.12, *Environmental Justice*, the commercial fisheries industry is experiencing socioeconomic impacts related to gentrification of the ocean environment, including significant pressure from new industries, such as offshore wind power generation, tourism, coastal development, and other elements. As these different industries compete for ocean space, the result could be adverse impacts for communities that are heavily dependent on either commercial fishing or recreational fishing, or both. The development of offshore lease areas for wind power generation creates a space-use conflict that may exacerbate this issue for these potentially vulnerable populations that support either the commercial fishing industry, for-hire recreational fishing services, or shoreside services. In many cases, shoreside support services, such as seafood processing and vessel/equipment repair services, are supported by lower-income workers that may have less capacity to absorb a reduction in pay and it can oftentimes be more challenging to identify alternative or supplemental employment.

An accurate assessment of the extent of the effects of planned offshore wind energy projects on commercial fisheries and for-hire recreational fishing would depend on project-specific information that is unknown at this time, such as the actual location of offshore activities within offshore wind lease areas and the arrangement of WTGs. However, it is possible to estimate the amount of commercial fishing revenue that would be “exposed” as a result of offshore wind energy development. Estimates of revenue exposure quantify the value of fishing that occurs in the footprint areas of individual offshore wind farms. Therefore, these estimates represent the fishing revenue that would be foregone if fishing vessel operators opt to no longer fish in these areas and cannot capture that revenue in a different location. However, there is not enough resolution in the data to allow estimates to be made on a small enough scale to differentiate impacts along wind farm export cable corridors. Therefore, estimates have only been made for individual offshore wind lease areas. Revenue exposure estimates should not be interpreted as measures of actual economic impact. Exposure is based on historical landings and actual economic impact would depend on many factors—foremost, the potential for continued fishing to occur within the footprint of the wind farm, together with the ecological impact on target species residing within the project areas. Economic impacts also depend on a vessel operator's ability to adapt to changing where fishing could occur. For example, if alternative fishing grounds are available nearby and could be fished at no additional cost, the economic impact would be lower. In addition, it is important to note that there may be cultural and traditional values to fishermen related to fishing in certain areas that go beyond expected monetary profit. For example, some fishermen may gain utility from being able to fish in locations that are known to them and also fished by their peers; the presence of other boats in the area can contribute to the fishermen's sense of safety.

Table 3.9-23 depicts the annual commercial fishing revenue exposed[6] to offshore wind energy development in the geographic analysis area by FMP fishery from 2021 through 2030. The amount of revenue at risk increases as proposed offshore wind energy projects are constructed and come online (see Table F-3) and would continue beyond 2030 during the continued operational phases of the offshore wind energy projects. The largest impacts in terms of exposed revenue are expected to be in the Sea Scallop, Surfclam/Ocean Quahog, and Mackerel/Squid/Butterfish FMP fisheries. Vessels from most fisheries remain close to home, such that the exposed revenue is expected to be greatest in fishing ports closest to offshore wind projects. A notable exception to this is the scallop fishery, in which vessels often travel several hundred miles to reach fishing grounds. The total average annual exposed revenue over the 2021–2030 period represents approximately 1.6 percent of the total average annual revenue of the FMP fisheries in the geographic analysis area during the 2008–2019 period (see Table 3.9-1). The maximum exposed revenue—which is projected to occur in year 2030 when construction on the last of the planned activities could begin—represents approximately 3.6 percent of the total regional revenue average; however, it is acknowledged that projects would be in operation beyond 2030 and therefore this revenue exposure would continue. In general, fisheries do not have high relative revenue intensity within the offshore wind lease areas compared with nearby waters because offshore wind lease areas were chosen to reduce potential use conflicts between the wind energy industry and fishers.

[6] Revenue exposure is the amount of revenue that could be potentially affected by WEA development.

Table 3.9-23 Annual Commercial Fishing Revenue Exposed to Offshore Wind Energy Development in the Geographic Analysis Area Under the No Action Alternative by FMP

FMP Fishery	Total Annual Revenue Exposed ($1,000s)									
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030[1]
Atlantic Herring	$0.0	$0.0	$65.3	$97.4	$116.7	$169.1	$210.5	$242.9	$275.3	$275.3
Bluefish	$0.0	$0.0	$5.9	$8.5	$12.7	$16.2	$18.2	$19.7	$21.3	$21.3
Golden Tilefish	$0.0	$0.0	$4.1	$9.6	$55.8	$76.4	$81.5	$86.4	$91.4	$91.4
Highly Migratory Species	$0.0	$0.0	$0.1	$0.3	$0.8	$1.0	$1.2	$1.4	$1.6	$1.6
Mackerel/Squid/Butterfish	$0.1	$0.1	$378.5	$621.5	$824.2	$1,190.3	$1,343.6	$1,477.5	$1,611.3	$1,611.3
Monkfish	$0.0	$0.0	$435.6	$508.8	$615.9	$780.3	$884.1	$966.6	$1,049.2	$1,049.2
Multispecies Large Mesh	$0.0	$0.0	$182.6	$197.2	$214.9	$264.1	$286.5	$300.8	$315.1	$315.1
Multispecies Small Mesh	$0.0	$0.0	$143.5	$185.4	$275.5	$366.4	$394.8	$411.7	$428.5	$428.5
Jonah Crab	$0.0	$0.0	$55.6	$93.2	$283.9	$325.6	$349.9	$370.4	$390.9	$390.9
Sea Scallop	$0.0	$0.0	$343.7	$2,587.9	$2,862.5	$7,805.7	$12,672.9	$17,513.2	$22,353.4	$22,353.4
Skate	$0.0	$0.0	$258.9	$298.1	$358.8	$453.9	$505.1	$537.4	$569.6	$569.6
Spiny Dogfish	$0.0	$0.0	$21.4	$28.7	$33.5	$39.5	$43.6	$45.7	$47.8	$47.8
Summer Flounder/Scup/Black Sea Bass	$0.2	$0.2	$294.7	$464.6	$644.3	$935.6	$1,121.5	$1,286.5	$1,451.4	$1,451.4
Surfclam/Ocean Quahog	$0.0	$0.0	$11.0	$47.8	$671.2	$1,070.4	$1,469.6	$1,868.8	$2,268.1	$2,268.1
American Lobster	$0.0	$0.0	$328.9	$374.5	$447.4	$603.8	$703.4	$758.1	$812.8	$812.8
None: Unmanaged[2]	$0.4	$0.4	$732.5	$895.7	$1,093.0	$1,693.2	$2,106.8	$2,488.7	$2,870.5	$2,870.5
All revenues of federally permitted vessels	**$0.7**	**$0.7**	**$3,262.4**	**$6,419.0**	**$8,486.0**	**$15,791.4**	**$22,193.3**	**$28,375.7**	**$34,558.1**	**$34,558.1**

Source: Developed using FMP Revenue Exposure Analysis – 2020 to 2030 Calculations data provided by BOEM 2022 and based on BOEM's OCS offshore wind schedule as of March 2022 and NMFS landings and revenue data for wind energy areas, 2008–2019, accessed October 2021. The analysis excludes the Proposed Action.

[1] This column represents the total average revenue exposed in 2030 in order to give a value reference for the percentage of revenue exposed in 2030.

[2] Includes revenues from all species not assigned to an FMP including American lobster and Jonah crab fisheries.

Notes: Revenue is in nominal dollars using the monthly, not seasonally, adjusted Producer Price Index by Industry for Fresh and Frozen Seafood Processing provided by the U.S. Bureau of Labor Statistics. The data represent the revenue-intensity raster developed using fishery-dependent landings' data. To produce the data set, Vessel Trip Report information was merged with data collected by at-sea fisheries observers, and a cumulative distribution function was estimated to present the distance between Vessel Trip Report points and observed haul locations. Resolution of the data does allow estimates to be made on a small enough scale to differentiate impacts along wind farm export cable corridors. Therefore, estimates only pertain to individual offshore wind lease areas. This provided a spatial footprint of fishing activities by FMPs. The percentages are expected to continue after 2030 until facilities are decommissioned. Slight differences in totals are due to rounding.

"–" indicates the value is zero; "$0" indicates the value is positive but less than $100.

With respect to impacts on individual fishing operations, long-term, negligible to minor, adverse impacts would occur for vessels that derive a small percentage of their total revenue from areas where offshore wind facilities would be located or are willing to seek and able to find suitable alternative fishing locations. Long-term, moderate adverse impacts would occur for fishing vessels that derive a large percentage of their total revenue from areas where offshore wind facilities would be located, if they choose to avoid these areas once the facilities become operational and either choose not to seek alternative fishing grounds or are unable to find suitable alternative fishing locations. NMFS (NMFS 2021e) determined, for each federally permitted commercial fishing vessel that fished in New England/Mid-Atlantic offshore wind lease areas, the percentage of the vessel's total fishing revenue that was derived from within each area during the 2008–2019 period. It is estimated that over that period, only 0.9 percent of the vessels that fished in one or more of the offshore wind lease areas generated more than 50 percent of their total fishing revenue for the year from one or more of the areas. According to the data presented, in each offshore wind lease area there was one or more vessels that earned a substantial (more than 5 percent) portion of their revenue from fishing in the area. Some vessels derived more than half of their revenue from fishing in a particular offshore wind lease area. However, 75 percent of the vessels fishing in any given offshore wind lease area derived less than 0.9 percent of their total revenue from the area. Given that a majority of fishing vessels derive a small percentage of their total revenue from any one offshore wind lease area and some but not all of those may choose to seek out other suitable fishing locations, or switch their targeted species, the overall adverse impact of offshore wind energy development on fishing access by commercial fishing vessels is expected to be long term and moderate to major, depending on the mitigation measures implemented by offshore wind developers. Impacts are expected to primarily result from reduced access to traditional fishing grounds and increased risk of fishing gear damage or loss.

Cable emplacement and maintenance: Displacement of fishing vessels and disruption of fishing activities would occur in over 183,868 acres (744 km^2) (see Table F2-2 in Appendix F), though this disruption would not occur all at the same time. Installation of offshore cables for each offshore wind energy facility would require temporary rerouting of all vessels, including commercial and for-hire recreational fishing vessels, away from areas of active construction.

Boulder clearance, sand wave clearance, and cable laying disturbs the seabed and can reduce water quality through resuspension of sediment, increase underwater noise, or introduce artificial lighting and can result in a behavioral response from mobile finfish species and injury or death of less-mobile species or benthic infauna such as scallops, surfclams, and ocean quahogs, as well as alter the seabed profile (see Section 3.13.5). In turn, these responses could decrease catchability for a fishery, such as by changing the species composition where seabed profiles are changed or due to disturbances causing fish to not bite at hooks or changing swim height. The relocation of boulders also could increase the risk of gear stags, as uncharged or unknown obstructions could result in damage to equipment, lost revenue, and potential safety impacts.

For any given offshore wind energy project, the impacts of behavioral responses on target species catch in commercial and for-hire recreational fisheries are expected to be confined to a small area, and to end shortly after construction activities end. Benthic species such as sea scallops and ocean quahogs would also be expected to repopulate cable areas once the offshore cables are installed and buried. Cable inspection and repair activities would result in types of impacts similar to those resulting from construction activities, such as temporary displacement or other behavioral responses of target species. The impacts are expected to be minor and temporary in nature, only occurring during cable placement or maintenance activities. Impacts related to gear entanglement from interactions with cables is discussed above under *Presence of structures*. Details regarding potential lighting and noise impacts on finfish and invertebrates are described in Section 3.13.

Climate change: Impacts on commercial fisheries and for-hire recreational fishing are expected to result from climate change events such as increased magnitude or frequency of storms, shoreline changes, ocean acidification, and water temperature changes. Risks to fisheries associated with these events include the ability to safely conduct fishing operations (e.g., due to storms) and habitat or distribution shifts in targeted species, disease incidence, and risk of invasive species. If these risk factors result in a decrease in catch or increase in fishing costs (e.g., transiting time), the profitability of businesses engaged in commercial fisheries and for-hire recreational fishing would be adversely affected. The catch potential for the temperate Northeast Atlantic is projected to decrease between now and the 2050s (Barange et al. 2018). Hare et al. (2016) predict that climate change would affect Northeast fishery species differently. For approximately half of the 82 species assessed, the authors report that overall climate vulnerability is high to very high; diadromous fish and benthic invertebrate species, including surfclam, ocean quahog, and scallops, exhibit the greatest vulnerability. In addition, most species included in the assessment have a high potential for a change in distribution in response to projected changes in climate. Adverse effects of climate change are expected for approximately half of the species assessed, while Hare et al. (2016) anticipate that, for approximately 17 percent of the species, including inshore longfin squid (*Doryteuthis pealeii* [formerly *Loligo pealeii*]), butterfish, and Atlantic croaker, fisheries will see some beneficial impacts. The intensity of the impacts of climate change on commercial fisheries and for-hire recreational fishing is anticipated to qualify as minor to major for fishing operations that target species adversely affected by climate change, and the beneficial impacts are anticipated to qualify as minor to major for fishing operations targeting fishery species that may benefit fishing operations due to climate change effects.

The economies of communities reliant on marine species that are vulnerable to the effects of climate change could be adversely affected. If the distribution of important fish stocks changes, it could affect where commercial and for-hire recreational fisheries are located. Furthermore, coastal communities with fishing businesses that have infrastructure near the shore could be adversely affected by sea level rise (Colburn et al. 2016; Rogers at al. 2019). Because offshore wind facilities would produce lower GHG emissions than fossil fuel–powered generating facilities with similar capacities, the reduction in GHG emissions per kilowatt of electricity produced from other offshore wind projects, as opposed to equivalent energy production powered by fossil fuels, would result in long-term, beneficial impacts on fishing operations that target species adversely affected by climate change. However, the benefits would be negligible. Section 3.4, *Air Quality*, describes the expected contribution of offshore wind development to climate change.

3.9.3.3. Conclusions

Impacts of the No Action Alternative. Under the No Action alternative, ongoing activities would have continuing impacts on commercial fisheries and for-hire recreational fishing, primarily through port use, vessel activity, other offshore development, climate change, and fisheries use and management. BOEM anticipates that the impacts of ongoing activities on commercial fisheries would be **minor** to **major**, and on for-hire recreational fishing would be **minor** to **moderate**, depending on the fishery or fishing operation. The major impact rating for some fisheries and fishing operations is primarily driven by regulated fishing effort and climate change associated with ongoing activities. The impacts could also include **minor** to **moderate** long-term, beneficial impacts for certain commercial fisheries and some for-hire recreational fishing operations, due to the artificial reef effect.

Cumulative Impacts of the No Action Alternative. Under the No Action Alternative, existing environmental trends and ongoing activities would continue, and planned non-offshore wind activities, including port expansions, new cable emplacement and maintenance, and future marine transportation and fisheries use, would contribute to impacts on commercial fisheries and for-hire recreational fishing. Planned offshore wind activities would affect commercial fisheries and for-hire recreational fishing through the primary IPFs of anchoring, cable emplacement and maintenance, noise, port utilization, presence of structures, and traffic.

BOEM anticipates that the cumulative impact of the No Action Alternative would result in **minor** to **major** adverse impacts on commercial fisheries and **minor** to **moderate** adverse impacts on for-hire recreational fishing, depending on the fishery or fishing operation. This impact rating would primarily result from regulated fishing effort, climate change, and the increased presence of offshore structures (cable protection measures and foundations), primarily those associated with planned offshore wind projects. The extent of adverse impacts would vary by fishery and fishing operation because of differences in target species, gear type, and predominant location of fishing activity. The impacts could also include **minor** to **moderate** long-term, beneficial impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

3.9.4 Relevant Design Parameters & Potential Variances in Impacts for the Action Alternatives

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than those described in the sections below. The following proposed PDE parameters (see Appendix E) would influence the magnitude of the impacts on commercial and for-hire recreational fisheries:

- The number, size, and location/orientation of WTGs, which are factors that could affect access to fishing grounds, allisions and vessel collisions, and availability of targeted species;
- Total length and route of inter-array and offshore export cables, including ability to reach target burial depths, which could affect the ability of fishing vessels to operate in or transit the area and cause entanglements and gear loss, as well as changes in benthic habitat type if armoring of cables with concrete mattresses is required in order to protect cables;
- Total length and location of offshore export cables, which could affect the ability for fishing vessels to operate in or transit the area and cause entanglements and gear loss;
- Number of simultaneous vessels, number of trips, and size of vessels, which could affect potential risk for vessel collisions and use of port facilities; and
- Time of year during which construction occurs, which could affect access to fishing areas and availability of targeted fish in the area, thereby reducing catch and fishing revenue.

Variability of the proposed Project design exists as outlined in Appendix E. Below is a summary of potential variances in impacts:

- Number, size, location, and amount of scour protection for WTGs, as the level of hazard related to WTGs is proportional to the number of WTGs installed.
- Cable routes: The route chosen (including variants within the general route) would determine targeted fishing areas affected.
- Season of construction: Certain fisheries have peak times during the year. For-hire recreational fisheries are most active when the weather is more favorable, while commercial fishing is active year-round, with many species harvested throughout the year. However, construction activities can affect access to fishing areas and availability of fish in the area, thereby reducing catch and fishing revenue.

Ocean Wind has committed to measures to minimize impacts on commercial fisheries and for-hire recreational fishing such as developing and implementing a Fisheries Communication and Outreach Plan (CFHFISH-02), working with commercial and recreational fishing entities to ensure the Project will minimize potential conflicts (CFHFISH-01), implementing Ørsted's corporate policy and procedure to compensate commercial/recreational fishing entities for gear loss as a result of Project activities (CFHFISH-03), and developing a Navigational Safety Fund by providing eligible commercial, charter, and for-hire fishing vessels operating in and near the Wind Farm Area with reimbursement for new radar equipment and training courses (CFHFISH-04) (COP Volume II, Table 1.1-2; Ocean Wind 2023). COP Volume III, Appendix AE, *Fisheries Mitigation Efforts* (Ocean Wind 2023), describes Ocean Wind's gear claim procedure, Direct Compensation Program, and Navigational Safety Fund. Ørsted administers a portfolio-wide gear claim procedure if Ørsted activities damage or destroy commercial fishing gear. The gear claim process requires a fisherman to file a claim within 30 days upon discovery of lost or damaged gear. They may request reimbursement for lost/damaged gear, economic loss (lost catch and business interruption), and reasonable claim preparation costs. After they submit a complete claim, the claim is reviewed and either accepted or rejected in whole or in part. If rejected in whole or in part, the fisher may appeal the decision to an independent third party. The independent third party's review is final. The full details of the gear claim process can be found at https://us.orsted.com/renewable-energy-solutions/offshore-wind/mariners.

If a regional fund has not been established, Ørsted would create a Direct Compensation Program for affected fisherman that will be in place 30 days after the receipt of all final federal, state, and local permits; authorizations; concurrences; and approvals necessary to construct and operate the Ocean Wind 1 Project as described in the approved COP. The Direct Compensation Fund would exist for the life of the Project. Ocean Wind would use the annual average commercial landings values and for-hire revenue stated in the Final EIS as a baseline for commercial and for-hire fishing. Ocean Wind would hold in reserve an amount determined by the formula set out in the draft BOEM guidance using the baseline amounts. This reserve amount would be used to pay claims brought by both commercial and for-hire fishermen in accordance with the draft guidance. Ocean Wind's compensation program would be open to any eligible commercial or for-hire fisherman regardless of homeport. The program itself would be managed by a third party. The third party would determine eligibility. Eligibility would be based on demonstrated fishing history in the Project area. The third party would also approve and deny claims and there would be an appeals process for those seeking to review a denied claim. Fishermen may make a claim during the construction and deconstruction phases of the Project. They may also make claims under certain circumstances during the operations phase of the Project. If the nine Atlantic states have established a regional compensation fund prior to the start of offshore construction, Ocean Wind would utilize the regional fund for management of funds held in reserve and processing of claims rather than establishing its own third-party managed program.

Ørsted would create a Navigational Safety Fund that will be in place 30 days after the receipt of all final federal, state, and local permits; authorizations; concurrences; and approvals necessary to construct and operate the Ocean Wind 1 Project as described in the approved COP and will exist until funds run out. The Navigational Safety Fund would enable eligible commercial fishermen and for-hire vessels to acquire navigation equipment through a voucher system. The Navigational Safety Fund would provide training and experiential learning opportunities to those navigating within Ørsted's Lease Area off the coast of New Jersey. Fishermen eligible for the Direct Compensation Program described above and who do not already possess AIS transceivers or pulse compression radar systems may receive one-time grants for up to $10,000 in order to upgrade or purchase pulse compression radar or AIS. Commercial fishing vessels and inspected for-hire/party vessels would be eligible for $10,000 in upgrades, and uninspected for-hire vessels would be eligible for $5,000 in upgrades. Eligible fishermen would be issued vouchers to spend at approved vendors for approved products. The process of issuing vouchers, approving vendors, and approving equipment would be managed by a third party, which could be the same third party managing the Direct Compensation Program. In addition to vessel upgrades, there would be an educational component to the Navigational Safety Fund. Those eligible for direct compensation may attend a professional training of their choice with support up to $1,000 per person. Eligible trainings include but are not limited to a captain's course, license upgrade, radar course, or rules of the road refresher. Like with vessel upgrades, a third-party manager would issue vouchers for training and be responsible for approving trainings, trainers, educators, and institutions.

Ocean Wind has developed a Fisheries Monitoring Plan that includes six different components to assess fisheries status in the Project area and a nearby control site throughout the pre-construction, construction, and post-construction phases. Survey types include trawl surveys, environmental deoxyribonucleic acid (DNA) surveys, structure-associated fishes surveys, clam surveys, pelagic fish surveys, and acoustic telemetry monitoring.

3.9.5 Impacts of the Proposed Action on Commercial Fisheries and For-Hire Recreational Fishing

3.9.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.9.8, *Impacts of Alternative E on Commercial Fisheries and For-Hire Recreational Fisheries*.

The sections below summarize the potential impacts of the Proposed Action on commercial fisheries and for-hire recreational fishing during the various phases of the proposed Project. Routine activities would include construction and installation, O&M, and conceptual decommissioning of the proposed Project, as described in Chapter 2, *Alternatives*.

Anchoring: Anchoring involves both anchoring of a vessel involved in the Project and the attachment of a structure to the sea bottom by use of an anchor or mooring. Anchoring vessels and other structures used in construction of the Project would pose a navigational hazard to fishing vessels. All impacts would be localized (within a few hundred meters of anchored vessels) and temporary (hours to days in duration). Although anchoring impacts would primarily occur during Project construction, some impacts could also occur during O&M and conceptual decommissioning. Therefore, the adverse effects of offshore wind energy–related anchoring on commercial fisheries and for-hire recreational fishing are expected to be long term, though periodic in nature, and minor.

Noise: Noise impacts associated with offshore construction activities for 98 WTGs, including pile driving, trenching for cable placement, O&M activities, G&G investigations, and vessels, could cause indirect impacts on commercial and for-hire recreational fisheries within the Wind Farm Area through their direct impacts on species targeted by the commercial and for-hire fisheries. See Section 3.13.5 for a full description of noise impacts on fish and invertebrates. Most noise impacts on species would be short term and behavioral in nature, with most finfish species avoiding the noise-affected areas, while invertebrates may exhibit stress and behavioral changes such as discontinuation of feeding activities. For example, noise has been shown to affect bivalves based on reactions where bivalves close their valves and burrow deeper when subjected to noise and vibration stimuli (Roberts and Elliott 2017). Prolonged closure could reduce respiration and growth, prevent expulsion of wastes, and lead to mortality and population-level impacts. Such biological impacts would have resulting moderate impacts on commercial fisheries.

The primary impacts of noise on finfish and invertebrates would occur during offshore construction activities associated with the Proposed Action. Primary noise impacts would occur from pile-driving activities; research has shown that finfish can suffer behavioral and physiological effects based on received sound levels, distance from the noise, and variables related to the noise-producing impact (e.g., materials, size of hammer). Fish response would be highest near impact pile driving (within tens of meters), moderate at intermediate distances (within hundreds of meters), and low at farther distances (within thousands of meters) (Küsel et al. 2022). During active pile-driving activities, highly mobile finfish likely would be displaced from the area, most likely showing a behavioral response; however, fish in the immediate area of pile-driving activities could suffer injury or mortality. To reduce potential impacts from pile driving, Ocean Wind has committed to using ramp-up procedures to allow mobile species to leave the area prior to experiencing the full noise impact of pile driving (GEN-9; COP Volume II, Table 1.1-2; Ocean Wind 2023). A dual noise mitigation system will also be deployed for all impact piling events, which will be a combination of two devices (e.g., bubble curtain, hydro-damper) to achieve 10-dB noise attenuation, to reduce noise propagation during monopile foundation pile driving (COP Appendix AA; Ocean Wind 2023). The soft start mitigation measure would minimize impacts by inducing fish to leave the immediate vicinity of the pile-driving activity, while the noise mitigation system will minimize behavioral and physical impacts resulting from pile driving on any fish that remain in the area.

Noise impacts related to pile driving are discussed extensively in Section 3.13 of the Final EIS and in Section 5.1.1.2 of the *Ocean Wind 1 Offshore Wind Farm Essential Fish Habitat Assessment.* Although other aspects of noise, such as vessel activity, are discussed, noise from pile driving during installation of the WTGs and OSS foundations would be the most direct acoustic effects on EFH-designated species, and in the context of this section, also fisheries that would be revenue-generating species for commercial fisheries and for-hire recreational fishing industries. As noted in Table 5-3 of the *Ocean Wind 1 Offshore Wind Farm Essential Fish Habitat Assessment,* behavioral impacts from monopile installation could occur up to 7.54 kilometers from the sound source for all fish sizes and up to 5.32 kilometers from pin pile installation. Within those areas, it is likely that some level of behavioral reaction is expected and could include startle responses or migration out of areas exposed to underwater noise (Hastings and Popper 2005). At these distances, there is also potential for secondary impacts on the periphery of the Lease Area, from adjacent offshore wind developments.

Noise from trenching of inter-array and export cables would occur during construction and would likely be limited to dispersal of species, including commercially targeted species, from the area. These disturbances would be temporary and localized and extend only a short distance beyond the emplacement corridor. While noise associated with operational WTGs may be audible to some finfish and invertebrates, this would only occur at relatively short distances from the WTG foundations, and there is no information to suggest that such noise would negatively affect this resource (English et al. 2017). Therefore, impacts on commercial and for-hire recreational fisheries would be unlikely.

Ocean Wind would conduct G&G surveys to inspect or monitor cable routes during the construction and O&M phases of the Project, or both. Noise from G&G surveys of the cable route could disturb finfish and invertebrates in the immediate vicinity of the investigation and could cause temporary behavioral changes; however, the noise is not anticipated to affect reproduction and recruitment of commercial fish stocks into the fishery. Noise impacts from surveys could have temporary, localized impacts during the short-term survey period. Impacts on commercial fisheries and for-hire recreational fishing are anticipated to be temporary and moderate given the small impact area and temporary nature of the impact.

Throughout the construction and O&M phases, vessel traffic associated with the Project would likely result in behavior responses from several species, including species targeted by fisheries. However, noise from vessels would be considered low intensity and would not be expected to affect species on a fisheries level; therefore, impacts on commercial and for-hire recreational fisheries would be minor.

Operating WTGs generate non-impulsive underwater noise that is audible to some fish species. The response of fishes to sustained anthropogenic noise is species-specific and may include disruption in social interactions, hearing loss, and a rise in noise-induced stress (Barton 2002; Popper and Hastings

2009; Debusschere et al. 2016, as cited in Siddagangaiah et al. 2021). Noise levels generated by operating WTGs are expected to reach ambient levels within a short distance of 10-MW turbines (Stöber and Thomsen 2021). Elliot et al. (2019) compared observed particle motion effects at 164 feet (50 meters) from an operational WTG at the Block Island Wind Farm to current research on particle motion sensitivity in fish. They concluded that particle motion effects could occasionally exceed the lower limit of observed behavioral responses in Atlantic cod and flatfish within these limits. Because behavioral impacts would be localized to the immediate area of WTGs, noise from operating WTGs is not expected to result in fishery-level impacts.

BOEM expects that underwater noise associated with the Proposed Action would cause short-term to long-term, localized, minor to moderate impacts on commercial and for-hire recreational fisheries. Moderate impacts are expected to result primarily from pile-driving noise during installation of foundations for WTGs and OSS and would be short term and localized, whereas minor impacts are expected to result from other noise sources. Noise impacts during decommissioning of the Project would be similar to those during the construction and O&M phases, although there would be no pile-driving activities.

Port utilization: Construction of the proposed Project would require a range of both construction and support vessels, including vessels for transferring crew, transporting heavy cargo, and conducting heavy lifts, as well as multipurpose vessels and barges. All of these vessels would add traffic to port facilities and would require berthing. For the proposed Project, construction vessels would travel between the Wind Farm Area and the following ports that are expected to be used during construction: Atlantic City, New Jersey, as a construction management base; Paulsboro, New Jersey, or from Europe directly for foundation fabrication and load out; Norfolk, Virginia, or Hope Creek, New Jersey, for WTG pre-assembly and load out; and Port Elizabeth, New Jersey, or Charleston, South Carolina, or directly from Europe for cable staging. Based on information provided by Ocean Wind, construction activities (including offshore installation of WTGs, substations, array cables, interconnection cable, and export cable) would require up to 20 to 65 simultaneous construction vessels (COP Volume I Tables 6.1.2-1 to 6.1.2-4; Ocean Wind 2023). In total, the Proposed Action would generate approximately 3,847 vessel trips during the construction and installation phase (COP Volume I, Section 6.1, Tables 6.1.2-1 through 6.1.2-5; Ocean Wind 2023). The construction vessels to be used for Project construction are described in Section 6.1.2.4.2 and Tables 6.1.2-1 to 6.1.2-4 in the COP (Ocean Wind 2023). Typical large construction vessels used in this type of project range from 325 to 350 feet (99 to 107 meters) in length, from 60 to 100 feet (18 to 30 meters) in beam, and draft from 16 to 20 feet (5 to 6 meters) (Denes et al. 2021). While there is no port expansion included as part of the Project, for the O&M phase, Ocean Wind would operate out of a new onshore O&M facility in Atlantic City, New Jersey, sited on a retired marine terminal. To accommodate the Project, the City of Atlantic City intends to secure authorization for marina upgrades—namely, dredging in the marina and at Absecon Inlet. The Project would use a variety of vessels to support O&M, including crew transfer vessels, service operation vessels, jack-up vessels, and supply vessels. In a year, the Proposed Action would generate a maximum of 908 crew vessel trips, 102 jack-up vessel trips, and 104 supply vessel trips (COP Volume I, Section 6.1.3.5, Table 6.1.2-11; Ocean Wind 2023).

The ports that would be used by Ocean Wind are also used by commercial fishing vessels and for-hire recreational fishing vessels. For example, Atlantic City ranks in the top ten for commercial fishing revenue attributed to catch from the Lease Area in the years 2008–2021. It ranked number one in average revenue ($118,846) and total revenue ($1,665,000)[7]; see Table 3.9-9 in Section 3.9.1. The additional vessel volume in the ports associated with Project operations could cause vessel traffic congestion, difficulties with navigating, and an increased risk for collisions, together with reduced access to high-

[7] Revenue in 2021 dollars with total revenue rounded to nearest $1,000.

demand port services (e.g., fueling and provisioning) by existing port users, including commercial and for-hire recreational fishing vessels. However, Ocean Wind proposes to employ a Fishing Liaison to communicate Project-related vessel movements with non-Project-related vessels and implement communication protocols to minimize adverse impacts on other users. In Atlantic City, New Jersey, the upgrades to the port undertaken to accommodate the Project vessels—namely, dredging at Absecon Inlet—would also potentially benefit larger commercial and for-hire recreational fishing vessels. In addition, the New Jersey Wind Port and the Port of Paulsboro are specifically being improved for the purpose of supporting offshore wind farm development, which would be an overall benefit for employment and the local economy. As a result, the adverse impact on commercial fisheries and for-hire recreational fishing would be both temporary during construction and long term and negligible to minor during O&M. These same impacts would occur during decommissioning of the Project, although no data are available for the number of vessels that would be required.

Traffic: The installation of offshore components for the Project and the presence of construction vessels (up to 65 construction vessels operating at any given time) and O&M vessels (up to 10 vessel trips per day) could temporarily restrict fishing vessel movement and thus transit and harvesting activities within the Project area and along the cable routing areas. It could also lead to traffic congestion and an increased risk for collisions. While Ocean Wind has not committed to creating safety zones around construction and O&M vessels, it would employ a Fishing Liaison to keep the fishing industry aware of Project vessel movements, construction timeline, and other information to help minimize conflicts and potential vessel collisions. Regardless of whether safety zones are in effect, fishing vessels would likely steer clear of construction vessels to avoid potential collisions and damage to their fishing gear. In doing so, fishing vessels could either forfeit fishing revenue or relocate to other fishing locations and continue to earn revenue. However, vessels that choose to relocate could incur increased operating costs such as increased fuel costs due to longer transit times to and from more distant fishing grounds, increased equipment maintenance/repair, and additional crew compensation due to more days at sea, among other factors. They could also experience lower revenue due to fishing potentially less-productive fishing grounds, potentially having to switch to less-valuable species, and potentially encountering more competition for a given resource. In addition, the increased steaming time may result in product spoilage for fisheries such as surfclams that must be processed shortly after harvest.

As noted in Section 3.9.4, Ocean Wind has committed to developing a Navigational Safety and Training program, which will further mitigate navigation and radar concerns. While this would not eliminate or address whether fishing vessels would transit through or around the Lease Area, it would provide the equipment and training to support the vessels and their captains to maintain safety in relation to the wind farm.

After construction is complete, WTG foundations and associated scour protection may produce an artificial reef effect, potentially increasing fish and invertebrate abundance within a facility's footprint (see Section 3.13, *Finfish, Invertebrates, and Essential Fish Habitat*), as well as recreational fishing use. Some commercial fishermen may avoid the Wind Farm Area if large numbers of recreational fishermen are drawn to the area by the prospect of higher catches (ten Brink and Dalton 2018). If these congestion concerns cause commercial fishermen to shift their fishing effort to areas outside of the Wind Farm Area to areas not routinely fished, conflict with existing users could increase as other areas are encroached upon. In general, the potential for conflict among commercial fishermen due to fishing displacement may be higher for fishermen engaged in fisheries that have regulations that constrain where fishermen can fish, such as the lobster fishery. However, the potential for vessel congestion and gear conflict may also increase if mobile species targeted by commercial fishermen, such as Atlantic herring, Atlantic mackerel, squid, tuna, and groundfish, are attracted to offshore wind energy facilities by the artificial reef effect, and fishermen targeting these species concentrate their fishing effort in the Wind Farm Area as a result. Overall, the adverse effects of vessel traffic on commercial and for-hire fishing vessels are expected to be moderate and long term. Similar impacts would also occur during decommissioning of the Project. Once the Project is fully decommissioned, navigational and fishing hazards (e.g., WTG foundations and inter-array cables) would be removed, minimizing space-use conflicts and vessel traffic impacts previously caused by the wind farm.

Presence of structures: The presence of structures can lead to impacts on commercial fisheries and for-hire recreational fishing through navigation hazards (including transmission cable infrastructure) and allisions (collisions with stationary objects), entanglement or gear loss/damage, fish aggregation, habitat conversion, and space-use conflicts, including potential vessel collisions (see Section 3.16, *Navigation and Vessel Traffic*).

Under current regulations, USCG is responsible for determining any type of safety or exclusionary zone around any structure placed in the open ocean. USCG has stated that it does not plan to create exclusionary zones around offshore wind facilities, with the exception of possibly implementing safety zones during construction and conceptual decommissioning, to be determined on a project-by-project basis (BOEM 2018). However, the presence of the Project's WTGs could result in the area essentially becoming an exclusion area for fishing if fishing vessel operators are not—or perceive that they are not—able to safely navigate the area around the WTGs.

Under the Proposed Action, Ocean Wind proposes to install 98 WTGs extending up to 906 feet (276 meters) above MLLW with spacing of 1 nm by 0.8 nm (1.9 by 1.5 kilometers) between WTGs in a southeast-northwest orientation. The Project design orients the WTG arrays in the southeast-northwest direction to support the predominant commercial fishing transit routes originating from Atlantic City (COP Volume I, Executive Summary; Ocean Wind 2023), the port with the highest average number of annual commercial fishing vessel trips to the Wind Farm Area from 2008 to 2021 (Table 3.9-8), as well as the highest average annual revenue and total revenue for the same timeframe (Table 3.9-9).

The presence of WTG arrays may restrict fishing vessel maneuverability (including risk of allisions) within the Wind Farm Area. Fishermen have expressed specific concerns about fishing vessels operating trawl gear that may not be able to safely deploy and operate in an offshore wind lease area given the size of the gear, the spacing between the WTGs, and the space required to safely navigate, especially with other vessels present and during poor weather conditions. Trawl and dredge vessel operators have commented that spacing less than 1 nm (1.9 kilometers) between WTGs may not be enough to operate safely due to maneuverability of fishing gear and gear not directly following in line with vessel orientation. Clam industry representatives (Atlantic Surfclam and Ocean Quahog fisheries) state that their operations require a minimum distance of 2 nm (3.7 kilometers) between WTGs, in alignment with the bottom contours, for safe operations (BOEM 2021a; RODA 2021). While there are a number of areas within the Lease Area designated as Prime Fishing Grounds of New Jersey, Atlantic City Bluefish Lump in the northeastern region, and Lobster Pots, Hambone, Teardrop, Triple Lumps, and The Ham in the northwestern region, navigating through the Wind Farm Area would not be as problematic for for-hire recreational fishing vessels, which tend to be smaller than commercial vessels and do not use large external fishing gear (other than hook and line) that makes maneuverability difficult. However, trolling for highly migratory species (e.g., bluefin tuna, swordfish) may involve deploying many feet of lines and hooks behind the vessel and then following large pelagic fish once they are hooked, which poses additional navigational and maneuverability challenges around WTGs (BOEM 2021a).

Ocean Wind's *Navigation Safety Risk Assessment* (NSRA) (COP Volume III, Appendix M; Ocean Wind 2023) concluded that it is technically possible to fish and transit through the Wind Farm Area with the proposed WTG spacing. Based on pertinent literature, the study concluded that the turning radius of a fishing vessel such as a medium-length (148-foot [80-meter]) hydraulic dredge would be smaller than 0.83 nm (1.5 kilometers) at a typical fishing speed of 4 knots (2 m/s) or less. However, the study does recognize that, depending on the exact type and length of gear being used, the distances between the

WTGs may limit safe fishing patterns within the Project area. While Ocean Wind's NSRA shows that it is technically feasible to navigate and maneuver fishing vessels and mobile gear through the Wind Farm Area, BOEM is cognizant that maneuverability within the Wind Farm Area may vary depending on many factors, including vessel size, fishing gear or method used, and environmental conditions such as wind, sea state, current, and visibility. In addition, BOEM recognizes that even when it is feasible to fish within the Wind Farm Area, some fishermen might still not consider it safe to do so. Furthermore, operating within the Wind Farm Area with other vessels and gear types present may restrict vessel maneuverability.

Because of the height of WTGs above the ocean surface, they would be visually detectable at a considerable distance during the day and easily detected by vessels equipped with radar regardless of the time of day. To further ensure navigational safety, all WTGs and OSS would be lit and marked in accordance with USCG, BOEM, and IALA guidelines, and WTG locations would be charted by NOAA and could include protocols for sound signals, radar beacons, and AIS, which would be finalized with consideration for other such private aids to navigation (PATON) in the area (i.e., foghorns) in coordination with USCG.

O&M of the Proposed Action would likely affect marine vessel radar performance near or within the Wind Farm Area. The National Academies of Sciences, Engineering, and Medicine report titled *Wind Turbine Generator Impacts to Marine Vessel Radar* notes that WTG interference decreases the effectiveness of marine vessel radar mounted on all vessel classes (National Academies of Sciences, Engineering, and Medicine 2022:5). Larger vessels may have more experienced bridge personnel; however, there is no requirement, domestic or international, for training to include specifics on WTGs and there is currently no standard system of active radar tailored to a WTG environment (National Academies of Sciences, Engineering, and Medicine 2022:21–25, 66). Smaller vessels operating in the vicinity of the Project may experience the same challenges as larger vessels if equipped with marine vessel radar, such as clutter due to the WTGs or ambiguous detections, and may also be harder to identify as distinct targets or become lost contacts by larger vessels while in the proximity of WTGs (National Academies of Sciences, Engineering, and Medicine 2022:38–48). While radar is one of several navigational tools available to vessel captains, including navigational charts, global positioning system, and navigation lights mounted on the WTGs (COP Volume III, Appendix M, NSRA, Section 11.3; Ocean Wind 2023), radar is the main tool used to help locate other nearby vessels that are not otherwise visible, particularly in adverse weather when visibility is limited. The navigational complexity of transiting through the Wind Farm Area, including the potential effects of WTGs and OSS on marine radars, would increase risk of collision with other vessels (including non-Project vessels and Proposed Action vessels). See also Section 3.16, *Navigation and Vessel Traffic*.

Development and implementation of Ocean Wind's Fisheries and Communication and Outreach Plan (COP Volume III, Appendix O; Ocean Wind 2023) will cover all phases of the proposed Project and provide a mechanism for coordination and communication related to commercial fishing vessels. In addition, as noted in Section 3.9.4, Ocean Wind has committed to developing a Navigational Safety Fund, which will further mitigate navigation and radar concerns. While this would not eliminate or address whether fishing vessels would transit through or around the Lease Area, it would enable eligible commercial fishermen and for-hire recreational vessels to acquire the navigation equipment and training to support the vessels and their captains to maintain safety in relation to the wind farm. The equipment and training would be managed by a third party, which could be the same third party managing the Direct Compensation Program.

Notwithstanding these safety measures, some fishermen have commented that, because of safety considerations, they would not enter an offshore wind array during inclement weather, especially during low-visibility events (Kirkpatrick et al. 2017). During interviews with commercial fishermen, ten Brink and Dalton (2018) found that fishermen had concerns that low visibility, wind, or crew exhaustion could lead to vessels hitting WTGs. Moreover, mechanical problems, such as loss of steerage, could result in an allision with a WTG as the vessel drifts during repair (DNV-GL 2021). Aside from these potential navigational issues, some commercial fishermen may avoid the Wind Farm Area if large numbers of recreational fishermen are drawn to the area by the prospect of higher catches. According to ten Brink and Dalton (2018), the influx of recreational fishermen into the Block Island Wind Farm in Rhode Island caused some commercial fishermen to cease fishing in the area because of vessel congestion and gear conflict concerns. In addition, if these concerns cause commercial fishermen to shift their fishing effort to areas not routinely fished, conflict with existing users could increase as other areas are encroached. In general, the potential for conflict among commercial fishermen due to fishing displacement may be higher for fishermen engaged in fisheries that have regulations that constrain where fishermen can fish, such as the lobster fishery. However, the potential for vessel congestion and gear conflict may also increase if mobile species targeted by commercial fishermen, such as Atlantic herring, Atlantic mackerel, squid, tuna, and groundfish, are attracted to the Wind Farm Area, and fishermen targeting these species concentrate their fishing effort in the Lease Area as a result.

Whether fishermen continue to fish in the Wind Farm Area is also determined by cultural and traditional values that go beyond expected profit. For example, it is advantageous for fishermen to be able to fish in locations that are known to them and also fished by their peers. In addition, the presence of other boats in the area can contribute to the fishermen’s sense of safety. Some fishermen may choose to not fish in the area due to their perception of risk. Impacts on commercial fisheries may affect the economic health, the cultural identity, and values, and therefore the wellbeing, of individuals and communities that identify as “fishing” communities. Impacts on cultural and traditional values are not quantifiable but are qualitatively considered when assessing the impacts of the Proposed Action. In addition, there could be a psychological effect on commercial fishermen, as studies have shown there are occasionally far-reaching impacts related to fisheries disasters, where an economic fisheries disaster was declared for the Atlantic cod. It was determined that overfishing was occurring largely due to uncertainties in stock estimates and noted that fishing pressure should be reduced by upwards of 90 percent (Scyphers et al. 2019). This resulted in low levels of trust in fisheries management and was a predictor of both initial and chronic psychological distress. Distress was most severe for individuals without income diversity and those with dependents in the household. Some fishing vessel operators unwilling or unable to travel through or deploy fishing gear in the Wind Farm Area may be able to find suitable alternative fishing locations and continue to earn revenue, although it is difficult to predict the ability of fishing operations displaced by the Project to locate alternative fishing grounds that would allow them to maintain revenue targets while continuing to minimize costs, and some vessel operators may choose not to seek alternate fishing grounds. If a vessel operator chooses to seek alternate fishing locations, the available data suggest the presence of alternative productive fishing grounds in proximity to the Wind Farm Area, especially for the two highest revenue-producing FMP species within the Wind Farm Area: sea scallop and surfclam/ocean quahog (COP Volume II, Section 2.3.4.1.3 Figures 2.3.4-12.3.4-2; Ocean Wind 2023). The figures in the COP indicate that the fishing level efforts in large expanses of ocean within 30 nm (55.6 kilometers) of the Lease Area are comparable to or higher than those within the Lease Area. While comparable fishing grounds may exist in proximity to the Wind Farm Area, shifting locations could result in increased operating costs (e.g., additional fuel to arrive at more distant locations; additional crew compensation due to more days at sea), lower revenue (e.g., fishing in a less-productive area, fishing for a less-valuable species, or increased competition for the same resource), or both. In addition, due to other offshore wind development in adjacent offshore wind lease areas, it would be expected that commercial fishing vessels would also be displaced and actively looking for alternative fishing grounds, which could increase competition for ocean space use. However, if, at times, a fishery resource is only available within the Wind Farm Area, some fishermen, primarily those using mobile gear, may lose the revenue from that resource for the time the resource is inaccessible. Not all fishermen would seek alternative fishing grounds and, while some may switch the species they target, some may also leave the fishery altogether (Murray et al. 2010; O’Farrell et al. 2019). Those vessel operators switching species targeted may also lose revenue from targeting a less valuable species and increased costs from switching gear type. They may also look to land their catch at a different port (Papaioannou et al. 2021). All of these impacts could remain until decommissioning of the Project is complete, although the magnitude of the impacts would diminish over time if fishing practices adapt to the presence of structures.

To evaluate the potential costs associated with reduced fishing revenues that may result from construction and O&M activities in the Wind Farm Area, BOEM obtained information from NMFS on fisheries revenue sourced from within the Lease Area. From these data, it is possible to estimate the amount of commercial fishing revenue that would be exposed as a result of the Proposed Action, although the data are only for those vessels issued federal fishing permits by the NMFS Greater Atlantic Region and therefore do not include all sources of commercial fishing revenue within the Lease Area. The estimate of revenue exposure quantifies the value of fishing that occurs in the Lease Area. Therefore, these estimates represent the fishing revenue that would be foregone if fishing vessel operators opt to no longer fish in these areas and cannot capture that revenue in a different location. Revenue exposure estimates should not be interpreted as measures of actual economic impact, as they are based on historic landings. Actual economic impact would depend on many factors—foremost, the loss of the potential for continued fishing to occur within the Wind Farm Area, together with the ecological impact on target species residing within the Project area. Economic impacts of these factors are lessened with a vessel's ability to adapt to changing where it fishes. For example, if alternative fishing grounds are available nearby and could be fished at no additional cost, the economic impact would be lower. There is also the potential to fish the boundary of the Wind Farm Area. If fish stocks increase within the Wind Farm Area due to reduced fishing efforts, stocks may also increase in areas immediately adjacent to the Wind Farm Area and, if fished, these adjacent areas may generate revenue similar to that of the Wind Farm Area.

Based on average annual revenue data from 2008 through 2021, Table 3.9-24 shows the annual revenue at risk in the Lease Area by FMP fishery. The average amount of commercial fishing revenue that would be exposed annually for the life of the Project is estimated to be $312,601 across all FMP and non-FMP fisheries, with any given year potentially above or below this value, and represents about 0.02 percent of the total average annual revenue of the FMP and non-FMP fisheries in the Mid-Atlantic and New England regions. The largest impacts in terms of exposed revenue as a percentage of total revenue in the Mid-Atlantic and New England regions would be in the Surfclam/Ocean Quahog FMP fishery (0.27 percent). In addition, as noted in Section 3.9.4, Ørsted would create a Direct Compensation Program for affected fisherman as described in the COP. The Direct Compensation Fund would serve to mitigate potential revenue at risk in the Lease Area related to claims from both commercial fishing and for-hire recreational fishing operations, regardless of their homeport. The program would be managed by a third party and eligibility would be based upon a demonstrated fishing history in the Project area.

As shown in Table 3.9-9, the ports most affected by revenue sourced from within the Lease Area in the years 2008 through 2021 were Atlantic City, New Jersey, followed distantly by Cape May, New Jersey; New Bedford, Massachusetts; and Newport News, Virginia.

As described above, the amount of fishing activity that could be affected within the Lease Area is a small fraction of the amount of fishing activity in the New England and Mid-Atlantic regions as a whole. However, for fishing vessels that choose to avoid the Wind Farm Area, have historically derived a large percentage of their total revenue from the area, and are unable to find suitable alternative fishing locations, the adverse impacts would be long term and moderate. While a small number of commercial fishing vessels fish heavily in the Lease Area, the highest percentage of total annual revenue attributed to catch within the Lease Area was 31 percent in 2017. However, three quarters of the vessels fishing in the area derived less than 0.16 percent of their total revenue from the area in 2008 through 2021 (see Section 3.9.1). In short, some vessels depended heavily on the Lease Area, but most vessels derived a small percentage of their total annual revenue from the area. In both cases, the impacts could be long term if the respective vessels choose to avoid the Lease Area, but the level of impact for vessels deriving only a small percentage of their revenue from the area would be substantially less than for vessels that derive a large portion of their revenue from the Lease Area. Considering the low revenue risk across ports, together with the small number of vessels and fishing activity that would be affected by the Project, the impacts on other fishing industry sectors, including seafood processors and distributors and shoreside support services, would be long term and negligible to moderate, depending on the fishery in question.

As noted above, there are a number of areas within the Lease Area designated as Prime Fishing Grounds of New Jersey; however, annual exposure of revenue for for-hire recreational fishing specific to the Lease Area is not available. However, BOEM conducted an economic analysis of recreational for-hire boats, as well as for-hire and private-boat angler trips that might be affected by the overall New Jersey WEA, which encompasses all of the New Jersey lease areas (Kirkpatrick et al. 2017). Recreational fishing was considered "exposed" to potential impact if at least part of the trip occurred within 1 nm (1.9 kilometer) of a WEA during the study period (2007–2012). Only the recreational fisheries in New Jersey and Maryland indicate trips to the New Jersey WEA, with a negligible amount from Delaware and New York for which approximately 0 percent of the revenue was exposed (Kirkpatrick et al. 2017). On average, approximately 8,177 for-hire boat trips and 153,989 for-hire angler trips were made from a home port in New Jersey annually during this period. Of these annual estimates, approximately 4.6 percent of boat trips and 3.8 percent of for-hire angler trips were estimated to be exposed to the New Jersey WEA (Kirkpatrick et al. 2017). Based on the information shown in Table 3.9-17 and Table 3.9-18, the vast majority of for-hire recreational fishing in the Wind Farm Area originates from New Jersey ports—namely, Atlantic City and Sea Isle, with other New Jersey ports having fewer than three permits. For Atlantic City and Sea Isle, the exposed revenue for all New Jersey WEAs was 20.8 percent and 9.8 percent, respectively (Kirkpatrick et al. 2017). As shown in Table 3.9-16, the average annual for-hire recreational fishing revenue for the Wind Farm Area from 2008 through 2021 was approximately $21,000; therefore, the exposed revenue as it relates to the Wind Farm Area would be smaller than the noted percentages.

Table 3.9-24 Annual Average Commercial Fishing Revenue Exposed to the Wind Farm Area by FMP Fishery Based on Annual Average Revenue 2008–2021

FMP Fishery	Peak Annual Revenue	Average Annual Revenue	Average Annual Exposed Revenue as a Percentage of Total Revenue from the Geographic Analysis Area
Atlantic Herring	$5,059	$405	0.00%
ASMFC	$102,285	$20,517	0.00%
Bluefish	$144	$67	0.00%
Highly Migratory Species	$746	$199	0.00%
Mackerel/Squid/Butterfish	$33,668	$10,527	0.02%
Monkfish	$14,557	$3,473	0.02%
Multispecies Small Mesh	$301	$64	0.00%
Northeast Multispecies	$162	$15	0.00%
Sea Scallop	$304,741	$110,567	0.02%
Southeast Regional Office FMP	$336	$29	0.01%
Skate	$5,380	$1,335	0.02%
Spiny Dogfish	$100	$24	0.00%
Summer Flounder/Scup/Black Sea Bass	$24,464	$12,730	0.03%
Surfclam/Ocean Quahog	$341,567	$107,850	0.13%
Tilefish	$42	$9	0.00%
None: Unmanaged[1]	$86,322	$22,903	0.01%

FMP Fishery	Peak Annual Revenue	Average Annual Revenue	Average Annual Exposed Revenue as a Percentage of Total Revenue from the Geographic Analysis Area
All Others[2]	$190,070	$21,905	0.02%
All FMP and non-FMP Fisheries	**$804,578**	**$312,601**	0.02%

Sources: Developed using data from NMFS 2022b).
Notes: Revenue is in nominal dollars and is estimated based on the annual average revenue by FMP from 2008 through 2021. Resolution of the data does allow estimates to be made on a small enough scale to differentiate impacts along wind farm export cable corridors. Therefore, estimates only pertain to the Lease Area itself. Peak annual revenue and average annual revenue are calculated independently for all rows, including the All FMP and non-FMP Fisheries row.
[1] Includes revenues from all species not assigned to an FMP (No Federal FMP).
[2] "All Others" is for data that have been aggregated for confidentiality purposes.

A potential effect of the offshore cables and WTGs is the entanglement and damage or loss of commercial and recreational fishing gear. Economic impacts on fishing operations associated with gear damage or loss include the costs of gear repair or replacement, together with the fishing revenue lost while gear is being repaired or replaced.

The Proposed Action would install approximately 384 miles (618 kilometers) of new submarine cable, including 190 miles (305.8 kilometers) of inter-array cables, 175 miles (281.6 kilometers) of offshore export cables, and 19 miles (30.1 kilometers) of OSS interconnector cables. As described in the COP (COP Volume I, Sections 6.1.1.5 and 6.1.1.6; Ocean Wind 2023) and summarized in Appendix E, Ocean Wind proposes to bury all cables to a target depth of 4 to 6 feet (1.2 to 1.8 meters). Four to six feet is well below the typical depth to which bottom trawls penetrate the ocean floor. In a study of seabed depletion and recovery from bottom trawl disturbance, Hiddink et al. (2017) found that hydraulic dredges penetrated the ocean floor the deepest at 6.3 inches (16.1 centimeters). Even with the common practice of dredge vessels fishing the same or similar tow paths on multiple occasions during the same trip, it is unlikely that fishing gear would penetrate deep enough to snag or become tangled in the cable. While it is possible that cables could become uncovered during extreme storm events due to mobile seabed conditions or other natural processes, burying and maintaining cables to the target depth would minimize the risk of exposure and potential damage to fishing gear.

In areas where seabed conditions might not allow for cable burial, other methods of cable protection would be employed, such as rock placement, concrete mattress placement, frond mattress placement, rock bags, or seabed spacers. It is anticipated that up to 10 percent of the offshore cable may require additional cable protection where burial depth may be less than 4 feet (1.3 meters). In addition to cable armoring, the Project would install approximately 84 acres (0.34 km^2) of scour protection for the 101 installed foundations (WTGs and OSS). The scour protection would extend out 72 yards (65.8 meters) from the foundations and have a layered thickness of 8.2 feet (2.5 meters) and, similar to cable armoring, would pose a risk to entanglement and gear loss for commercial fishers, as well as gear loss for for-hire recreational fishers because trolling, bait fishing, and shark fishing could be more challenging, as the fish could use foundations and the scour protection to break free.

Cable, WTG, and OSS locations would be indicated on nautical charts, helping to reduce the potential for fishing gear interactions. Additionally, while Ocean Wind does not currently plan to establish formal exclusion/safety zones around construction vessels during the laying of cables, USCG may implement safety zones, as described in Ocean Wind's Fisheries and Communication and Outreach Plan (COP Volume III, Appendix O; Ocean Wind 2023). However, Ocean Wind employs a Fisheries Liaison to coordinate outreach to the fishing industry and disseminate information regarding Project activities such as Project vessel movements and construction schedule to minimize potential adverse interactions between commercial and for-hire recreational fisheries and Project operations. Additionally, as noted in Section 3.9.4, Ocean Wind has developed a financial compensation policy and procedure to be used when interactions between the fishing industries and Project activities or infrastructure cause gear loss or damage as described in Ocean Wind's Fisheries and Communication and Outreach Plan (COP Volume III, Appendix O; Ocean Wind 2023). The use of this policy for qualifying gear interactions that may occur during construction, as well as during O&M activities, is considered part of the Proposed Action and would help reduce moderate adverse impacts for commercial fisheries to minor impacts. Applicants may request reimbursement for lost/damaged gear, economic loss (lost catch and business interruption), and reasonable claim preparation costs. The full details of the gear claim process can be found at https://us.orsted.com/renewable-energy-solutions/offshore-wind/mariners.

Impacts due to entanglement and gear damage/loss would persist for the duration of Project operations. During decommissioning of the Project, all foundations for WTGs and OSS would be removed to 15 feet below the mudline, and while Ocean Wind proposes to leave any scour protection placed around the base of the monopiles in place (COP Volume I, Section 6.3; Ocean Wind 2023), BOEM would most likely require that the scour protection be removed in accordance with 30 CFR 285.902(a), eliminating the opportunities for entanglement and gear damage/loss. However, if left in place, the scour protection would continue to pose an indefinite threat for entanglement and gear damage/loss. Offshore cables may be either left in place or removed depending on the regulatory requirements at the time of decommissioning, although it is assumed that all inter-array cables would be removed. Any scour protection or materials (e.g., concrete mattresses) that were used to protect exposed cables permitted to be left in-situ would continue to affect bottom trawl fisheries as well as for-hire recreational fishing due to possible entanglement and gear loss.

In addition to posing hazards to fishing gear, the presence of the WTG foundations and associated scour protection, as well as cable protection, would convert existing sand or sand with mobile gravel habitat to hard bottom, which, in turn, would reduce the habitat for target species that prefer soft-bottom habitat (e.g., surfclams, sea scallops, squid, summer flounder) and increase the habitat for target species that prefer hard-bottom habitat (e.g., lobster, striped bass, black sea bass, Atlantic cod). Where WTG foundations, scour, and cable protection produce an artificial reef effect and attract finfish and invertebrates, the aggregation of species could increase the catchability of target species (Kirkpatrick et al. 2017). Although species that rely on soft-bottom habitat would experience a reduction in favorable conditions, the impacts from structures are not expected to result in population-level impacts (see Section 3.13, *Finfish, Invertebrates, and Essential Fish Habitat*) and changes to species biomass are not expected to be significant enough to affect total quotas.

The habitat changes would likely benefit for-hire recreational fishing due to increased fishing opportunities around the infrastructure, which is what ten Brink and Dalton (2018) found occurred at the Block Island Wind Farm in Rhode Island. Impacts from habitat conversion would last throughout the life span of the Project and, in areas where scour and cable protection are left in place after decommissioning, would last indefinitely, although the scale of impact will not be known until decommissioning and the actual acreage of scour and cable protection to be left in place is known.

The change in habitat from soft bottom to hard bottom could slow the movements of migratory fish species through habitat occupation. However, water temperature is expected to be a bigger driver of habitat occupation and species movement than structure (Fabrizio et al. 2014; Moser and Shepherd 2009; Secor et al. 2018).

The Proposed Action is expected to add up to 101 foundations and 178 acres (0.7 km^2) of scour/cable protection. Foundations and scour/cable protection would remain for the life of the Project. This could tend to slow migration. However, water temperature is expected to be a bigger driver of habitat occupation and species movement (Fabrizio et al. 2014; Moser and Shepherd 2009; Secor et al. 2018).

Migratory animals would likely be able to proceed from structures unimpeded. Therefore, this impact is anticipated to be negligible and would only last for the duration of the Project, as the foundations and scour/cable protection would be removed during decommissioning.

Cable emplacement and maintenance: The Proposed Action would install approximately 384 miles (618 kilometers) of new submarine cable, including 190 miles (305.8 kilometers) of inter-array cables, 175 miles (281.6 kilometers) of offshore export cables, and 19 miles (30.1 kilometers) of OSS interconnector cables. As described in the COP (COP Volume I, Sections 6.1.1.5 and 6.1.1.6; Ocean Wind 2023) and summarized in Appendix E, Ocean Wind proposes to bury all cables to a target depth of 4 to 6 feet (1.2 to 1.8 meters). Cable-laying activities, including preparatory boulder and sand wave clearance activities, would directly disrupt commercial and for-hire recreational fishing activities in areas of active construction, although disruption in any given area would be temporary. Existing aquaculture leases would be avoided to the extent practicable; however, the aquaculture lease near the Oyster Creek marina landfall option may be temporarily affected by cable installation and anchor lines for installation vessels. Boulder clearance would be performed using a combination of displacement plow, subsea grab, or, in shallower waters, a backhoe dredger, while sand wave clearance may be undertaken by traditional dredging methods such as a trailing suction hopper or, alternatively, by a controlled-flow excavator or sand wave removal plow, with the ultimate method chosen based on the results from the site investigation, surveys, and cable design (COP Volume I, Sections 6.1.2.1.3 and 6.1.2.1.5; Ocean Wind 2023).

Boulder clearance, sand wave clearance, and cable laying disturbs the seabed and can reduce water quality through resuspension of sediment, increase underwater noise, or introduce artificial lighting and can result in a behavioral response from mobile finfish species and injury or death of less-mobile species or benthic infauna such as scallops, surfclams, and ocean quahogs, as well as alter the seabed profile (see Section 3.13.5). In turn, these responses could decrease catchability for a fishery, such as by changing the species composition where seabed profiles are changed or due to disturbances causing fish to not bite at hooks or changing swim height. The maximum impacts for boulder and sand wave clearance would be 4,552 acres (18.4 km^2), assuming a 98-foot (30-meter) wide corridor along 100 percent of the cable route within both the Wind Farm Area and the export cable routes (COP Volume I, Section 6.1.1.4; Ocean Wind 2023), even though the actual clearance area is likely to be less than the assumed maximum area. New cable emplacement and maintenance are estimated to affect up to 169 acres (0.7 km^2) of seafloor within the export cable route. The relocation of boulders also could increase the risk of gear stags, as uncharged or unknown obstructions could result in damage to equipment, lost revenue, and potential safety impacts. Behavioral responses of target species in commercial and for-hire recreational fisheries are expected to be confined to a small area at any one time, and to end shortly after construction activities end. Cable inspection and repair activities would result in types of impacts similar to those of construction activities, with temporary disturbance, displacement, injury, or mortality of target species. However, the areas of impact would be expected to be minor and the duration of impacts to be temporary.

Fishing activities for all gear types could be disrupted during periods of active cable site preparation, installation, and maintenance along cable routes in the Wind Farm Area and export cable corridors. Fishing vessels may not have access to affected areas, which could lead to reduced revenue if alternative fishing locations are not available or there is increased conflict over other fishing grounds. Ocean Wind estimates the simultaneous cable lay and burial speed for the offshore export cables would be an average speed of approximately 3 kilometers per day (125 meters per hour) (COP Volume I; Ocean Wind 2023). Cable-laying activities would not restrict large areas, and navigational impacts would likely be on the scale of hours.

Climate change: The types of impacts from global climate change on commercial fisheries and for-hire recreational fisheries described for the No Action Alternative would also occur under the Proposed Action (see Section 3.9.3.2). The Proposed Action could contribute to a long-term net decrease in GHG emissions due to its use of renewable energy. While this decrease may not be measurable, it would be expected to help reduce climate change to some degree, although any negligible benefit would only last until the Project is decommissioned.

3.9.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned activities.

Anchoring: The Proposed Action would contribute a noticeable increment to the combined anchoring impacts on commercial fisheries and for-hire recreational fishing from ongoing and planned activities including offshore wind. Anchoring activities would result in localized, short-term, minor impacts on commercial fisheries and for-hire recreational fishing, including navigational hazards to fishing vessels, especially if projects are overlapping in the same area as fishing or transiting fishing vessels.

Noise: The incremental contributions of the Proposed Action to the combined noise impacts on commercial fisheries and for-hire recreational fishing associated with ongoing and planned activities would be noticeable. The most significant sources of noise are expected to be from pile driving, followed by vessels. The 101 foundations for the Proposed Action would represent approximately 3 percent of the 3,159 foundations that would be installed on the OCS for planned offshore wind farms, including the Proposed Action. The noise from Project vessels would only represent a small fraction of the large volume of existing traffic in the geographic analysis area.

Traffic: BOEM expects the Proposed Action would contribute a noticeable increment to the combined vessel traffic impacts on commercial fisheries and for-hire recreational fishing from ongoing and planned activities including offshore wind. Increased vessel traffic during the construction timeframe, as well as during O&M activities, would result in moderate impacts.

Port utilization: The incremental contributions of the Proposed Action to the combined port utilization impacts associated with ongoing and planned activities would be noticeable.

Presence of structures: BOEM expects the Proposed Action would contribute a noticeable increment to the combined presence of structure impacts on commercial fisheries and for-hire recreational fishing from ongoing and planned activities including offshore wind. The increased number of structures would increase the risk of highly localized and periodic impacts on commercial fisheries that could be major and impacts on for-hire recreational fishing that could be minor for those trolling for highly migratory species or beneficial due to increased fishing opportunities for other for-hire recreational fisheries.

Cable emplacement and maintenance: The Proposed Action would contribute a noticeable increment to the combined cable emplacement and maintenance impacts on commercial fisheries and for-hire recreational fishing from ongoing and planned activities including offshore wind, which would be localized, short term, and minor due to fishing vessel displacement.

3.9.5.3. Conclusions

Impacts of the Proposed Action. Project construction and installation, O&M, and conceptual decommissioning could affect port and fishing access, as well as transit and harvesting activities, fishing gear interactions, and target species catch. BOEM anticipates that the adverse impacts of the Proposed Action on commercial fisheries and for-hire recreational fishing would vary by fishery and fishing operation due to differences in target species abundance in the Project Area, gear type, and predominant location of fishing activity. It is conceivable that some of the small number of fishing operations that derive a large percentage of their total revenue from areas where Project facilities would be located would choose to avoid these areas once the facilities become operational. In the event that these specific fishing operations are unable to find suitable alternative fishing locations, they could experience long-term, major disruptions. However, it is estimated that the majority of vessels would only have to adjust somewhat to account for disruptions due to impacts and that the Direct Compensation Fund would serve to mitigate potential revenue at risk in the Lease Area. Therefore, BOEM expects the incremental impact of the Proposed Action, when compared with the No Action Alternative, to be minor to moderate for commercial fisheries and for-hire recreational fishing operations, depending on the fishery or fishing operation. In addition, the incremental impacts of the Proposed Action could include long-term, minor to moderate beneficial impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

When including the baseline status (No Action Alternative), including regulated fishing effort and climate change, into the impact findings, BOEM expects that the impacts resulting from the Proposed Action would range from **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreational fishing operations, depending on the fishery or fishing operation. The impacts of the Proposed Action could include long-term, **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

Cumulative Impacts of the Proposed Action. The incremental impacts contributed by the Proposed Action to the cumulative impacts on commercial fisheries and for-hire recreational fishing would be appreciable. BOEM anticipates that the cumulative impacts on commercial fisheries and for-hire recreational fishing associated with the Proposed Action when combined with impacts from ongoing and planned activities including offshore wind would be **minor** to **major** for commercial fisheries and **minor** to **moderate** for-hire recreational fishing operations because some fisheries and fishing operations would experience substantial disruptions indefinitely, even with APMs. This impact rating is primarily driven by the presence of offshore structures, climate change, and regulated fishing effort. Cumulative impacts could include long-term, **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

The majority of offshore structures in the geographic analysis area would be attributable to the offshore wind industry. However, given the array of measures available to mitigate impacts of offshore wind projects on commercial fisheries and for-hire recreational fishing, this impact rating is driven mostly by reduced stock levels from ongoing fishing mortality because of regulated fishing effort, changes in the abundance and distribution of fish and invertebrates associated with ongoing climate change, and permanent impacts from the presence of structures associated with planned offshore wind projects.

3.9.6 Impacts of Alternatives B and D on Commercial Fisheries and For-Hire Recreational Fishing

Impacts of Alternatives B and D. The relevant change from the Proposed Action to Alternatives B-1 and B-2 would be the removal of up to 19 WTGs from the two most shoreward (northwest) rows within the Wind Farm Area to reduce visual impacts. For Alternative D, the relevant change would be the removal up to 15 WTGs to avoid sand ridge and trough habitat in the northeast corner. Even with removal of these WTGs, implementation of these alternatives would result in most of the same types of impacts from all of the IPFs on commercial fisheries and for-hire recreational fisheries from construction and installation, O&M, and conceptual decommissioning activities as described for the Proposed Action, with some impacts being minimally decreased. The reduction of WTGs in Alternative D may have additional benefits to recreational fisheries in that it can preserve natural fish habitat of the area. Sand ridges and troughs are areas of biological significance for migration and spawning of mid-Atlantic fish species, many of which are recreationally targeted in those specific areas.

Alternatives B-1, B-2, and D would reduce the overall footprint of the Project, providing more area within the Lease Area for commercial fishing vessels to operate and fish without potential impacts from structures, slightly reducing the potential for gear entanglement and loss, as well as allisions. There would likely be fewer construction vessel trips, slightly decreasing congestion and possibly slightly reducing the risk of vessel collisions. With no structures in the northwestern portion of the Lease Area, it would benefit for-hire recreational fishing by removing impacts on some of the Prime Fishing Grounds of New Jersey while also decreasing potential vessel conflicts for the commercial fishery vessels that transit or choose to fish the area. The biological benefits of preserving natural fish habitat may have beneficial impacts on the fish communities and recreational fishing. Additional potential benefits of Alternative D preserving sand ridge and trough habitat would be in the troughs providing migratory pathways for many diadromous fish species. The sand ridges and troughs also influence water and sediment dynamics and provide a complex habitat for multiple life stages of varying species. However, given the small size of the added structure-free area, any additional revenue realized by the commercial fishery would likely be minimal and dependent on the targeted species that may be in that particular area and whether commercial fishermen are willing to fish that part of the Lease Area. According to VMS density mapping available through Northeast Ocean Data (2023), fisheries benefiting the most from removal of the WTGs under Alternatives B and D would be the Surfclam/Quahog and Scallop FMP fisheries, for which hydraulic clam dredges are the primary gear type used, and dredge and pots/traps gear types in general.

Cumulative Impacts of Alternatives B and D. The incremental impacts contributed by these action alternatives to the cumulative impacts on commercial fisheries and for-hire recreational fishing would be similar to or slightly less than those described under the Proposed Action, which would be appreciable.

3.9.6.1. Conclusions

Impacts of Alternatives B and D. The anticipated incremental minor to moderate impacts and minor to moderate beneficial impacts associated with Alternatives B-1, B-2, and D without the baseline (No Action Alternative) scenario would not be substantially different than the incremental impacts of the Proposed Action. While these action alternatives could slightly change the impacts on commercial fisheries and for-hire recreational fishing, ultimately the same or highly similar construction, operation, and decommissioning impacts would still occur. Any additional revenue realized by commercial fisheries would be minimal, and for-hire recreational fishing may see a slight decrease due to fewer structures providing reef habitat for targeted species. When considering all of the IPFs and including the baseline (No Action Alternative), including regulated fishing effort and climate change, the impact on commercial fisheries and for-hire recreational fishing would still be **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreational fishing operations, depending on the fishery or fishing operations. The impacts of Alternatives B and D could include long-term, **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

Cumulative Impacts of Alternatives B and D. The incremental impacts contributed by Alternatives B-1, B-2, and D to the cumulative impacts on commercial fisheries and for-hire recreational fishing would be noticeable. Incremental impacts on commercial fisheries and for-hire recreational fishing would be slightly less, due to fewer WTGs or shorter inter-array cables, but not substantially different from those of the Proposed Action. BOEM anticipates that the cumulative impacts on commercial fisheries and for-hire recreational fishing associated with Alternatives B-1, B-2, and D when combined with the impacts from ongoing and planned activities including offshore wind would be **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreational fishing operations, the same level as under the Proposed Action, because some commercial and for-hire recreational fisheries and fishing operations would experience substantial disruptions indefinitely even with APMs. Cumulative impacts could include long-term, **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

3.9.7 Impacts of Alternative C on Commercial Fisheries and For-Hire Recreational Fishing

Impacts of Alternative C. Alternative C was developed to create an 0.81-nm to 1.08-nm buffer between WTGS in the Lease Area (OCS-A 0498) and WTGs in the Atlantic Shores South Lease Area (OCS-A 0499). Under Alternative C-1, up to eight WTGs (the entirety of the northeastern-most row of WTGs) would be removed and possibly relocated to the northwestern boundary of the Lease Area. Under Alternative C-2, the array of WTGs would be compressed such that inter-row spacing would be reduced to no less than 0.92 nm (1.9 to 1.7 kilometers). This would create the buffer without reducing the number of WTGs within the array. Prior to construction, additional geotechnical or engineering surveys (which may be necessary to determine the new WTG placements) may result in a small, temporary increase in vessel use and bottom disturbance that would not occur under the Proposed Action. BOEM anticipates that this disturbance would be brief and localized, particularly compared to other proposed Project activities, and have negligible to minor impacts. For these alternatives, no changes would be made to the export cable routes; therefore, there would be no changes to impact evaluations outside the Wind Farm Area compared to the Proposed Action. Most other impacts would be similar to those of the Proposed Action as well, except as noted below.

Cumulative Impacts of Alternative C. The removal of WTGs from the boundary with the Atlantic Shores South Lease Area, either through relocation under Alternative C-1 or through compression of the WTG spacing under Alternative C-2, would provide an 0.81-nm- to 1.08-nm-wide buffer, or wider depending on how the alignment is set for the Atlantic Shores South Lease Area, that would be free of structures, making it easier and safer for fishing vessels to transit beyond the Lease Area. Depending on a vessel’s ultimate destination, it may make the trip slightly shorter, reducing overall costs, although any reduction would likely be minor. While the decreased spacing of the WTGs under Alternative C-2 would likely preclude more commercial fishing vessels from being willing to fish the area due to safety concerns related to navigation and gear loss, the impact for potential exposed revenue (for federally permitted fisheries) would not differ from that of the Proposed Action, as it would be within the maximum parameters defined in the PDE. This does not include potential impacts from the compression of WTG spacing on non-federally permitted species, such as menhaden and welk fisheries. For Alternatives C-1 and C-2, the cumulative level of impact and the level of each IPF are anticipated to be the same as under Proposed Action, except for vessel traffic and presence of structures because the 0.81-nm- to 1.08-nm-wide buffer would provide slightly more safety for vessels transiting the area. According to VMS and density mapping available through Northeast Ocean Data (2023), fisheries benefiting the most from removal of the WTGs under Alternative C would be the Surfclam/Quahog and Scallop FMP fisheries. Specifically, those vessels transiting to the Mid-Atlantic Access Scallop Rotational Area from New Jersey ports would not have to circumnavigate the Lease Area (Wilson pers. comm.). The corridor would also benefit those vessels transiting from New Jersey ports to the outer shelf to target squid (Wilson pers. comm.). The incremental impacts contributed by these alternatives on ongoing and planned activities including offshore wind would be similar to those under the Proposed Action, which would be appreciable.

3.9.7.1. Conclusions

Impacts of Alternative C. The anticipated incremental minor to moderate impacts and minor to moderate beneficial impacts associated with Alternatives C-1 and C-2 without the baseline (No Action Alternative) would not be substantially different from the incremental impacts of the Proposed Action. While these action alternatives could slightly change the impacts on commercial fisheries and for-hire recreational fishing, ultimately the same or highly similar construction, O&M, and decommissioning impacts would still occur. The only difference would be a slight increase in safety for vessels using the new structure-free corridor (up to 2.2 nm [4 kilometers]) to transit the area. While Alternative C-2 would likely preclude additional commercial fisheries vessels from fishing within the Wind Farm Area, it is within the maximum parameters defined in the PDE, and therefore the exposed revenue that could be lost would not differ from that under the Proposed Action. When considering all of the IPFs and including the baseline (No Action Alternative), including regulated fishing effort and climate change, the impact on commercial fisheries and for-hire recreational fishing would still be **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreational fishing operations, depending on the fishery or fishing operation. The impacts of Alternative C could include long-term, **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

Cumulative Impacts of Alternative C. The incremental impacts contributed by Alternatives C-1 and C-2 to the cumulative impacts on commercial fisheries and for-hire recreational fisheries would be noticeable. BOEM anticipates that cumulative impacts on commercial fisheries and for-hire recreational fishing associated with Alternatives C-1 and C-2, when combined with the impacts from ongoing and planned activities including offshore wind, would be **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreation fishing operations, the same level as under the Proposed Action, because some commercial and for-hire recreational fisheries and fishing operations would experience substantial disruptions indefinitely even with APMs. Cumulative impacts could include long-term, **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

3.9.8 Impacts of Alternative E on Commercial Fisheries and For-Hire Recreational Fisheries

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. Alternative E would still make landfall on Island Beach State Park; however, the alternative route would continue north before entering Barnegat Bay at a location such that SAV impacts along the eastern shore of the bay could be minimized (see Figure 2-12). Alternative E would then continue west through a historically used remnant channel and then south within Barnegat Bay to connect with the route associated with the Proposed Action. Alternative E would continue to affect SAV at each of the three proposed landing sites on the western shore of Barnegat Bay.

Alternative E would lead to the same types of impacts on commercial fisheries and for-hire recreational fishing from construction and installation, O&M, and conceptual decommissioning activities as described for the Proposed Action, although there may be slightly greater, but temporary, construction impacts related to avoidance of the area for nearshore fisheries and transiting vessels due to the extended length of the export cable. Based on the Mid-Atlantic Ocean Data Portal, scallop fishing could be affected as well as some for-hire recreational fishing, although the relatively minor additional length of the route and the data resolution do not allow estimates to be made on a small enough scale to differentiate impacts among this alternative and the other alternatives. Based on survey data collected by Ocean Wind, the acreage of SAV affected by cable emplacement and maintenance would be reduced by an estimated 14.7 acres (Ocean Wind 2021), which would slightly benefit the fisheries. SAV provides nursery habitat for targeted fishery species, thus possibly enhancing potential recruitment to the fishery, although any enhancement would likely be negligible.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts on commercial and for-hire recreational fishing would be noticeable and slightly less than those under the Proposed Action due to avoidance of SAV, which serves as a nursery habitat for species targeted by commercial and for-hire recreational fisheries.

3.9.8.1. Conclusions

Impacts of Alternative E. The anticipated incremental minor to moderate impacts and minor beneficial impacts associated with Alternative E without the baseline (No Action Alternative) would not be substantially different from the incremental impacts of the Proposed Action. While Alternative E could slightly change the impacts on commercial fisheries and for-hire recreational fishing, ultimately the same or highly similar construction, O&M, and decommissioning impacts would still occur. Alternative E would provide a slight benefit to commercial and for-hire recreational fisheries by reducing the impact on SAV, a nursery habitat for targeted species. Alternative E would also result in slightly greater construction impacts related to avoidance of the area for nearshore fisheries due to the extended length of the export cable, but the impact would be temporary, only lasting as long as the construction time frame. When considering all of the IPFs, and including the baseline (No Action Alternative), including regulated fishing effort and climate change, the impact on commercial fisheries and for-hire recreational fishing would still be **minor** to **major** for commercial fisheries and **minor** to **moderate** for for-hire recreational fishing operations, depending on the fishery or fishing operation. The impacts of Alternative E could include long-term, **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts on commercial fisheries and for-hire recreational fishing would be noticeable. BOEM anticipates that cumulative impacts on commercial fisheries and for-hire recreational fishing associated with Alternative E when combined with the impacts from ongoing and planned activities including offshore wind would be **major** because impacts would be slightly less, due to reducing the impact on SAV, but not substantially different from those of the Proposed Action. Cumulative impacts could include long-term, **minor** to **moderate beneficial** impacts for certain commercial fisheries and some for-hire recreational fishing operations due to the artificial reef effect.

3.9.9 Proposed Mitigation Measures

In the Draft EIS, BOEM analyzed proposed measures for the compensation of gear loss and damage and compensation for lost fishing income to minimize impacts on commercial fisheries and for-hire recreational fishing. After publication of the Draft EIS, Ocean Wind updated its COP to include APMs for the lost or damaged gear claim procedure and Direct Compensation Program, so these APMs are analyzed in the Final EIS as part of the Proposed Action in Section 3.9.5.1.

Several measures are proposed to minimize impacts on commercial fisheries and for-hire recreational fishing (Appendix H, Table H-3). If the measures analyzed below are adopted by BOEM or cooperating agencies, some adverse impacts could be further reduced.

Table 3.9-25 Additional Proposed Measures (Also Identified in Appendix H, Table H-3): Commercial Fisheries and For-Hire Recreational Fishing

Measure	Description	Effect
Shoreside seafood business compensation	In addition to the Direct Compensation Fund Proposed by the Lessee, BOEM would require the Lessee to ensure that the Direct Compensation Fund includes losses to shoreside businesses. The Lessee shall analyze the impacts to shoreside seafood businesses adjacent to ports listed in Table 3.9-10. The shoreside seafood business analysis would be used to further supplement funds available for settling claims of lost (unrecovered) economic activity as a result of the Ocean Wind 1 project. The Lessee must submit to BOEM (1) a description of the structure of the Fund and its consistency with BOEM's draft Guidance and (2) an analysis of the impacts of the Project on shoreside businesses for review and comment. The Lessee must then submit to BOEM evidence of the implementation of the Fund, including: • A description of any implementation details not covered in the report to BOEM regarding the mechanism established to compensate for losses to commercial and for-hire recreational fishermen and related shoreside businesses resulting from all phases of the project development on the Lease Area (pre-construction, construction, operation, and decommissioning); • The Fund charter, including the governance structure, audit and public reporting procedures, and standards for paying compensatory mitigation for impacts to fishers and related shoreside businesses from lease area development; and • Documentation regarding the funding account, including the dollar amount, establishment date, financial institution, and owner of the account.	If adopted, this measure would reduce negative impacts associated with shoreside economic activity specifically resulting from revenue exposure and potential for reduced catch due to the Ocean Wind 1 Project.
Mobile Gear–Friendly Cable Protection Measures	Cable protection measures should reflect the pre-existing conditions at the site. This mitigation measure chiefly ensures that seafloor cable protection does not introduce new hangs for mobile fishing gear. Thus, the cable protection measures should be trawl-friendly with tapered/sloped edges. If cable protection is necessary in "non-trawlable" habitat, such as rocky habitat, then the lessee should consider using materials that mirror the benthic environment.	If adopted, this measure would reduce negative impacts resulting from mobile gear loss by using materials that would minimize the potential for introducing new hangs associated with cable protection features.

Measure	Description	Effect
Sand Wave Leveling, Boulder Clearance, and Boulder Relocation Plan	Sand wave leveling and boulder relocation clearance should be limited and micrositing should be used to avoid these areas to the extent practicable. The Lessee should develop and implement a boulder relocation plan to ensure potential impacts to essential fish habitat and commercial and recreational fisheries are adequately minimized.	This measure would reduce impacts on habitat of species targeted in fisheries and reduce the risk of gear damage or loss associated with relocated boulders.

3.9.9.1. Measures Incorporated in the Preferred Alternative

BOEM has identified the following additional measures in Table 3.9-25 as incorporated in the Preferred Alternative: shoreside seafood business compensation, mobile gear-friendly cable protection measures, sand wave leveling, boulder clearance, and a boulder relocation plan. These measures, if adopted, would further reduce impacts; however, the impact from the Proposed Action would remain minor to major for commercial fisheries and minor to moderate for for-hire recreational fishing operations, depending on the fishery or fishing operation.

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3.10. Cultural Resources

This section discusses potential impacts on cultural resources from the proposed Project, alternatives, and ongoing and planned activities in the cultural resources geographic analysis area. The cultural resources geographic analysis area, as shown on Figure 3.10-1, is equivalent to the Project's area of potential effects (APE), as defined in the implementing regulations for NHPA Section 106 at 36 CFR Part 800 (Protection of Historic Properties). In 36 CFR 800.16(d), the APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alteration in the character or use of historic properties, if any such properties exist." BOEM (2020) defines the Project APE as the following:

- The depth and breadth of the seabed potentially affected by any bottom-disturbing activities, constituting the marine archaeological resources portion of the APE;
- The depth and breadth of terrestrial areas potentially affected by any ground-disturbing activities, constituting the terrestrial archaeological portion of the APE;
- The viewshed from which renewable energy structures, whether located offshore or onshore, would be visible, constituting the viewshed portion of the APE; and
- Any temporary or permanent construction or staging areas, both onshore and offshore.

The phrase *cultural resources* refers to archaeological sites, buildings, structures, objects, and districts, which may include cultural landscapes and traditional cultural properties (TCP). These resources may be historic properties as defined in 36 CFR 800 and may be listed on national, state, or local historic registers or be identified as being important to a particular group during consultation. Federal, state, and local regulations recognize the public's interest in cultural resources. Many of these regulations, including NEPA and the NHPA, as well as the New Jersey Register of Historic Places Act and New Jersey Public Law 2004, Chapter 170, which protects archaeological sites on state, county, and municipal lands, require a project to consider how it might affect significant cultural resources.

Cultural resources in this section are discussed in terms of three categories: cultural resources landward of the shoreline (hereafter referred to as *onshore*), resources seaward of the shoreline (hereafter referred to as *offshore*), and the viewshed from which Project elements would be visible (hereafter referred to as *visual*).

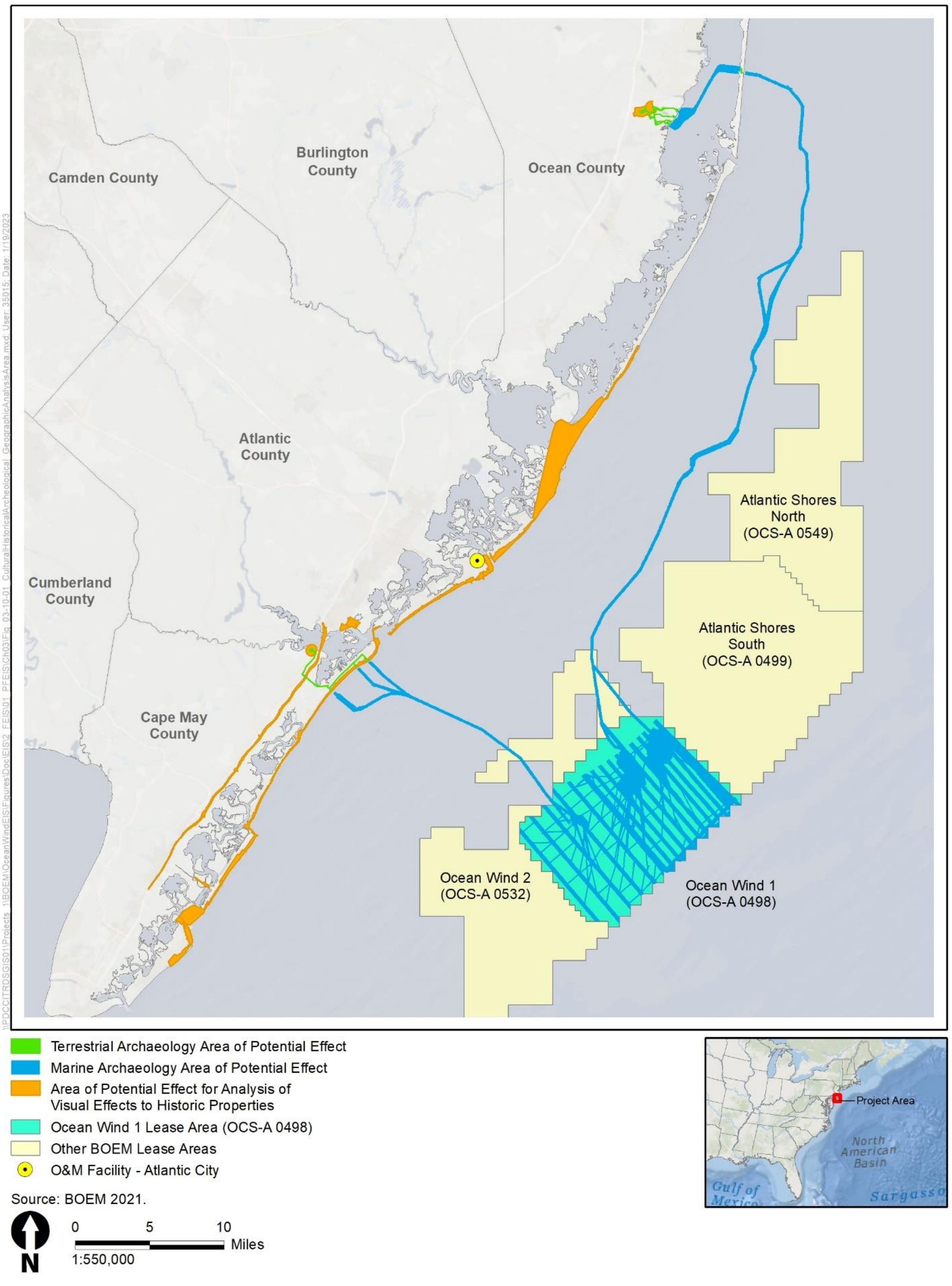

Figure 3.10-1 Cultural, Historical, and Archaeological Geographic Analysis Area

3.10.1 Description of the Affected Environment for Cultural Resources

This section discusses baseline conditions in the geographic analysis area for cultural resources as described in the COP Volume III, Appendix F documents and supplemental cultural resources studies (COP Volume III, Appendix F-1 through Appendix F-5; Ocean Wind 2023). Specifically, this includes terrestrial and offshore areas potentially affected by the proposed Project's land- or bottom-disturbing activities, areas where structures from the Proposed Action would be visible, and the area of intervisibility where structures from both the Proposed Action and offshore wind projects would be visible simultaneously.

Ocean Wind has conducted onshore and offshore cultural resource investigations to identify known and previously undiscovered cultural resources within the marine archaeological, terrestrial archaeological, and viewshed portions of the APE. Table 3.10-1 presents a summary of the pre-Contact period and post-Contact period cultural context of New Jersey based on the Project's Marine Archaeological Resources Assessment (COP Volume III, Appendix F-1; Ocean Wind 2023). COP Volume III, Appendix F documents and supplemental cultural resources studies, including scope, methods, results, and key findings, are further described in Appendix N, *Finding of Effects*.

Table 3.10-1 Summary of New Jersey Prehistoric and Historic Contexts

Period	Description
Paleoindian (>14,500–11,500 BP)	This period was characterized by highly mobile hunter gatherers traversing recently deglaciated landscapes. Paleoindian sites are identified by the presence of Clovis fluted points. This period of development is well represented in New Jersey.
Archaic Period (10,000–3000 BP)	This period is typically divided into two subperiods: Early Archaic (10,000–8000 BP), Middle (8000–6000 BP), and Late (6000–3000 BP). The Early Archaic period was marked by rapid sea level rise and coastal wetland boundary changes. By the Middle Archaic period, stone tool manufacture included grinding and polishing. In the Late Archaic period, both climate and sea level rise began to stabilize. This greater stability fostered increased sedentism. Material culture expanded rapidly, as evidenced by a wide array of new hunting and fishing technologies. Tribal-level societies also emerged during this time.
Woodland Period (3000 BP–European Contact)	This period is typically divided into three subperiods: Early (3000–2000 BP) Middle (2000–1000 BP), and Late (1,000 BP–European Contact). During the Early Woodland Period, pottery became prevalent, as did Oriental Fishtail and Meadowood projectile points. During the Middle Woodland Period, garden farming became common and pottery became more refined. The variability in the distribution of cultural material suggests two distinct cultural groups existed in New Jersey at this time. In the Late Woodland Period, garden farming became more intensive, and occupied settlements became increasingly frequent. People began using food storage pits and pottery became larger and locally distinct. The bow and arrow were introduced.
Contact and Colonization (European Contact–1775)	In 1524, Italian explorer Giovanni de Verrazano and his crew were probably the first European explorers to set eyes on the New Jersey coast. Others soon followed. Trade among European explorers and colonizers and Native American tribes began in about 1604. The colonization of southern New Jersey began with the establishment of the New Sweden (1638–1655) and New Netherlands (1614–1667 and 1673–1674) colonies. New Netherlands was transferred to English rule in 1674. New Jersey became the site of numerous regional trades, including whaling, farming, fishing, hunting, iron ore production, and shipbuilding.

Period	Description
Revolutionary War (1775–1783)	During the Revolutionary War, the coastline of New Jersey was a pivotal geographic feature in the naval efforts. Sandy Hook in northern New Jersey was the site of multiple naval engagements.
Antebellum Period (1783–1861)	Life along the New Jersey coast returned to normal following the Revolutionary War. During the War of 1812 (1812–1815), the bays and tributaries of southern New Jersey became an epicenter for privateering activity, just as they had been during the Revolutionary War. Absecon Island remained largely undeveloped until the 1850s, with the birth of Atlantic City.
Civil War (1861–1865)	New Jersey served as a source of troops, equipment, and resources for the Union Army during the American Civil War. No battles were fought in the state.
Reconstruction and Early 20th Century (1865–1945)	Atlantic City became a major entertainment and commercial hub and experienced explosive population growth. The city was a major site of bootlegging activity during Prohibition (1920–1933); however, it was hit hard during the Great Depression (1929–1939), when the city's reliance on tourism dollars flattened as Americans stopped vacationing.
WW II and Postwar (1945–Present)	During World War II, the New Jersey coast was the scene of numerous German U-Boat attacks. During this time, Absecon Island became a training hub for the U.S. Army. Despite a reinvigorated national economy following the war, Atlantic City continued to suffer economically until the casino boom of the late 1970s and 1980s.

Source: Ocean Wind 2023.
BP = before present

Cultural resources review of the onshore landfall locations of the two export cable corridors identified eight archaeological resources and ten historic structures at these locations. Most of the resources are along the BL England corridor. The archaeological resources include pre-Contact Period Native American sites and 17th through 20th century European-American sites. The historic standing structures date from the 18th through 20th centuries (COP Volume III, Appendix F-2; Ocean Wind 2023).

Offshore cultural resources in the region include pre-Contact and post-Contact period Native American and European-American resources. Offshore archaeological resources include pre-Contact period Native American landscapes on the OCS, which likely contain Native American archaeological sites inundated and buried as sea levels rose at the end of the last Ice Age. Marine geophysical remote sensing studies performed for the Proposed Action identified 16 submerged landform features (hereafter referred to as *ancient submerged landform features*) with the potential to contain Native American archaeological resources. This included 13 within the Lease Area and three within the two export cable corridors. In addition to having archaeological potential, remnant submerged landscape features are considered by Native American tribes in the region to be TCP resources representing places where their ancestors lived. In addition to ancient submerged landform features, 19 potential submerged cultural resources were identified via marine remote-sensing studies. This included 12 within the Lease Area and seven within the two export cable corridors. These resources include both known and potential shipwrecks from the Historic period. Based on known historic and modern maritime activity in the region, the Lease Area and two export cable corridors have a high probability for containing shipwrecks, downed aircraft, and related debris fields (COP Volume III, Appendix F-1; Ocean Wind 2023).

Cultural resources review of the offshore visual area identified nine historic districts and 40 individual historic properties, and review of the onshore visual area identified three historic properties (COP Volume III, Appendix F-3; Ocean Wind 2023).

3.10.2 Environmental Consequences

3.10.2.1. Impact Level Definitions for Cultural Resources

Definitions of impact levels are provided in Table 3.10-2.

Table 3.10-2 Impact Level Definitions for Cultural Resources

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts would be so small as to be unmeasurable (i.e., finding of “no historic properties affected” or “no historic properties adversely affected” pursuant to 36 CFR 800).
	Beneficial	Impacts that benefit cultural resources would be so small as to be unmeasurable.
Minor	Adverse	Cultural resources (historic properties that include archaeological sites, buildings, structures, objects, and districts that are listed or eligible for listing in the NRHP) would be affected; however, conditions would be imposed to ensure consistency with the Secretary’s Standards for the Treatment of Historic Properties (36 CFR 68) to avoid adverse impacts. (i.e., finding of “no historic properties adversely affected” pursuant to 36 CFR 800).
	Beneficial	Impacts that benefit cultural resources (historic properties that include archaeological sites, buildings, structures, objects, and districts that are listed or eligible for listing in the NRHP) would passively preserve historic properties consistent with the Secretary’s Standards for the Treatment of Historic Properties or passively create conditions to protect archaeological sites.
Moderate	Adverse	Characteristics of cultural resources would be altered in a way that would diminish the integrity of the property’s location, design, setting, materials, workmanship, feeling, or association (i.e., finding of “historic properties adversely affected” pursuant to 36 CFR 800). Measures to resolve adverse effects would minimize impacts and the adversely affected property would remain NRHP eligible. However, compensatory mitigation may still be required.
	Beneficial	Impacts that benefit cultural resources would actively preserve historic properties (historic properties that include archaeological sites, buildings, structures, objects, and districts that are listed or eligible for listing in the NRHP) consistent with the Secretary’s Standards for the Treatment of Historic Properties.
Major	Adverse	Characteristics of cultural resources would be affected in a way that would diminish the integrity of the property’s location, design, setting, materials, workmanship, feeling, or association (i.e., finding of “historic properties adversely affected” pursuant to 36 CFR 800). Measures to resolve adverse effects would mitigate impacts; however, important characteristics would be altered to the extent that the adversely affected property would no longer be listed or eligible for listing on the NRHP.
	Beneficial	Impacts that benefit cultural resources would rehabilitate, restore, or reconstruct historic properties consistent with the Secretary’s Standards for the Treatment of Historic Properties, including cultural landscapes and traditional cultural properties.

NRHP = National Register of Historic Places

3.10.3 Impacts of the No Action Alternative on Cultural Resources

Section 3.1 of the Final EIS explains the approach to predicting impacts related to the No Action Alternative. When analyzing the impacts of the No Action Alternative on cultural resources, BOEM considered the impacts of past and ongoing trends and activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for cultural resources. BOEM separately analyzes how resource conditions will be affected over time as reasonably foreseeable activities are implemented. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*. Separate impact conclusions are presented for both scenarios.

3.10.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for cultural resources described in Section 3.10.1, *Description of the Affected Environment for Cultural Resources*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind activities. There are no ongoing offshore wind activities within the geographic analysis area for cultural resources.

Under the No Action Alternative, cultural resources would continue to be affected by regional commercial, industrial, and recreational activities. Ongoing activities within the geographic analysis area that contribute to onshore impacts on cultural resources include ground-disturbing activities and the introduction of intrusive visual elements. These activities have the potential to disturb or destroy terrestrial archaeological resources or to damage, destroy, or diminish the integrity that conveys the historic significance of buildings, structures, objects, and historic districts onshore. The primary sources of ongoing offshore impacts include dredging, cable emplacement, and activities that disturb the seafloor. Onshore and offshore construction activities and associated impacts are expected to continue at current trends, range in severity from minor to major, and have the potential to affect cultural resources.

Sea level rise, ocean acidification, increased storm severity/frequency, and increased sedimentation and erosion, have the potential to result in long-term, permanent impacts on cultural resources. Sea level rise will lead to the inundation of terrestrial archaeological sites and historic standing structures. Increased storm severity and frequency will likely increase the severity and frequency of damage to coastal historic standing structures. Increased erosion along coastlines could lead to the complete destruction of coastal archaeological sites and the collapse of historic structures as erosion undermines their foundations. Ocean acidification could accelerate the rate of decomposition and corrosion of shipwrecks, downed aircraft (another common submerged archaeological resource type), and other marine archaeological resources on the seafloor. The incremental contribution of offshore wind development projects on slowing or arresting impacts related to global warming and climate change would result in beneficial impacts on cultural resources that range from negligible to minorly beneficial.

3.10.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with other planned activities (without the Proposed Action). Planned non-offshore wind activities that may affect cultural resources include new submarine cables and pipelines, increasing onshore construction, marine minerals extraction, port expansions, and installation of new structures on the OCS (see Section F.2 in Appendix F for a description of ongoing and planned activities). These activities may result in ground disturbance, which has the potential to disturb or destroy terrestrial archaeological resources; seafloor disturbance, which has the potential to damage or destroy marine archaeological resources or ancient submerged landform features; construction, which could damage, destroy, or diminish the integrity of buildings, structures, objects, and historic districts onshore; or introduction of intrusive visual elements, which could diminish integrity of setting, feeling, or association for cultural resources. See Table F1-8 for a summary of potential impacts associated with ongoing and planned non-offshore wind activities by IPF for cultural resources.

The No Action Alternative assumes the full build-out of all reasonably foreseeable wind projects. BOEM assumes that each of the reasonably foreseeable offshore wind projects will be subject to NEPA and NHPA reviews and, as a result, will require the identification of cultural resources within their NEPA geographic analysis areas and NHPA APEs. The results of these project-specific studies to identify cultural resources are not yet available. Therefore, the No Action Alternative assumes that the same types of cultural resources identified within the geographic analysis area of the Proposed Action (i.e., historic structures, terrestrial archaeological sites, marine archaeological sites, and TCPs) are present within the geographic scopes of the reasonably foreseeable wind projects, and will be subject to the same IPFs as the Proposed Action. The following discussion assesses the potential impacts on these types of cultural resources from proposed wind facility developments, excluding the Proposed Action. BOEM assumes that if project-specific cultural resource investigations identify historic properties within a project's APE and determines that the project would adversely affect said historic properties, BOEM will require the project to develop treatment plans to avoid, minimize, or mitigate effects to comply with the NHPA.

BOEM expects planned offshore wind activities to affect cultural resources through the following primary IPFs.

Accidental releases: Accidental release of hazmat and trash or debris, if any, may pose long-term, infrequent risks to cultural resources. The majority of impacts associated with accidental releases would be incidental due to cleanup activities that require the removal of contaminated soils. In the planned activities scenario, there would be a low risk of a leak of fuel, fluids, or hazardous materials from any of the WTGs offshore New Jersey. The number of accidental releases from the No Action Alternative, volume of released material, and associated need for cleanup activities would be limited due to the low probability of occurrence, low volumes of material released in individual incidents, low persistence time, standard BMPs to prevent releases, and localized nature of such events. As such, the majority of individual accidental releases from offshore wind development would not be expected to result in measurable impacts on cultural resources and would be considered negligible impacts.

Although the majority of anticipated accidental releases would be small, resulting in small-scale impacts on cultural resources, a single, large-scale accidental release such as an oil spill could have significant impacts. A large-scale release would require extensive cleanup activities to remove contaminated materials, resulting in damage to or complete removal of coastal and marine cultural resources during the removal of contaminated terrestrial soil or marine sediment; temporary or permanent impacts on the setting of coastal historic buildings, structures, objects, and districts, which could include significant landscapes and TCPs; and damage to or removal of nearshore shipwreck or debris field resources during contaminated soil/sediment removal. In addition, the accidentally released materials in deep-water settings could settle on seafloor cultural resources such as shipwreck sites and ancient submerged landform features. In the case of shipwreck sites, this may accelerate their decomposition or cover them and make them inaccessible or unrecognizable to researchers, resulting in a significant loss of historic information. As a result, although considered unlikely, a large-scale accidental release and associated cleanup could result in permanent, geographically extensive, and large-scale major impacts on cultural resources.

Anchoring and gear utilization: Anchoring and gear utilization associated with ongoing commercial and recreational activities and the development of offshore wind projects have the potential to cause permanent, adverse impacts on marine cultural resources. These activities would increase during the construction, maintenance, and eventual decommissioning of offshore wind energy facilities. Construction of offshore wind projects could result in impacts on cultural resources on the seafloor caused by anchoring in the geographic analysis area. The placement and relocation of anchors and other seafloor gear such as wire ropes, cables, and anchor chains that affect or sweep the seafloor could potentially disturb marine cultural resources and ancient submerged landform features on or just below the seafloor surface. The damage or destruction of submerged archaeological sites or other underwater cultural resources from these activities would result in the permanent and irreversible loss of scientific or cultural value and would be considered major impacts.

The scale of impacts on shipwreck and debris field cultural resources would depend on the number of wreck and debris field sites within the offshore wind lease areas. The potential for impacts would be mitigated, however, by existing federal and state requirements to identify and avoid marine cultural resources. Specifically, as part of its compliance with the NHPA, BOEM requires offshore wind developers to conduct geophysical remote sensing surveys of proposed development areas to identify cultural resources and implement plans to avoid, minimize, or mitigate impacts on these resources. As a result, impacts on marine cultural resources from anchoring and gear utilization are considered unlikely and would only affect a small number of individual marine cultural resources if they were to occur, resulting in long-term, localized, adverse impacts. The scale of any impacts on individual resources (the proportion of the resource damaged or removed) would vary on a case-by-case basis and could range from minor to major.

Lighting: Development of offshore wind projects would increase the amount of offshore anthropogenic light from vessels, area lighting during construction and decommissioning of projects (to the degree that construction occurs at night), and use of aircraft and vessel hazard/warning lighting on WTGs and OSS during operation. Up to 574 WTGs with a maximum blade tip height of 1,049 feet (320 meters) above mean sea level (AMSL) would be added within the analysis area for cumulative visual effects on historic properties.

Construction and decommissioning lighting would be most noticeable if construction activities occur at night. Up to five planned offshore wind projects (Atlantic Shores South, Atlantic Shores North, Ocean Wind 2, Garden State, and Skipjack) could contribute to cumulative visual effects on historic properties. These could be constructed from 2024 through 2030 (with up to four projects simultaneously under construction in 2026–2027; Table F-3). Some of the offshore wind projects could require nighttime construction lighting, and all would require nighttime hazard lighting during operations. Construction lighting from any project would be temporary, lasting only during nighttime construction, and could be visible from shorelines and elevated locations, although such light sources would be limited to individual WTG or OSS sites rather than the entirety of the lease areas in the geographic analysis area. Aircraft and vessel hazard lighting systems would be in use for the entire operational phase of each offshore wind project, resulting in long-duration impacts. The intensity of these impacts would be relatively low, as the lighting would consist of small, intermittently flashing lights at a significant distance from the resources.

The impacts of construction and operational lighting would be limited to cultural resources on the coast of New Jersey for which a dark nighttime sky is a contributing element to historical integrity. The National Park Service has indicated that a dark nighttime sky should be assumed to be a character-defining feature of certain resource types such as lighthouses or resources associated with historic events that may have occurred at night, such as battlefields. The intensity of lighting impacts would be limited by the distance between resources and the nearest lighting sources, as the majority of the proposed WTGs would be over 15 miles (24.1 kilometers) from the nearest shoreline (see Section 3.18, *Recreation and Tourism*). The intensity of lighting impacts would be further reduced by atmospheric and environmental conditions such as clouds, fog, and waves that could partially or completely obscure or diffuse sources of light. As a result, nighttime construction and decommissioning lighting would have temporary, intermittent, and localized adverse impacts on a limited number of cultural resources. Operational lighting would have longer-term, continuous, and localized adverse impacts on a limited number of cultural resources.

Lighting impacts would be reduced if ADLS is used to meet FAA aircraft hazard lighting requirements. ADLS would activate the aviation lighting on WTGs and OSS only when an aircraft is within a predefined distance of the structures (for a detailed explanation, see Section 3.20, *Scenic and Visual Resources*). For the Proposed Action, it is anticipated that the reduced time of FAA hazard lighting resulting from an implemented ADLS would reduce the duration of the potential impacts of nighttime aviation lighting to less than 1 percent of the normal operating time that would occur without using ADLS. The use of ADLS on offshore wind projects other than the Proposed Action would likely result in similar limits on the frequency of WTG and OSS aviation warning lighting use. This technology, if used, would reduce the already low-level impacts of lighting on cultural resources. As such, lighting impacts on cultural resources would be negligible.

Port utilization—expansion: Expected increases in port activity associated with the development of offshore wind projects would likely require modifications and expansions at ports along the East Coast. These port modification and expansion projects could affect historic structures and archaeological sites within or near port facilities. Future channel deepening by dredging that may be required to accommodate larger vessels necessary to carry WTG and OSS components and increased vessel traffic associated with offshore wind projects could affect marine cultural resources in or near ports. Due to state and federal requirements to identify and assess impacts on cultural resources as part of NEPA and the NHPA and the requirements to avoid, minimize, or mitigate adverse impacts on cultural resources, these impacts would be long term, adverse, and isolated to a limited number of cultural resources that cannot be avoided or that were previously undocumented. As such, impacts from port utilization would range from minor to major.

Presence of structures: The development of other offshore wind projects would introduce new, modern, and intrusive visual elements to the viewsheds of cultural resources along the coast of New Jersey. Up to 574 WTGs would be added within the analysis area for cumulative visual effects on historic properties, assuming WTGs with a maximum blade tip height of 1,049 feet (320 meters) AMSL.

Impacts on cultural resources from the presence of structures would be limited to those cultural resources from which offshore wind projects would be visible, which would typically be limited to historic buildings, structures, objects, and districts and could include significant landscapes and TCPs relatively close to shorelines and on elevated landforms near the coast. The magnitude of impacts from the presence of structures would be greatest for cultural resources for which a maritime view, free of modern visual elements, is an integral part of their historic integrity and contributes to their eligibility for listing on the National Register of Historic Places (NRHP). Due to the distance between the reasonably foreseeable wind development projects and the nearest cultural resources, in most instances exceeding 15 miles (24.1 kilometers), WTGs of individual projects would appear relatively small on the horizon, and the visibility of individual structures would be further affected by environmental and atmospheric conditions such as vegetation, clouds, fog, sea spray, haze, and wave action (for a detailed explanation, see Section 3.20). While these factors would limit the intensity of impacts, the presence of visible WTGs from offshore wind activities would have long-term, continuous, moderate to major impacts on cultural resources.

Cable emplacement and maintenance: Construction of offshore wind infrastructure would have permanent, geographically extensive, adverse impacts on cultural resources. Offshore wind projects would result in seabed disturbance from foundation construction and installation of inter-array and offshore export cables. The only other offshore wind development project (other than the Proposed Action) that is expected to lay cable in the geographic analysis area is Atlantic Shores South (Lease Area OCS-A 0499), which would lay cable that crosses the same offshore export cable corridor as the Proposed Action. The 2012 BOEM study and the Proposed Action studies (BOEM 2012; COP Volume III, Appendix F; Ocean Wind 2023) suggest that the offshore wind lease areas and offshore export cable corridors of the offshore wind projects would likely contain a number of archaeological sites and submerged landform features, which could be affected by offshore construction activities.

As part of compliance with the NHPA, BOEM and state historic preservation officers (SHPO) will require offshore wind project applicants to conduct geophysical surveys of offshore wind lease areas and offshore export cable corridors to identify shipwreck and debris field resources and avoid, minimize, or mitigate these resources when identified. Due to these federal and state requirements, the adverse impacts of offshore construction on shipwreck and debris field resources would be infrequent and isolated and, in cases where conditions are imposed to avoid submerged cultural resources, impacts would be minor. However, if submerged cultural resources cannot be avoided, the magnitude of these impacts would remain moderate to major, due to the permanent, irreversible nature of the impacts. As such, across potential circumstances, the magnitude of impacts would range from minor to major.

If present within a project area, the number, extent, and dispersed character of ancient submerged landform features makes avoidance impossible in many situations, and makes extensive archaeological investigations of formerly terrestrial archaeological sites within these features logistically challenging and prohibitively expensive. As a result, offshore construction would result in geographically widespread and permanent adverse impacts on portions of these resources. For those ancient submerged landform features that are contributing elements to an NRHP-eligible TCP but cannot be avoided, mitigations would likely be considered under the NHPA Section 106 review process, including studies to document the nature of the paleontological environment during the time these now-submerged landscapes were occupied and provide Native American tribes with the opportunity to include their history in these studies. However, the magnitude of these impacts would remain moderate to major, due to the permanent, irreversible nature.

Land disturbance: The construction of onshore components associated with offshore wind projects, such as electrical export cables and onshore substations, could result in adverse physical impacts on known and undiscovered cultural resources. Such ground-disturbing construction activities could disturb or destroy undiscovered archaeological sites and TCPs, if present. The number of cultural resources affected, scale and extent of impacts, and severity of impacts would depend on the location of specific project components relative to recorded and undiscovered cultural resources and the proportion of the resource affected. State and federal requirements to identify cultural resources, assess project impacts, and develop treatment plans to avoid, minimize, or mitigate adverse impacts would limit the extent, scale, and magnitude of impacts on individual cultural resources; as a result, if adverse impacts from this IPF occur, they would likely be permanent but localized, and range from negligible to major.

3.10.3.3. Conclusions

Impacts of the No Action Alternative. BOEM expects ongoing activities to have continuing short- and long-term impacts on baseline conditions for cultural resources. The primary source of onshore impacts from ongoing activities includes ground-disturbing activities and the introduction of intrusive visual elements, while the primary source of offshore impacts includes dredging, cable emplacement, and activities that disturb the seafloor. These ongoing activities would have minor to major impacts on individual onshore and offshore cultural resources. Examples of individual resources are ancient submerged landform features, terrestrial archaeological sites, historic standing structures, and TCPs. Impacts would vary widely because the impacts would be dependent on the unique characteristics of the individual resources. The construction and installation of onshore components and port expansions, as well as their O&M, would have negligible to major impacts on individual cultural resources. BOEM anticipates that implementation of existing state and federal cultural resource laws and regulations would include requirements to avoid, minimize, or mitigate project-specific impacts on cultural resources. These state and federal requirements may not be able to reduce the severity of impacts on some cultural resources due to the unique character of specific resources but would reduce the severity of potential impacts in a majority of cases, resulting in overall moderate impacts on cultural resources. As such, the No Action Alternative would result in **moderate** impacts on cultural resources.

Cumulative Impacts of the No Action Alternative. Under the No Action Alternative, existing environmental trends and activities would continue, and cultural resources would continue to be affected by natural and human-caused IPFs. Planned non-offshore wind activities could include the same types of onshore and offshore actions listed for ongoing activities, and in different locations than ongoing activities. These planned activities would also have minor to major impacts on individual onshore and offshore cultural resources depending on the scale and extent of impacts and the unique characteristics of the resource. The construction and installation and O&M of offshore wind projects would have minor to major effects as well as negligible to minor beneficial impacts on individual offshore cultural resources. The primary sources of impacts would be physical disturbance from onshore and offshore construction, as well as changes in views from cultural resources. The impacts would be geographically limited to marine and terrestrial archaeological resources within onshore and offshore construction areas and historic structures and TCPs for which an uninterrupted sea view, free of intrusive visual elements, is a contributing element to NRHP eligibility with views of offshore and onshore wind components. The duration of impacts would range from temporary to permanent, while the extent and frequency of impacts would be largely dependent on the unique characteristics of individual cultural resources, resulting in a range of potential impacts from minor to major. BOEM anticipates that implementation of existing state and federal cultural resource laws and regulations would include requirements to avoid, minimize, or mitigate project-specific impacts on cultural resources. These state and federal requirements may not be able to reduce the severity of impacts on some cultural resources due to the unique character of specific resources, but would reduce the severity of potential impacts in a majority of cases. As such, cumulative impacts of the No Action Alternative would result in overall **moderate** impacts on cultural resources.

3.10.4 Relevant Design Parameters & Potential Variances in Impacts for the Action Alternatives

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than those described in the sections below. The following proposed PDE parameters (Appendix E) would influence the magnitude of the impacts on cultural resources:

- Physical impacts on terrestrial cultural resources (e.g., archaeological sites), depending on the location of onshore ground-disturbing activities;
- Physical impacts on underwater cultural resources (e.g., archaeological sites and ancient submerged landform features), depending on the location of offshore bottom-disturbing activities, including the locations where Ocean Wind would embed the WTG and OSS into the seafloor in the Wind Farm Area and the location of the cable in the offshore export cable corridor; and
- Visual impacts on cultural resources (e.g., historic buildings, structures, objects, and districts, which could include landscapes and TCPs), depending on the design, height, number, and distance of WTGs visible from these resources.

Variability of the proposed Project design exists as outlined in Appendix E. Below is a summary of potential variances in impacts:

- WTG and OSS number, size, and location: If marine cultural resources cannot be avoided, impacts can be minimized with fewer WTGs and substation footprints, smaller footprints, and the selection of footprint locations in areas of lower archaeological or ancient submerged landform sensitivity.
- WTG and substation lighting: Arrangement and type of lighting systems could affect the degree of nighttime visibility of WTGs onshore and decrease visual impacts on cultural resources for which a dark nighttime sky is a contributing element to historical integrity.

- Size of scour protection around foundations: If marine cultural resources cannot be avoided, a smaller size of scour protection around foundations can minimize disturbance or destruction of marine cultural resources.
- Offshore cable (inter-array, substation interconnector) burial location, length, depth of burial, and burial method: If marine cultural resources cannot be avoided entirely, specific location, length, and depth of burial could minimize disturbance or destruction of marine cultural resources. Cable burial method such as jetting tool, vertical injection, pre-trenching, scare plow, trenching (including leveling, mechanical cutting), plowing, and controlled-flow excavation could have varying degrees of potential to disturb or destroy marine cultural resources.
- Landfall for offshore export cable installation method: Selection of trenchless installation over open-cut installation could have decreased potential for unanticipated disturbance of terrestrial archaeology.
- Onshore export cable width and burial depth: Reduced width and burial depth to reduce overall volume of excavation in the export cable construction corridor could decrease potential for unanticipated disturbance of terrestrial archaeology.

Ocean Wind has committed to measures to minimize impacts on cultural resources, which include developing and implementing an Post-Review Discovery Plan for terrestrial and submerged archaeology (CUL-01); using G&G surveys to identify potential resources (CUL-02); consulting with the SHPO and affected tribes to support avoidance of known cultural resources to the extent practicable and identifying additional minimization or mitigation measures as necessary (CUL-03); designing the Project to minimize visual impacts on cultural resources to the extent feasible, including adjustment to WTG locations, ADLS, and markings (CUL-04); and developing an anchoring plan for vessels prior to construction to identify avoidance/no anchorage areas (COP Volume II, Table 1.1-2; Ocean Wind 2023). In addition to minimization, APMs include mitigation in the form of documentation, planning, or educational materials, developed in coordination with stakeholders (CUL-05). These measures are further described in Appendix H, Table H-1. In addition, Ocean Wind has prepared two historic property treatment plans to detail purpose, intended outcome, scope of work, methodology, standards, deliverables, and schedules associated with fulfillment of mitigation measures to resolve adverse effects on ancient submerged landform features and to resolve adverse visual effects. These documents are the *Historic Property Treatment Plan for the Ocean Wind 1 Farm Ancient Submerged Landform Features, Federal Waters on the Outer Continental Shelf* (see Attachment 3 of Appendix N, Attachment A) and *Historic Property Treatment Plan for the Ocean Wind 1 Farm Project, Historic Properties Subject to Adverse Visual Effect, Cape May and Atlantic Counties, New Jersey* (see Attachment 4 of Appendix N, Attachment A).

3.10.5 Impacts of the Proposed Action on Cultural Resources

3.10.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.10.8, *Impacts of Alternative E on Cultural Resources*.

Under the Proposed Action, Ocean Wind would install 98 WTGs and related facilities, which would have negligible to minor impacts on most cultural resources but would have moderate impacts on the Brigantine Hotel, Brigantine City; Absecon Lighthouse, Atlantic City; Atlantic City Boardwalk, Atlantic City; Atlantic City Convention Hall, Atlantic City; Ritz-Carlton Hotel, Atlantic City; Haddon Hall/ Resorts Casino Hotel, Atlantic, City; Riviera Apartments in Atlantic City; Vassar Square Condominiums, the house at 114 South Harvard Avenue; Lucy the Margate Elephant in Margate City; Great Egg Coast

Guard Station, Longport Borough; Ocean City Boardwalk, Ocean City; Ocean City Music Pier in Ocean City; the Flanders Hotel, Ocean City; Hereford Lighthouse, North Wildwood; North Wildwood Lifesaving Station, North Wildwood; U.S. Lifesaving Station #35, Stone Harbor Borough; Little Egg Harbor U.S. Lifesaving Station #23, Little Egg Harbor Township; and submerged landform features within the Wind Farm Area and the offshore export cable corridor.[1]

Potential impacts on cultural resources include damage or destruction of terrestrial archaeological sites or TCPs from onshore ground-disturbing activities and damage to or destruction of submerged archaeological sites or other underwater cultural resources (e.g., shipwreck, debris fields, ancient submerged landform features) from offshore bottom-disturbing activities, resulting in a loss of scientific or cultural value. Potential impacts also include demolition of, damage to, or alteration of historic buildings, structures, objects, or districts, including landscapes and TCPs, resulting in a loss of historic or cultural value.

Potential visual impacts also include introduction of visual elements out of character with the setting or feeling of historic properties, if that setting is a contributing element to the resource’s eligibility for listing on the NRHP. The most impactful IPFs would include light, the presence of structures, and offshore construction.

Accidental releases: Accidental release of hazardous materials and trash or debris, if any, could affect cultural resources. The 98 WTG foundations and three OSS foundations for the Proposed Action alone would include storage for up to 39,690 gallons (150,242 liters) of coolants, 426,671 gallons (1.6 million liters) of oils and lubricants, and 236,216 gallons (894,175 liters) of diesel fuel. The volume of materials released is unlikely to require cleanup operations that would permanently affect cultural resources. As a result, the impacts of accidental releases from the Proposed Action alone on cultural resources would be short term, localized, and negligible.

Anchoring and gear utilization: Anchoring and gear utilization could affect cultural resources. Of the total 19 potential submerged archaeological resources, seven are in the export cable corridors. Of the total 16 ancient submerged landform features, three are in the export cable corridors. The Proposed Action has committed to avoiding the 19 potential submerged archaeological resources identified in the Lease Area and two export cable route corridors during construction, maintenance, and decommissioning activities. However, the Project would encroach on the 50-meter avoidance buffers of two submerged archaeological resources in the BL England export cable route corridor. The Proposed Action may avoid impacts on up to three of the 16 ancient submerged landform features: Targets 20, 27, and 32, all within in the Lease Area. However, impacts from the Proposed Action on 13 ancient submerged landform features within the Lease Area cannot be avoided, as WTGs and associated work zones are proposed for locations within the defined areas of these resources.

Due to the avoidance commitments, BOEM does not anticipate impacts on the majority of known shipwrecks, submerged aircraft, or debris fields from development of the Proposed Action. However, it does anticipate impacts on the two submerged archaeological resources where the Project would encroach within the avoidance buffer and 13 ancient submerged landform features where WTGs are proposed under the current PDE. As a result, anchoring under the Proposed Action (19 acres [0.08 km^2]) would have negligible impacts on most marine cultural resources, except for potentially major impacts on the two known submerged archaeological resources and 13 of the 16 ancient submerged landform features. More substantial impacts could occur if the final Project design cannot avoid known resources or if previously undiscovered resources are discovered during construction.

[1] While the technical study to assess visual effects on historic properties identified Villa Maria by the Sea in Stone Harbor among the properties affected, that building was demolished in 2021 and is no longer included among the affected properties analyzed herein (COP Volume III, Appendix F-3; Ocean Wind 2022). See Appendix M.

Lighting: As previously discussed, development of the offshore wind industry would increase the amount of offshore anthropogenic light from vessels, area lighting during construction and decommissioning of projects (to the degree that construction occurs at night), and use of hazard/warning lighting on WTGs and OSS during operations. The susceptibility and sensitivity of cultural resources to lighting impacts from the Proposed Action would vary based on the unique characteristics of individual cultural resources. Nighttime lighting impacts would be restricted to cultural resources for which a dark nighttime sky is a contributing element to their historic integrity. The National Park Service has indicated during consultation that a dark nighttime sky should be assumed to be a character-defining feature of certain resource types such as lighthouses or resources associated with historic events that may have occurred at night, such as battlefields. Given this assumption, of the nine historic districts and 40 individual properties reviewed in the offshore visual APE, a dark nighttime sky is considered a character-defining feature of Absecon Light House, Hereford Inlet Lighthouse, Great Egg Coast Guard Station, North Wildwood Lifesaving Station, U.S. Lifesaving Station #35, and Little Egg Harbor U.S. Lifesaving Station #23.

Construction of the Proposed Action may require nighttime vessel and construction area lighting. The lighting impacts would be short term, as they would be limited to the construction phase of the Proposed Action. The intensity of nighttime construction lighting from the Proposed Action would be limited to the active construction area at any given time. Impacts would be further reduced by the distance between the nearest construction area (i.e., the closest line of WTGs) and the nearest cultural resources on the New Jersey coast. The intensity of lighting impacts would be further reduced by atmospheric and environmental conditions such as clouds, fog, and waves that could partially or completely obscure or diffuse sources of light. As previously stated, these impacts would be limited to cultural resources for which a dark nighttime sky is a contributing element to their historic integrity, limiting the scale of impacts on cultural resources. Absecon Light House, Hereford Inlet Lighthouse, Great Egg Coast Guard Station, North Wildwood Lifesaving Station, U.S. Lifesaving Station #35, and Little Egg Harbor U.S. Lifesaving Station #23 met these conditions. As such, lighting from the Proposed Action alone would have moderate impacts on cultural resources.

The Proposed Action would include nighttime and daytime use of operational phase aviation and vessel hazard avoidance lighting on WTGs and OSS. Ocean Wind has committed to voluntarily implementing ADLS to reduce operational phase nighttime lighting impacts (GEN-07; COP Volume II, Table 1.1-2; Ocean Wind 2023). ADLS would only activate the required FAA aviation obstruction lights on WTGs and OSS when aircraft enter a predefined airspace and turn off when the aircraft were no longer in proximity to the Wind Farm Area. Implementation of the ADLS or similar system to turn aviation obstruction lights on and off in response to detection of aircraft near the wind farm is estimated to be 1 hour 19 minutes and 17 seconds over a 1-year period (COP Volume III, Appendix AD; Ocean Wind 2023). As such, use of operational lighting on WTGs by the Proposed Action would result in negligible impacts on cultural resources.

Operational lighting from the Proposed Action would have moderate impacts on cultural resources because of the nine historic districts and 40 individual properties reviewed in the offshore visual APE, only Absecon Light House, Hereford Inlet Lighthouse, Great Egg Coast Guard Station, North Wildwood Lifesaving Station, U.S. Lifesaving Station #35, and Little Egg Harbor U.S. Lifesaving Station #23 meet the conditions required to be affected by this IPF. If ADLS were used by offshore wind developments, nighttime hazard lighting impacts on cultural resources from ongoing and planned activities including offshore wind and the Proposed Action would be negligible.

Presence of structures: The presence of structures, including foundations and scour protection for WTGs and OSS, in the Lease Area could affect offshore cultural resources. Of the total 19 potential submerged archaeological resources, 12 are in the Lease Area. Of the total 16 ancient submerged landform features, 13 are in the Lease Area. The Proposed Action has committed to avoiding the 12 potential submerged archaeological resources identified in the Lease Area during construction, maintenance, and decommissioning activities. The Proposed Action may avoid impacts under this IPF on up to three ancient submerged landform features within the Lease Area (Targets 20, 27, and 32) but cannot avoid impacts on the other 10 ancient submerged landform features in the Lease Area (Targets 21–26 and 28–31), as WTGs are proposed for locations within the defined areas of these resources. Due to the avoidance commitments, BOEM does not anticipate impacts on known shipwrecks, submerged aircraft, or debris fields within the Lease Area from development of the Proposed Action. However, it does anticipate impacts on the 10 ancient submerged landform features where WTGs are proposed under the current PDE. As a result, the presence of structures under the Proposed Action would have negligible impacts on most marine cultural resources, except for potentially major impacts on 10 of the 13 ancient submerged landform features within the Lease Area. More substantial impacts could occur if the final Project design cannot avoid known resources or if previously undiscovered resources are discovered during construction. However, the protocols identified in the Post-Review Discovery Plan (CUL-01) would apply to minimize impacts (see Appendix H for a summary of CUL-01, and Appendix N, Attachment A for Post-Review Discovery Plan documents). In addition, BOEM has committed to working with applicants, consulting parties, tribes, and the New Jersey SHPO to develop specific treatment plans to address impacts on ancient submerged landform features that cannot be avoided by other offshore wind development projects. Implementation of project-specific treatment plans, agreed to by all consulting parties, would likely reduce the magnitude of unmitigated impacts on ancient submerged landform features; however, the magnitude of these impacts would remain moderate to major due to the permanent, irreversible nature of the impacts, unless these ancient submerged landform features can be avoided.

In addition, Ocean Wind has conducted outreach to the SHPO, affected tribes, and consulting parties to support identification of mitigation measures as necessary (CUL-05). Based on feedback from that outreach, to mitigate for adverse effects on the 13 ancient submerged landform features that cannot be avoided, Ocean Wind has committed to funding of preconstruction geoarchaeology, open-source geographic information system and story maps, ancient submerged landform features post-construction seafloor impact inspection, and ethnographic studies to resolve adverse effects on Targets 21–26, 28–31, and 33–35.

A Historic Resources Visual Effects Assessment for the Proposed Action determined that the construction of the WTGs would adversely affect 18 historic properties: the Brigantine Hotel in Brigantine City; Absecon Lighthouse in Atlantic City; the Atlantic City Boardwalk in Atlantic City; the Atlantic City Convention Hall in Atlantic City; the Ritz-Carlton Hotel in Atlantic City; Haddon Hall/Resorts Casino Hotel in Atlantic, City the Riviera Apartments in Atlantic City; Vassar Square Condominiums in Ventnor City; the house at 114 South Harvard Avenue in Ventnor City; Lucy the Margate Elephant in Margate City; Great Egg Coast Guard Station in Longport Borough; Ocean City Boardwalk in Ocean City; Ocean City Music Pier in Ocean City; the Flanders Hotel in Ocean City; Hereford Inlet Lighthouse in North Wildwood; North Wildwood Lifesaving Station in North Wildwood; U.S. Lifesaving Station #35 in Stone Harbor Borough; and Little Egg Harbor U.S. Lifesaving Station #23 in Little Egg Harbor Township (Appendix N). The studies determined that an uninterrupted sea view, free of modern visual elements, is a contributing element to the NRHP eligibility of the 18 historic properties. Although the operational life of the Project is 35 years, and the WTGs and OSS would be removed after that period, the presence of visible WTGs from the Proposed Action would have long-term, continuous, widespread, moderate impacts on these resources. The study determined that the scale, extent, and intensity of these impacts would be partially mitigated by environmental and atmospheric factors such as clouds, haze, fog, sea spray, vegetation, and wave height that would partially or fully screen the WTGs from view during various times throughout the year. In addition, the Proposed Action would only affect seaward (southeast) views from these resources. To further minimize the Proposed Action’s effects, Ocean Wind has voluntarily committed to designing the Project to minimize visual impacts on cultural resources to the extent feasible, including adjustment to WTG locations, ADLS, and markings (CUL-04). This includes:

- Use of an ADLS to minimize nighttime effects by only activating the FAA-required warning lights when an aircraft is in the vicinity of the Wind Farm Area
- Use of non-reflective pure white (RAL Number 9010) or light gray (RAL Number 7035) paint on offshore infrastructure to minimize daytime visual effects

In addition, Ocean Wind has conducted outreach to the SHPO, affected tribes, and consulting parties to support identification of mitigation measures as necessary (CUL-05). Consultation with consulting parties regarding measures to resolve adverse effects is ongoing and will be documented in the executed Memorandum of Agreement for the Project. Based on feedback from that outreach, to mitigate for adverse effects on the 18 properties with visual impacts, Ocean Wind has committed to:

- Multi-property and Multi-county Mitigation
    - Funding of Historic Context addressing early 20th century New Jersey Shore Hotels to resolve adverse effects on Brigantine Hotel, Ritz-Carlton Hotel, Haddon Hall/Resorts Casino Hotel, and Flanders Hotel
    - Funding of Historic Context addressing mid-century high-rise residential buildings at the New Jersey shore to resolve adverse effects on Riviera Apartments and Vassar Square Condominiums
    - Funding of Historic Context addressing New Jersey shore boardwalks, including surveys and evaluations of the Atlantic City Boardwalk, Ocean City Boardwalk, and Wildwood Boardwalk to resolve adverse effects on the Atlantic City Boardwalk and Ocean City Boardwalk
- Funding of Visitor Experience and Public Access for Lucy the Margate Elephant, a National Historic Landmark (NHL)
- Atlantic County Historic Properties Mitigation
    - Funding of Visitor Experience and Public Access for Absecon Lighthouse
    - Funding of Visitor Experience and Public Access for Atlantic City Boardwalk
- Mitigation Fund to resolve visual adverse effects on the following 15 historic properties: Brigantine Hotel, Brigantine City, Atlantic County; Atlantic City Convention Hall, Atlantic City, Atlantic County; Ritz-Carlton Hotel, Atlantic City, Atlantic County; Haddon Hall/Resorts Casino Hotel, Atlantic City, Atlantic County; Riviera Apartments, Atlantic City, Atlantic County; Vassar Square Condominiums, Ventnor City, Atlantic County; House at 114 South Harvard Avenue, Ventnor City, Atlantic County; Great Egg Coast Guard Station, Longport Borough, Atlantic County; Ocean City Boardwalk, Ocean City, Cape May County; Ocean City Music Pier, Ocean City, Cape May County; Hereford Lighthouse, North Wildwood, Cape May County; North Wildwood Life Saving Station, North Wildwood, Cape May County; U.S. Lifesaving Station #35, Stone Harbor Borough, Cape May County; Flanders Hotel, Ocean City, Cape May County; and Little Egg Harbor U.S. Life Saving Station #23 (U.S. Coast Guard Station #119), Little Egg Harbor Township, Ocean County

BOEM conducted a Cumulative Historic Resources Visual Effects Assessment to evaluate visual impacts on the Brigantine Hotel in Brigantine City; the Absecon Lighthouse in Atlantic City; the Atlantic City Boardwalk in Atlantic City; the Atlantic City Convention Hall in Atlantic City; the Ritz-Carlton Hotel in Atlantic City; Haddon Hall/Resorts Casino Hotel in Atlantic City; the Riviera Apartments in Atlantic City; Vassar Square Condominiums in Ventnor City; the house at 114 South Harvard Avenue in Ventnor City; Lucy the Margate Elephant in Margate City; Great Egg Coast Guard Station in Longport Borough; Ocean City Boardwalk in Ocean City; Ocean City Music Pier in Ocean City; the Flanders Hotel in Ocean City; Hereford Inlet Lighthouse in North Wildwood, North Wildwood Lifesaving Station in North Wildwood; U.S. Lifesaving Station #35 in Stone Harbor Borough; and Little Egg Harbor U.S. Lifesaving Station #23 in Little Egg Harbor Township (BOEM 2023). The planned activities scenario effects assessment determined the number of WTGs from the Proposed Action and five offshore wind projects that could be theoretically visible (based on distance, topography, vegetation, and intervening structures) from each of the five historic properties affected by the Proposed Action. Other offshore wind projects included in the cumulative WTG count from historic properties included Atlantic Shores North, Atlantic Shores South, Ocean Wind 2, Garden State, and Skipjack.

The Cumulative Historic Resources Visual Effects Assessment demonstrated that portions of WTGs could theoretically be visible from each of the 18 resources. The Flanders Hotel would be subject to the largest-scale impacts of the 18 resources, with portions of up to 662 WTGs theoretically visible from the resource and with the closest WTG approximately 11.3 miles (18.2 kilometers) from the property. Similarly, Absecon Lighthouse would have theoretical visibility to up to 618 WTGs, but the closest WTG would be approximately 9.0 miles (14.5 kilometers) from the property. Ocean City Boardwalk and Great Egg Coast Guard Station would be similarly affected, with theoretical visibility of up to 593 and 592 WTGs, respectively; the closest WTGs would be approximately 10.9 miles (17.5 kilometers) from both Ocean City Boardwalk and Great Egg Coast Guard Station. Similarly, Ocean City Music Pier and Little Egg Harbor U.S. Lifesaving Station #23 would have comparable impacts, with theoretical visibility of up to 581 and 575 WTGs, respectively; the closest WTGs would be approximately 11.0 miles (17.7 kilometers) from Ocean City Music Pier and approximately 11.6 miles (18.7 kilometers) from Little Egg Harbor U.S. Lifesaving Station #23. The study demonstrated that the Atlantic City Boardwalk would have theoretical visibility to up to 561 WTGs, with the closest WTG approximately 8.8 miles (14.2 kilometers) away from the property. Portions of up to 561 WTGs could also theoretically be visible from the eight other properties: Atlantic City Convention Hall, with the closest WTGs approximately 9.2 miles (14.8 kilometers); Ritz-Carlton Hotel, with the closest WTGs approximately 9.3 miles (14.9 kilometers), Riviera Apartments, with the closest WTGs approximately 9.5 miles (15.2 kilometers); Brigantine Hotel, with the closest WTGs approximately 9.6 miles (15.4 kilometers); Vassar Square Condominiums, with the closest WTGs approximately 9.7 miles (15.6 kilometers); the house at 114 South Harvard Avenue, with the closest WTGs approximately 9.9 miles (15.9 kilometers); Lucy the Margate Elephant, with the closest WTGs approximately 10.8 miles (17.4 kilometers); and U.S. Lifesaving Station #35, with the closest WTGs approximately 14.5 miles (23.3 kilometers). Hereford Inlet Lighthouse would have theoretical visibility to up to 549 WTGs, with the closest WTG approximately 11.3 miles (18.2 kilometers) away; while WTG visibility data were not available for Haddon-Hall/Resorts Casino Hotel, this property is close to the Ritz-Carlton Hotel and visibility is expected to be similar. North Wildwood Lifesaving Station would be subject to smallest-scale impacts of the 18 resources, with portions of up to 528 WTGs theoretically visible from the resource and with the closest WTG approximately 15.9 miles (26.6 kilometers) from the property. The Project WTG locations represent 16 to 19 percent of the total WTGs that are potentially visible from the 18 historic properties in the planned activities scenario (see Appendix F). For this reason, the Project WTGs would foreseeably be surrounded by other offshore wind energy development activities that would constitute 82 to 83 percent of the total WTGs potentially visible from the 18 historic properties.

Views from the historic properties to the Project WTGs could be obstructed by a portion of Ocean Wind 2 and Atlantic Shores South, which include WTG locations positioned closer to shore (Ocean Wind 2 between 8.8 and 9.0 miles, and Atlantic Shores South between 10.5 and 11.1 miles). The intensity of visual impacts on the historic properties could be limited by distance and environmental and atmospheric factors. As discussed in Section 3.20, the visibility of WTGs would be further reduced by environmental and atmospheric factors such as cloud cover, haze, sea spray, vegetation, and wave height. While these factors would limit the intensity of impacts, the presence of visible WTGs from ongoing and planned activities, including offshore wind and the Proposed Action, would have long-term, continuous, moderate to major impacts on the historic properties listed above. The Proposed Action would contribute a noticeable increment to these impacts.

Cable emplacement and maintenance: The installation of array cables and offshore export cables would include site preparation activities (e.g., sand wave clearance, boulder removal) and cable installation via jet plow, mechanical plow, or mechanical trenching, which could affect cultural resources. Of the total 19 potential submerged archaeological resources, seven are in the export cable corridors. Of the total 16 ancient submerged landform features, three are in the export cable corridors. The Proposed Action has committed to avoiding the 19 potential submerged archaeological resources identified in the Lease Area and two export cable route corridors during construction, maintenance, and decommissioning activities. The Proposed Action has committed to avoiding 3 of the 16 ancient submerged landform features (Targets 20, 27, and 32, all in the Lease Area), but 13 ancient submerged landform features (Targets 21–26, 28–31, and 33–35) cannot be avoided, as WTGs and associated work zones are proposed for locations within the defined areas of these resources. Targets 21–26 and 28–31 are in the Lease Area, Target 33 is in the BL England Export Cable Route Corridor, and Targets 34 and 35 are in the Oyster Creek Export Cable Route Corridor.

Due to the avoidance commitments, BOEM does not anticipate impacts on the 16 known shipwrecks, submerged aircraft, or debris fields from development of the Proposed Action. However, it does anticipate impacts on the 13 ancient submerged landform features where WTGs and export cable routes are proposed under the current PDE. As a result, new cable emplacement and maintenance under the Proposed Action would have negligible impacts on most marine cultural resources (19 potential submerged archaeological resources and three ancient submerged landform features), except for potentially major impacts on 13 of the 16 ancient submerged landform features. More substantial impacts could occur if the final Project design cannot avoid known resources or if previously undiscovered resources are discovered during construction.

Land disturbance: Land disturbance associated with onshore export cable installation could affect cultural resources. Cultural resources review—including records reviews and a shovel test survey program in areas identified as having moderate to high archaeological sensitivity, and a historic structure analysis at the onshore landfall locations of the two export cable corridors and associated onshore cable corridors—identified eight archaeological resources and ten historic structures in the vicinity of the export cable corridor locations. Most of the resources are along the BL England corridor. Of the eight archaeological resources identified, only two appear to extend into the BL England and Oyster Creek landfall sites. Intensive archaeological survey revealed that intact archaeological deposits associated with these resources do not appear to extend into either export cable corridor. As a result, the disturbed archaeological deposits within the two export cable corridors do not appear to contribute to the NRHP eligibility of either of the archaeological resources (COP Volume III, Appendix F-2; Ocean Wind 2023). The historic structure review and analysis revealed that no direct effects on historic structures are anticipated. This review also revealed that while there are three historic structures in the visual impacts analysis area—two at the BL England area and one at the Oyster Creek area—they would not be adversely affected by the Project (COP Volume III, Appendix F; Ocean Wind 2023). Based on this information, the impacts of the Proposed Action on terrestrial cultural resources are still expected to be negligible.

Information pertaining to identification of cultural resources within onshore cable routes added to the Project in March 2022 and associated with Oyster Creek landfall locations will not be available until after the Final EIS. BOEM will use the Memorandum of Agreement to establish commitments for reviewing the sufficiency of supplemental terrestrial archaeological investigations as phased identification; assess impacts; and implement measures to avoid, minimize, or mitigate impacts in these areas prior to construction. See the Memorandum of Agreement as an attachment to Appendix N.

In the event of changes to the Project design or inadvertent archaeological discoveries during construction, BOEM could further reduce potential impacts of onshore construction by requiring compliance with the Post-Review Discovery Plan (see Appendix N, Attachment A) and fulfillment of mitigation measures (see Section 3.10.9 and Appendix H, Table H-2, and Appendix N, Attachment A) as a condition of COP approval.

3.10.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned activities.

Accidental releases: Impacts from planned offshore wind projects would be similar to those of the Proposed Action and be negligible in most cases, except for in rare cases of large-scale accidental releases that represent major impacts. The Proposed Action would contribute an undetectable increment to the combined impacts of accidental releases from ongoing and planned activities including offshore wind, which would be short term, localized, and negligible. The Proposed Action would account for 18 percent of the WTGs and OSS in the geographic analysis area and there is a low risk of a leak of fuel, fluids, or hazardous materials from any of the WTGs and OSS, which would include storage of these substances.

Anchoring and gear utilization: Construction of the Proposed Action and other offshore wind projects could result in anchoring occurring within the geographic analysis area that could potentially affect cultural resources. BOEM anticipates that lead federal agencies and relevant SHPOs would require the applicants for offshore wind projects to conduct extensive geophysical remote sensing surveys (i.e., similar to those conducted for the Proposed Action) to identify and avoid marine cultural resources and ancient submerged landform features as part of NEPA and NHPA Section 106 compliance activities fulfilled through the NEPA substitution process as described in 36 CFR 800.8(c). BOEM would also continue to require developers to avoid, minimize, or mitigate impacts on any identified marine archaeological resources and ancient submerged landform features during construction, operation, and decommissioning. As a result, the Proposed Action would contribute a noticeable increment to the combined anchoring and gear utilization impacts from ongoing and planned activities including offshore wind on shipwreck and debris field resources, as well as ancient submerged landform features. Impacts on cultural resources would be long term and moderate to major unless these resources could be avoided.

Lighting: Construction of planned offshore wind projects in the geographic analysis area would contribute similar lighting impacts from nighttime vessel and construction area lighting as under the Proposed Action. However, of the nine historic districts and 40 individual properties reviewed in the offshore visual APE, only Absecon Light House, Hereford Inlet Lighthouse, Great Egg Coast Guard Station, North Wildwood Lifesaving Station, U.S. Lifesaving Station #35, and Little Egg Harbor U.S. Lifesaving Station #23 meet the conditions required to be affected by this IPF. As such, nighttime construction and decommissioning lighting associated with the Proposed Action in combination with other ongoing and planned activities including offshore wind would have moderate impacts on cultural resources in the geographic analysis area. The Proposed Action would contribute a noticeable increment to the combined lighting impacts on cultural resources from ongoing and planned nighttime vessel and construction area lighting.

Permanent aviation and vessel warning lighting would be required on all WTGs and OSS built by offshore wind projects. Nighttime lighting from aviation obstruction lights on the WTG nacelles associated with the Project and other proposed offshore wind development projects and from use of an ADLS to reduce the period and intensity of effects from aviation obstruction lights on the Project would not contribute to cumulative visual adverse effects. Implementation of the ADLS or similar system to turn aviation obstruction lights on and off in response to detection of aircraft near the wind farm is estimated to be 1 hour 19 minutes and 17 seconds over a 1-year period (COP Volume III, Appendix AD; Ocean Wind 2023). Even if offshore wind projects do not commit to using ADLS, operational lighting from the Proposed Action would account for 16–19 percent of the visible WTGs and OSS in the geographic analysis area. The Proposed Action would contribute a noticeable increment to the combined lighting impacts on cultural resources from ongoing and planned aviation and vessel warning lighting on WTGs and OSS.

Presence of structures: Offshore wind projects would result in construction of WTGs and OSS, inter-array cable systems, and offshore export cable corridors. The marine G&G studies conducted for the proposed Project, a 2012 BOEM study (BOEM 2012), and the NOAA Automated Wreck and Obstruction Information System and Electronic Navigational Chart databases suggest that the entire New Jersey lease area covers areas with a high probability for containing submerged cultural resources (BOEM 2012). As with the Proposed Action, other offshore wind projects would likely be able to avoid impacts on shipwrecks, downed aircraft, and debris field cultural resources due to their relatively small, discrete size, but may be unable to avoid impacts on all ancient submerged landform features. The Proposed Action would contribute a noticeable increment to the combined cable emplacement impacts on cultural resources from ongoing and planned activities including offshore wind, which would be localized, long term, and minor for shipwrecks, downed aircraft, and debris fields; and long term, widespread, and moderate to major for ancient submerged landform features. BOEM has committed to working with applicants, consulting parties, Native American tribes, and the New Jersey SHPO to develop specific treatment plans to address impacts on ancient submerged landform features that cannot be avoided by future offshore wind development projects. Development and implementation of project-specific treatment plans, agreed to by all consulting parties, would likely reduce the magnitude of unmitigated impacts on ancient submerged landform features; however, the magnitude of these impacts would remain moderate to major, due to the permanent, irreversible nature of the impacts, unless these ancient submerged landform features can be avoided.

Land disturbance: Construction of onshore components for offshore wind activities could result in impacts on known cultural resources and undiscovered cultural resources (if present). Ground-disturbing construction activities could affect undiscovered archaeological sites. BOEM anticipates that federal (i.e., NEPA and NHPA Section 106 fulfilled through NEPA substitution) and state-level requirements to identify cultural resources, assess impacts, and implement measures to avoid, minimize, or mitigate impacts would minimize impacts on cultural resources from the reasonably foreseeable offshore wind developments. The Proposed Action would contribute an undetectable increment to the combined impacts on terrestrial cultural resources from ongoing and planned activities including offshore wind, which would be localized and long term and would range from negligible to major.

3.10.5.3. Conclusions

Impacts of the Proposed Action. The Proposed Action would have a range of negligible to major impacts on cultural resources for individual IPFs. Impacts would be reduced through the NHPA Section 106 consultation process fulfilled through NEPA substitution as described in 36 CFR 800.8(c) as a result of the commitments made by Ocean Wind and implementation of mitigation measures to resolve adverse effects on historic properties. Similarly, the analysis of impacts is based on a maximum-case scenario; impacts would be reduced by implementation of a less-impactful construction or infrastructure development scenario within the PDE.

Greater impacts would occur without the pre-construction NHPA requirements to identify historic properties, assess potential effects, and develop treatment plans to resolve effects through avoidance, minimization, or mitigation. These NHPA-required, “good-faith” efforts to identify historic properties and address impacts resulted in or contributed to Ocean Wind making a number of commitments to reduce the magnitude of impacts on cultural resources including, but not limited to:

- Post-Review Discovery Plan (CUL-01)
- G&G surveys to identify potential resources (CUL-02)

- Consulting with the SHPO and affected tribes to support avoidance of known cultural resources to the extent practicable and identifying additional minimization or mitigation measures as necessary (CUL-03), such as funding documentation or interpretation activities to resolve adverse effects on the Brigantine Hotel in Brigantine City; the Absecon Lighthouse in Atlantic City; the Atlantic City Boardwalk in Atlantic City; the Atlantic City Convention Hall in Atlantic City; the Ritz-Carlton Hotel in Atlantic City; Haddon Hall/Resorts Casino Hotel in Atlantic City; the Riviera Apartments in Atlantic City; Vassar Square Condominiums in Ventnor City; the house at 114 South Harvard Avenue in Ventnor City; Lucy the Margate Elephant in Margate City; Great Egg Coast Guard Station in Longport Borough; Ocean City Boardwalk in Ocean City; Ocean City Music Pier in Ocean City; the Flanders Hotel in Ocean City; Hereford Inlet Lighthouse in North Wildwood, North Wildwood Lifesaving Station in North Wildwood; U.S. Lifesaving Station #35 in Stone Harbor Borough; and Little Egg Harbor U.S. Lifesaving Station #23 in Little Egg Harbor Township
- Designing the Project to minimize visual impacts on cultural resources to the extent feasible, including adjustment to WTG locations, using ADLS hazard lighting (if approved), and using non-reflective pure white and light gray paint on offshore structures (CUL-04)
- Mitigation in the form of documentation, planning, or educational materials coordinated with stakeholders, as in COP Appendix F-4 (CUL-05)
- Develop an anchoring plan for vessels prior to construction to identify avoidance/no anchorage areas (CUL-06)

A treatment approach for ancient submerged landform features has already been developed and is outlined in the Memorandum of Understanding (see attachment to Appendix N). BOEM anticipates that NHPA requirements to identify historic properties and resolve adverse effects would similarly reduce the significance of potential impacts on historic properties from offshore wind projects as they complete the NHPA Section 106 review process fulfilled through NEPA substitution as described in 36 CFR 800.8(c). However, mitigation of adverse visual effects on historic properties will still be needed under the Proposed Action. Therefore, the overall impacts on historic properties from the Proposed Action would likely qualify as **moderate** because a notable and measurable impact requiring mitigation is anticipated, but in most cases resources affected by adverse visual effects would likely recover completely when the affecting agent (visible offshore WTGs) were removed.

Cumulative Impacts of the Proposed Action. The incremental impacts contributed by the Proposed Action to the cumulative impacts on cultural resources would be noticeable. BOEM anticipates that the cumulative impacts on cultural resources associated with the Proposed Action would be **moderate** due to the long-term or permanent and irreversible impacts on the Brigantine Hotel in Brigantine City; the Atlantic City Boardwalk in Atlantic City; the Atlantic City Convention Hall in Atlantic City; the Ritz-Carlton Hotel in Atlantic City; Haddon Hall/Resorts Casino Hotel in Atlantic City; the Riviera Apartments in Atlantic City; Vassar Square Condominiums in Ventnor City; the house at 114 South Harvard Avenue in Ventnor City; Lucy the Margate Elephant in Margate City; the Ocean City Boardwalk in Ocean City; the Ocean City Music Pier in Ocean City; and archaeological resources and ancient submerged landform features if they cannot be avoided.

3.10.6 Impacts of Alternative B on Cultural Resources

Impacts of Alternative B. Alternative B would reduce the severity of impacts on a small proportion of known ancient submerged landform features within the marine APE compared to the Proposed Action. Alternatives B-1 and B-2 would exclude WTGs nearest to the shore. Impacts on one ancient submerged landform feature (Target 28) would be avoided or reduced under Alternative B-1 and impacts on three ancient submerged landform features (Targets 28, 25, and 20) would be avoided or reduced under Alternative B-2. The impacts resulting from individual IPFs associated with Alternatives B-1 and B-2 alone on terrestrial cultural resources would be similar to those of the Proposed Action because the nature and physical extent of proposed activities under these alternatives would be comparable to those of the Proposed Action. Alternatives B-1 and B-2 would exclude WTGs nearest to the onshore coastal communities where onshore cultural resources are located. However, given the size, location, and number of retained WTGs, these alternatives would not substantially change the overall visual impact of the wind farm on onshore cultural resources. As such, the degree of visual impact is not substantially different from that of the Proposed Action.

Information pertaining to identification of historic properties within certain portions of the APE related to Alternatives B-1 and B-2 would not be available until after the ROD is issued and the COP is approved, should BOEM select those alternatives. However, the differences among alternatives with respect to cultural, historic, and archaeological resources are not expected to be significant. If Alternative B-1 or B-2 is selected, BOEM will use the Memorandum of Agreement as an agreement document to establish commitments for phased identification and evaluation of historic properties within the APE in accordance with BOEM's existing *Guidelines for Providing Archaeological and Historic Property Information Pursuant to Title 30 Code of Federal Regulations Part 585*, ensuring potential historic properties are identified, effects assessed, and adverse effects resolved prior to construction (see the Memorandum of Agreement as an attachment to Appendix N). If Alternative B-1 or B-2 is selected, previously un-surveyed areas associated with WTG positions and inter-array cable routing may need to be surveyed for marine archaeology.

Cumulative Impacts of Alternative B. The incremental impacts contributed by Alternatives B-1 and B-2 to the overall impacts on cultural resources would be reduced compared to those described under the Proposed Action.

3.10.6.1. Conclusions

Impacts of Alternative B. Alternatives B-1 and B-2 would have a similar range of negligible to major impacts on cultural resources as the Proposed Action assuming implementation of the mitigation measures outlined in Section 3.10.9. The degree of impact on ancient submerged landform features under Alternatives B-1 and B-2 would be slightly reduced relative to the Proposed Action. However, mitigation for impacts on 12 ancient submerged landform features would still be required if Alternative B-1 is selected and mitigation for impacts on 10 ancient submerged landform features would still be required if Alternative B-2 is selected. While the degree of visual impacts on cultural resources under Alternatives B-1 and B-2 would be lower than under the other alternatives, these impacts would still require comparable mitigation. In most cases of visual impact, the resource would likely recover completely when the affecting agent were gone or remedial or mitigating action were taken. The magnitude of impacts from disturbance to ancient submerged landform features would remain moderate to major due to the permanent, irreversible nature of the impacts, unless these ancient submerged landform features can be avoided. Therefore, as with the Proposed Action, the overall impacts on historic properties from these build alternatives would likely qualify as **moderate** because a notable and measurable impact requiring mitigation is anticipated.

Cumulative Impacts of Alternative B. The incremental impacts contributed by Alternatives B-1 and B-2 to the overall impacts on cultural resources would be noticeable, but slightly reduced when compared to the Proposed Action. BOEM anticipates that the overall impacts on cultural resources associated with Alternatives B-1 and B-2 when each combined with the impacts from ongoing and planned activities including offshore wind would be **moderate**.

3.10.7 Impacts of Alternatives C and D on Cultural Resources

Impacts of Alternatives C and D. The impacts resulting from individual IPFs associated with Alternatives C-1, C-2, and D on terrestrial and marine cultural resources would be similar to those of the Proposed Action because the nature and physical extent of proposed activities under these alternatives would be comparable to those of the Proposed Action. Turbine exclusion or turbine relocation under Alternative C-1, turbine layout compression under Alternative C-2, and turbine exclusion under Alternative D could reduce the number of WTGs visible to onshore cultural resources. However, given the size, location, and number of retained WTGs, these alternatives would not substantially change the overall visual impact of the wind farm on cultural resources onshore. These approaches would also not change the degree of impact on offshore cultural resources, given the specific locations of the ancient submerged landform features affected by the Proposed Action are not in the same locations as WTGs proposed for exclusion or relocation under Alternatives C and D. As such, the degree of impact is not substantially different from that of the Proposed Action.

Information pertaining to identification of historic properties within certain portions of the APE related to Alternatives C-1, C-2, and D would not be available until after the ROD is issued and the COP is approved, should BOEM select those alternatives. However, the differences among alternatives with respect to cultural, historic, and archaeological resources are not expected to be significant. If Alternative C-1, C-2, or D is selected, BOEM will use the Memorandum of Agreement as an agreement document to establish commitments for phased identification and evaluation of historic properties within the APE in accordance with BOEM's existing *Guidelines for Providing Archaeological and Historic Property Information Pursuant to Title 30 Code of Federal Regulations Part 585,* ensuring potential historic properties are identified, effects assessed, and adverse effects resolved prior to construction (see the Memorandum of Agreement as an attachment to Appendix N). If Alternative C-1, C-2 with any distance other than the 0.81-nm buffer, or D is selected, previously un-surveyed areas associated with WTG positions and inter-array cable routing will need to be surveyed for marine archaeology.

Cumulative Impacts of Alternatives C and D. The incremental impacts contributed by Alternatives C-1, C-2, and D to the overall impacts on cultural resources would be similar to those described under the Proposed Action.

3.10.7.1. Conclusions

Impacts of Alternatives C and D. Alternatives C-1, C-2, and D would have the same range of negligible to major impacts on cultural resources as the Proposed Action assuming implementation of the mitigation measures outlined under Section 3.10.9. While the degree of visual impacts on cultural resources under Alternatives C-1, C-2, and D would be lower than under the other alternatives, these impacts would still require comparable mitigation for these impacts. As with the Proposed Action, the overall impacts on historic properties from these build alternatives would likely qualify as **moderate** because a notable and measurable impact requiring mitigation is anticipated, but in most cases the resource would likely recover completely when the affecting agent were gone or remedial or mitigating action were taken.

Cumulative Impacts of Alternatives C and D. The incremental impacts contributed by Alternatives C-1, C-2, and D to the overall impacts on cultural resources would be noticeable, the same as for the Proposed Action. BOEM anticipates that the overall impacts on cultural resources associated with Alternatives C-1, C-2, and D when each combined with the impacts from ongoing and planned activities including offshore wind would be **moderate**.

3.10.8 Impacts of Alternative E on Cultural Resources

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. Under Alternative E, the Oyster Creek export cable route would be modified to avoid impacts on SAV. The Oyster Creek export cables would reroute through the Swimming Beach #2 parking lots after making landfall within the adjacent auxiliary parking lot. The cables would cross Shore Road diagonally to the northwest to an existing maintenance/storage yard, where the cables would then be installed along a historically dredged remnant channel. Alternative E would be predominantly located in previously disturbed areas. A Phase 1B Cultural Resource Survey was conducted within the terrestrial archaeological portion of the APE for Alternative E and demonstrated that, given the extent of prior disturbance, the potential for terrestrial archaeology to be present and affected by Alternative E is low. Therefore, BOEM does not anticipate impacts to be materially different to those described under the Proposed Action.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the overall impacts on cultural resources would be similar to those described under the Proposed Action.

3.10.8.1. Conclusions

Impacts of Alternative E. Alternative E would have the same range of **negligible** to **major** impacts on cultural resources as the Proposed Action assuming implementation of the mitigation measures outlined under Section 3.10.9. BOEM anticipates that, given the extent of prior disturbance, the potential for terrestrial archaeology to be present and affected by Alternative E is low. Therefore, BOEM does not anticipate impacts to be materially different to those described under the Proposed Action. As with the Proposed Action, the overall impacts on historic properties from Alternative E would likely qualify as **moderate** because a notable and measurable impact requiring mitigation is anticipated, but in most cases the resource would likely recover completely when the affecting agent were gone or remedial or mitigating action were taken.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the overall impacts on cultural resources would be noticeable, the same as under the Proposed Action. BOEM anticipates that the overall impacts associated with Alternative E when combined with the impacts from ongoing and planned activities including offshore wind would be **moderate**.

3.10.9 Proposed Mitigation Measures

In the Draft EIS, BOEM analyzed several measures proposed to minimize impacts on cultural resources. After publication of the Draft EIS, BOEM continued Section 106 consultation with consulting parties to develop measures for resolving adverse effects on historic properties pursuant to 36 CFR 800.6 and will execute the Section 106 Memorandum of Agreement prior to issuance of the ROD. A copy of the revised draft Memorandum of Agreement is provided in Appendix N, *Finding of Adverse Effect for the Ocean Wind 1 Construction and Operations Plan*. These mitigation measures, analyzed in Table 3.10-3, are also identified in Appendix H, Table H-2. Ocean Wind will be required to comply with the executed Section 106 Memorandum of Agreement.

Table 3.10-3 Measures Resulting from Consultations (Also Identified in Appendix H, Table H-2): Cultural Resources

Measure	Description	Effect
Avoid or mitigate impacts on identified archaeological resources	Ocean Wind must avoid any identified archaeological resource or TCP, including avoidance of 50-meter buffers for identified archaeological resources. If Ocean Wind cannot avoid the resource, it must perform additional investigations for the purpose of determining eligibility for listing in the NRHP. Of those resources determined eligible, BOEM would require Phase III data recovery investigations for the purposes of resolving adverse effects per 36 CFR 800.6. If Ocean Wind determines it cannot avoid an archaeological resource or TCP after the ROD has been issued, additional Section 106 consultation will be required.	Avoidance would result in negligible direct impacts whereas data recovery investigations would result in minor impacts on terrestrial archaeological resources.
Terrestrial Archaeological monitoring and terrestrial post-review discovery plans	Implementation of terrestrial archaeological monitoring and terrestrial post-review discovery plan for terrestrial archaeology, which include training and orientation for construction staff, designation of a Cultural Resources Compliance Manager, and post-review discovery procedures and contacts, to reduce potential impacts on any previously undiscovered archaeological resources (if present) encountered during construction.	Enforcement of this measure would be under the jurisdiction of NJDEP. Implementation of a post-review discovery plan would reduce potential impacts on undiscovered archaeological resources to a negligible level by preventing further physical impacts on the archaeological resources encountered during construction.

Measure	Description	Effect
Historic Properties Treatment Plans	BOEM will ensure implementation by Ocean Wind of Historic Property Treatment Plans developed in consultation with consulting parties who have demonstrated interest in specific historic properties and property owners. This will include the *Historic Property Treatment Plan for the Ocean Wind 1 Offshore Wind Farm Ancient Submerged Landform Features, Federal Waters on the Outer Continental Shelf*, prepared by Ocean Wind to address impacts on ancient submerged landform features if they cannot be avoided. Specifically, this treatment plan provides details and specifications for actions consisting of mitigation measures to resolve adverse effects on Targets 21–26, 28–31, and 33–35. BOEM will also ensure implementation by Ocean Wind of the *Historic Properties Treatment Plan for the Ocean Wind 1 Offshore Wind Farm Project, Historic Properties Subject to Adverse Visual Effect,* Cape May and Atlantic Counties, New Jersey, which was prepared by Ocean Wind to provide details and specifications for actions consisting of mitigation measures to resolve adverse visual effects and cumulative adverse visual effects on Brigantine Hotel in Brigantine City; the Absecon Lighthouse in Atlantic City; the Atlantic City Boardwalk in Atlantic City; the Ritz-Carlton Hotel in Atlantic City; Haddon Hall/Resorts Casino Hotel in Atlantic City; the Riviera Apartments in Atlantic City; Vassar Square Condominiums in Ventnor City; Lucy the Margate Elephant in Margate City; Ocean City Boardwalk in Ocean City; the Flanders Hotel in Ocean City.	Development and implementation of Historic Properties Treatment Plans detailing and specifying processes, responsibilities, and schedule for completion associated with fulfilling compensatory mitigation actions appropriate to fully address the nature, scope, size, and magnitude of impacts, including cumulative impacts caused by the Project, on historic properties would not reduce impacts from the Proposed Action or change the impact level. Rather, this measure would guide fulfillment of compensatory mitigation actions.
Multi-property and Multi-county mitigation	Funding from Ocean Wind will be applied to the preparation of three historic contexts: early 20th century New Jersey Shore Hotels (Brigantine Hotel, Ritz-Carlton Hotel, Haddon Hall/Resorts Casino Hotel, and Flanders Hotel), mid-century High-rise residential buildings at the New Jersey Shore (Riviera Apartments and Vassar Square Condominiums), and Boardwalks of the New Jersey Shore (with surveys and evaluations of Atlantic City Boardwalk, Ocean City Boardwalk, and Wildwood Boardwalk).	Implementation of this mitigation measure would not reduce impacts from the Proposed Action or change the impact level. Rather, this measure would compensate appropriately for the nature, scope, size, and magnitude of visual impacts, including cumulative visual impacts, caused by the Project.

Measure	Description	Effect
Mitigation to resolve adverse effects to Lucy the Margate Elephant	Funding from Ocean Wind will be applied to compensatory mitigation actions such as funding for visitor experience and public access for Lucy the Margate Elephant.	Implementation of this mitigation measure would not reduce impacts from the Proposed Action or change the impact level. Rather, this measure would compensate appropriately for the nature, scope, size, and magnitude of visual impacts, including cumulative visual impacts, caused by the Project.
Absecon Lighthouse, Atlantic City	Funding from Ocean Wind will be used to improve visitor experience and public access; priority projects will be determined in collaboration with representatives for the property owner. This work will use already available plans or develop plans appropriate to the identified project, and submit plans for review by BOEM and representatives of the property owner; take necessary steps to ensure the project is carried out by qualified contractors, including staff who meet SOI Professional Qualifications for Architecture or Architectural History, who will execute plans; and take necessary steps to ensure planned work is completed.	Implementation of this mitigation measure would not reduce impacts from the Proposed Action or change the impact level. Rather, this measure would compensate appropriately for the nature, scope, size, and magnitude of visual impacts, including cumulative visual impacts, caused by the Project.
Atlantic City Boardwalk, Atlantic City	Funding from Ocean Wind will be applied to compensatory mitigation actions such as support for planned, preservation-related improvements to the Atlantic City Boardwalk.	Implementation of this mitigation measure would not reduce impacts from the Proposed Action or change the impact level. Rather, this measure would compensate appropriately for the nature, scope, size, and magnitude of visual impacts, including cumulative visual impacts, caused by the Project.

Measure	Description	Effect
Mitigation Fund to resolve visual adverse effects to the following 15 historic properties: Brigantine Hotel, Brigantine City; Atlantic City Convention Hall, Atlantic City; Ritz-Carlton Hotel, Atlantic City; Haddon Hall/ Resorts Casino Hotel, Atlantic City; Riviera Apartments, Atlantic City; Vassar Square Condominiums, Ventnor City; House at 114 South Harvard Avenue, Ventnor City; Great Egg Coast Guard Station, Longport Borough; Ocean City Boardwalk, Ocean City; Ocean City Music Pier, Ocean City; Hereford Lighthouse, North Wildwood; North Wildwood Life Saving Station, North Wildwood; U.S. Lifesaving Station #35, Stone Harbor Borough; Flanders Hotel, Ocean City; and Little Egg Harbor U.S. Life Saving Station #23 (U.S. Coast Guard Station #119), Little Egg Harbor Township.	Funding from Ocean Wind will be deposited into a compensatory mitigation fund to be managed by a third-party administrator for the purpose of providing grants in support of preservation, interpretation, or commemoration of historic sites, buildings, or events.	Implementation of this mitigation measure would not reduce impacts from the Proposed Action or change the impact level. Rather, this measure would compensate appropriately for the nature, scope, size, and magnitude of visual impacts, including cumulative visual impacts, caused by the Project.
Phased Identification	If Alternative B-1, B-2, C-1, C-2, or D is selected, BOEM will implement steps for phased identification and evaluation of historic properties within the Marine APE in accordance with BOEM's existing Guidelines for Providing Archaeological and Historic Property Information Pursuant to Title 30 Code of Federal Regulations Part 585. The final identification and evaluation of historic properties within the APE may occur after publication of the Final EIS, but prior to the initiation of construction.	Implementation of this mitigation measure would not reduce impacts from the Proposed Action or change the impact level, but would ensure identification and evaluation of historic properties within the marine APE that could not be surveyed prior to publication of the Final EIS.

3.10.9.1. Measures Incorporated in the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.10-3 and Table H-2 in Appendix H, *Mitigation and Monitoring*, are incorporated in the Preferred Alternative. Mitigation to resolve adverse visual effects on historic properties and to comply with the stipulations of the Memorandum of Agreement would not reduce the impacts on the historic property. Rather, these measures would compensate appropriately for the nature, scope, size, and magnitude of visual impacts, including cumulative visual impacts, caused by the Project. Implementation of phased identification of marine archaeological resources would not reduce impacts or change the impact level but would ensure identification and evaluation of historic properties within the marine APE that could not be surveyed prior to publication of the Final EIS. Implementation of a Post-Review Discovery Plan would reduce potential impacts on undiscovered archaeological resources to a negligible level by preventing further physical impacts on the archaeological resources encountered during construction.

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3.11. Demographics, Employment, and Economics (see Appendix G)

The reader is referred to Appendix G for a discussion of current conditions and potential impacts on demographics, employment, and economics from implementation of the No Action Alternative, the Proposed Action, and other action alternatives.

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3.12. Environmental Justice

This section discusses environmental justice impacts from the proposed Project, alternatives, and ongoing and planned activities in the environmental justice geographic analysis area. The geographic analysis area for environmental justice, as shown on Figure 3.12-1, Figure 3.12-2, and Figure 3.12-3, includes the counties where proposed onshore infrastructure and potential port cities are located, as well as the counties in closest proximity to the Wind Farm Area: Atlantic, Cape May, Cumberland, Gloucester, Ocean, and Salem Counties, New Jersey; Charleston County, South Carolina; and Norfolk, Virginia. These counties are the most likely to experience beneficial or adverse environmental justice impacts from the proposed Project related to onshore and offshore construction and use of port facilities.

Environmental justice impacts are characterized for each IPF as negligible, minor, moderate, or major using the four-level classification scheme outlined in Section 3.12.2.1. A determination of whether impacts are "disproportionately high and adverse" in accordance with Executive Order 12898 is provided in the conclusion sections for the Proposed Action and action alternatives.

3.12.1 Description of the Affected Environment for Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (Subsection 1-101). When determining whether environmental effects are disproportionately high and adverse, agencies are to consider whether there is or will be an impact on the natural or physical environment that significantly and adversely affects a minority population, low-income population, or Indian tribe, including ecological, cultural, human health, economic, or social impacts; and whether the effects appreciably exceed those on the general population or other appropriate comparison group (CEQ 1997). Beneficial impacts are not typically considered environmental justice impacts; however, this section identifies beneficial effects on environmental justice populations, where appropriate, for completeness.

Executive Order 12898 directs federal agencies to consider the following with respect to environmental justice as part of the NEPA process (CEQ 1997):

- The racial and economic composition of affected communities;
- Health-related issues that may amplify project effects on minority or low-income individuals; and
- Public participation strategies, including community or tribal participation in the NEPA process.

According to USEPA guidance, environmental justice analyses must address disproportionately high and adverse impacts on minority populations (i.e., who are non-white, or who are white but have Hispanic ethnicity) when minority populations represent over 50 percent of the population of an affected area or when the percentage of minority or low-income populations in the affected area is "meaningfully greater" than the minority percentage in the "reference population"—defined as the population of a larger area in which the affected population resides (i.e., a county, state, or region depending on the geographic extent of the analysis area). Low-income populations are those that fall within the annual statistical poverty thresholds from the U.S. Department of Commerce, Bureau of the Census, Population Reports, Series P-60 on Income and Poverty (USEPA 2016).

The State of New Jersey's Environmental Justice Law, New Jersey Statutes Annotated 13:1D-157, directs the publishing of a list of overburdened communities. An *overburdened community,* as defined by the law, is any census block group, as determined in accordance with the most recent United States Census data, in which (NJDEP 2021):

- At least 35 percent of the households qualify as low-income households (at or below twice the poverty threshold as determined by the United States Census Bureau);
- At least 40 percent of the residents identify as minority or as members of a state-recognized tribal community; or
- At least 40 percent of the households have limited English proficiency (without an adult that speaks English "very well" according to the United States Census Bureau).

Using this definition, environmental justice communities in the New Jersey portion of the geographic analysis area are clustered around larger cities and towns (shown on Figure 3.12-1), and occur in Atlantic City, Bridgeton, Glassboro, Millville, and Vineland, which contain populations that meet the income or minority criteria. CEQ and USEPA guidance do not define *meaningfully greater* in terms of a specific percentage or other quantitative measure. As the states of Virginia and South Carolina do not provide specific thresholds, this analysis defines an environmental justice population as a block group that either (1) meets USEPA's "50 percent" criterion for race, or (2) is in the 80th or higher percentile for minority or low-income status as compared to the state population for Virginia and South Carolina. USEPA's Environmental Justice Screening and Mapping Tool's (EJSCREEN) data were used to assess the 50 percent criterion for race and the 80th percentile criterion for minority and low-income status (USEPA 2021a). Environmental justice populations meeting the minority and income criteria are present within and near North Charleston, South Carolina, and Norfolk, Virginia. Figure 3.12-2 and Figure 3.12-3 provide mapped locations of environmental justice populations in the geographic analysis area in Norfolk and Charleston, respectively.

Table 3.12-1 summarizes trends for non-white populations and the percentage of residents with household incomes below the federally defined poverty line in the counties studied in the geographic analysis area. The non-white population percentage generally increased throughout the geographic analysis area between 2000 and 2019. The percentage of population living under the poverty level has generally increased from 2000 to 2010 and declined slightly by 2019.

Table 3.12-1 State and County Minority and Low-Income Status

Jurisdiction	Percentage of Population below the Federal Poverty Level			Non-White Population Percentage[1]		
	2000	2010	2019	2000	2010	2019
State of New Jersey	8.5%	10.3%	10.0%	34.0%	40.6%	44.5%
Atlantic County	10.5%	14.3%	13.3%	36.1%	42.0%	43.6%
Cape May County	8.6%	10.5%	9.8%	10.0%	12.9%	14.5%
Cumberland County	15.0%	16.9%	16.5%	41.6%	47.2%	52.2%
Gloucester County	6.2%	6.3%	7.4%	14.3%	19.0%	21.3%
Ocean County	7.0%	11.2%	10.1%	10.1%	14.0%	15.3%
Salem County	9.5%	11.3%	12.4%	20.4%	23.1%	25.6%
State of South Carolina	14.1%	18.2%	15.2%	33.9%	35.6%	36.0%
Charleston County	8.4%	18.9%	13.7%	39.2%	37.7%	35.3%
Commonwealth of Virginia	9.6%	11.1%	10.6%	29.8%	35.0%	37.9%
Norfolk City	16.4%	16.4%	18.7%	53.0%	55.6%	56.8%

Sources: USCB 2000a, 2000b, 2010, 2019.
[1] Non-White Population Percentage is considered the White alone, not Hispanic or Latino population.

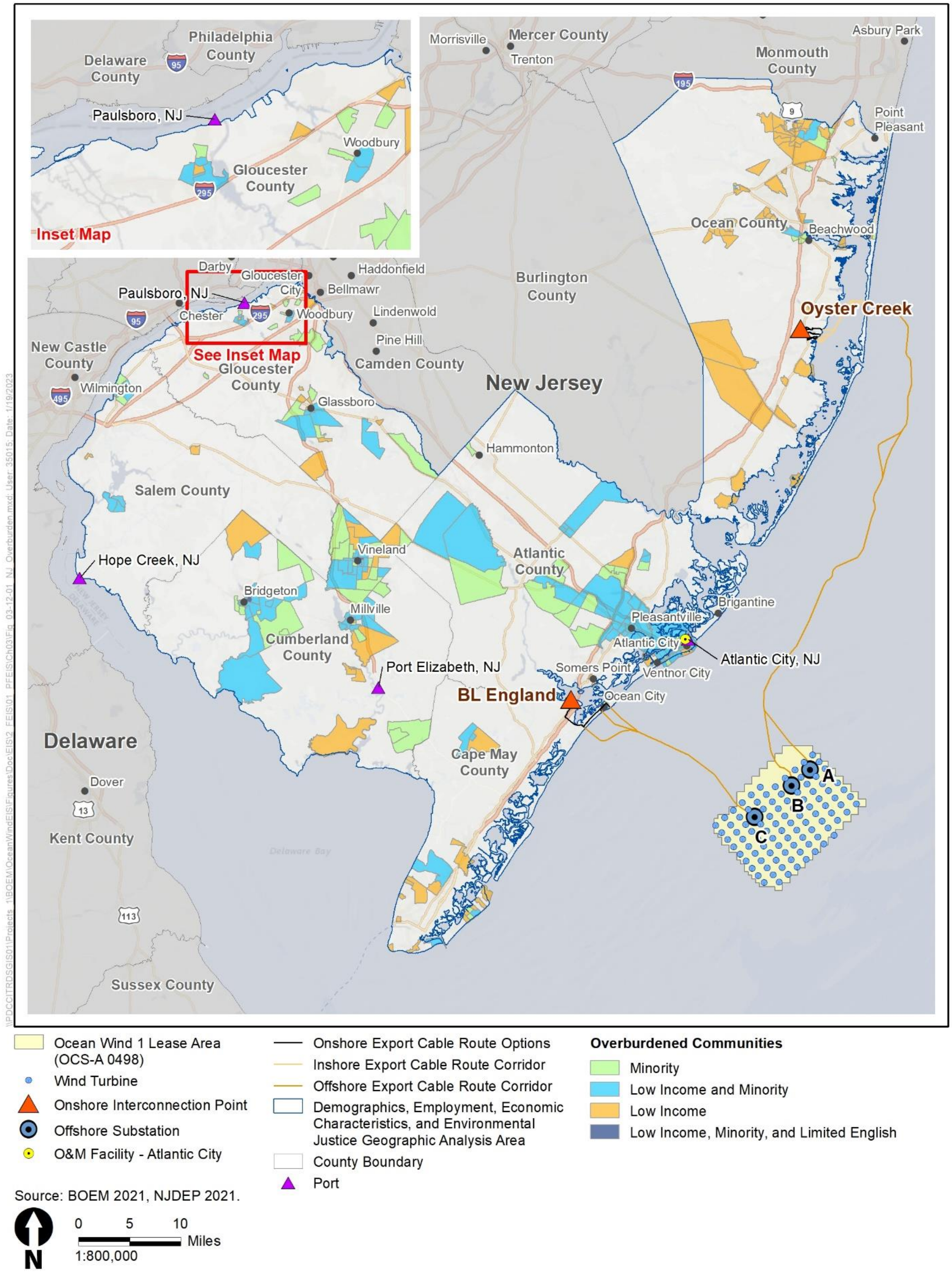

Figure 3.12-1 Environmental Justice Populations in New Jersey

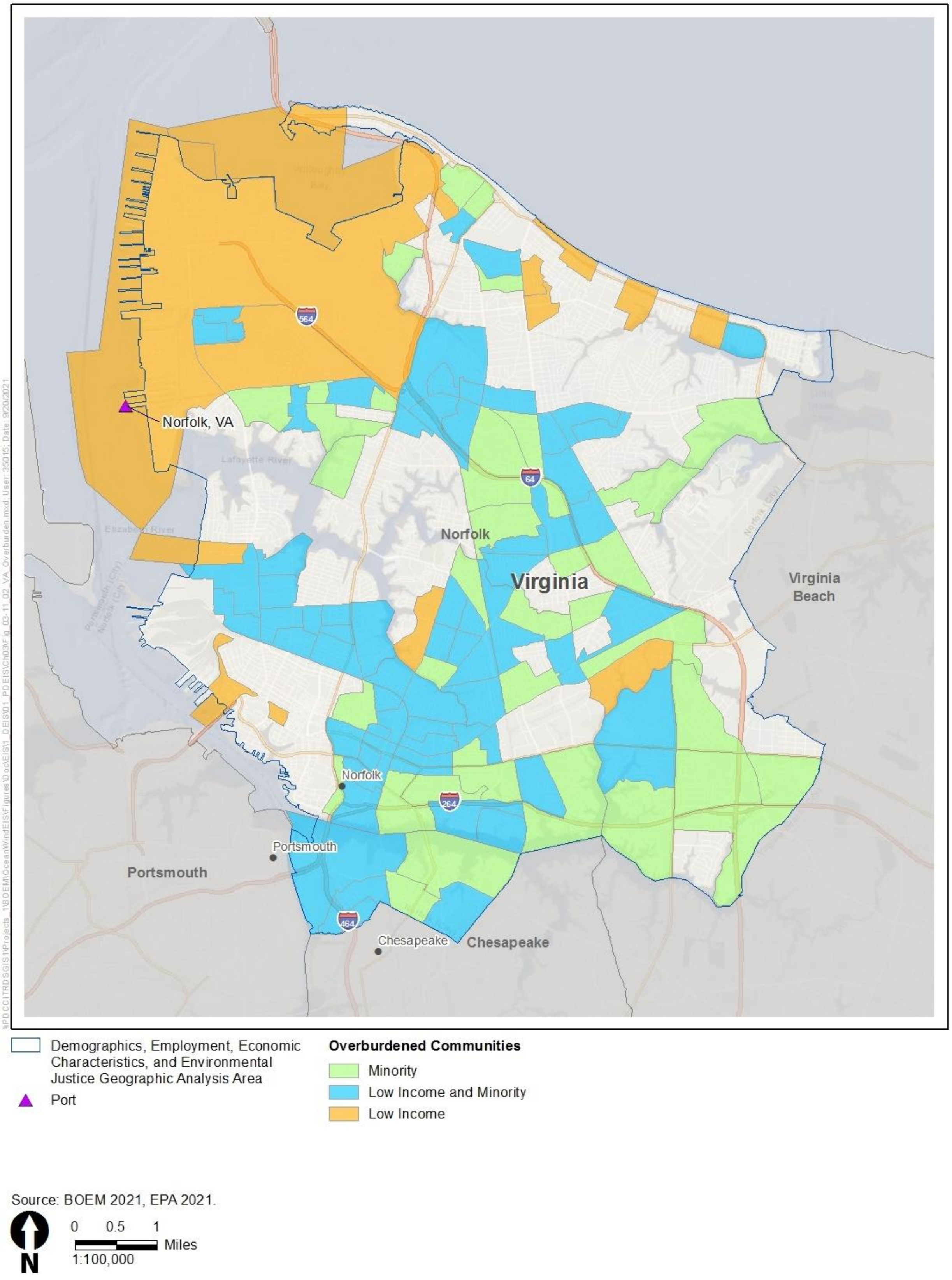

Figure 3.12-2 Environmental Justice Populations in Virginia

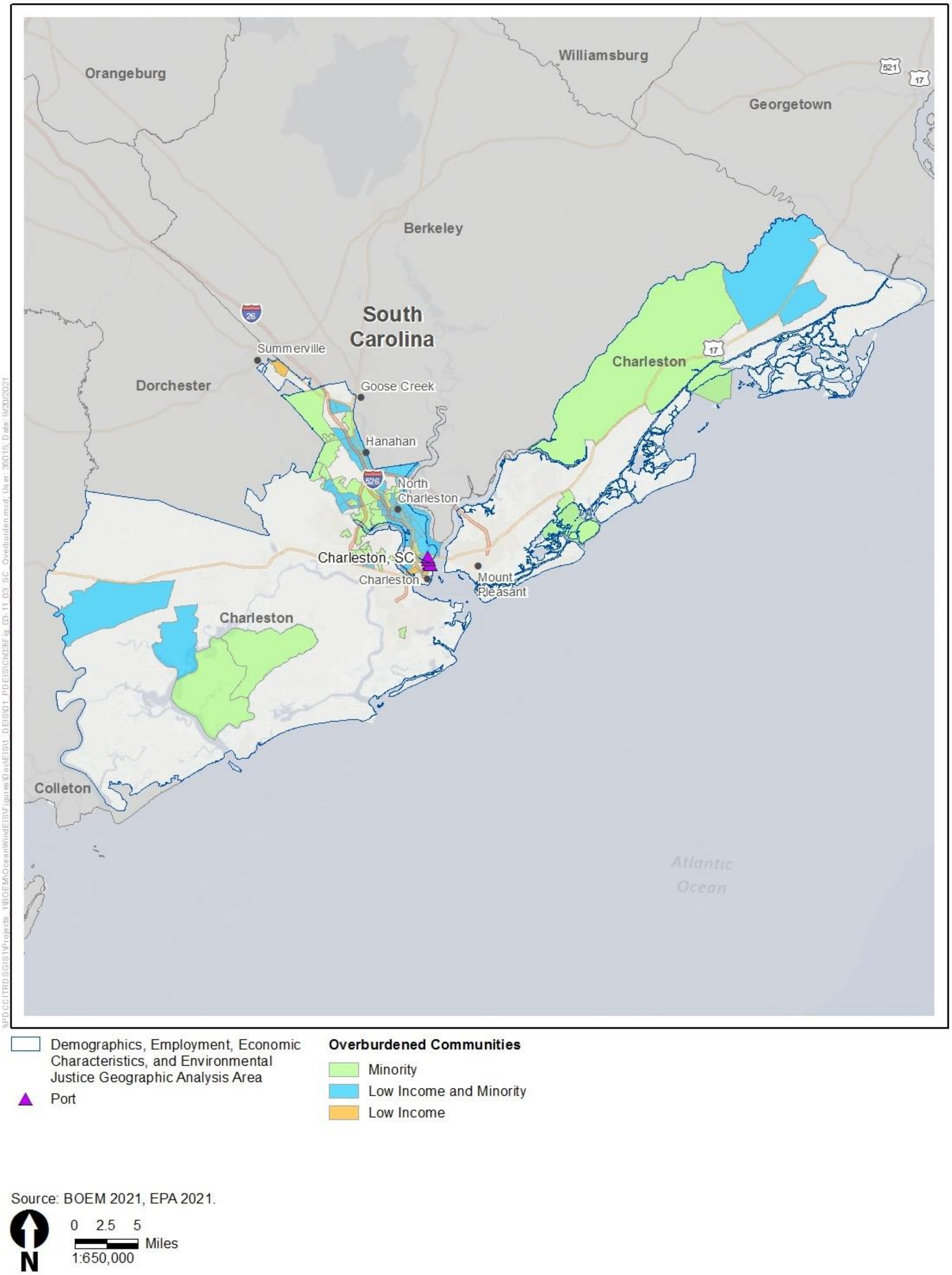

Figure 3.12-3 Environmental Justice Populations in South Carolina

Low-income and minority workers may be employed in commercial fishing and supporting industries that provide employment on commercial fishing vessels, at seafood processing and distribution facilities, and in trades related to vessel and port maintenance, or operation of marinas, boat yards, and marine equipment suppliers and retailers.

NOAA's social indicator mapping (NOAA 2022a) was used to identify environmental justice populations in the geographic analysis area that also have a high level of fishing engagement or fishing reliance. The fishing engagement and reliance indices portray the importance or level of dependence of commercial or recreational fishing to coastal communities:

- Commercial fishing engagement measures the presence of commercial fishing through fishing activity as shown through permits, fish dealers, and vessel landings. A high rank indicates more engagement.
- Commercial fishing reliance measures the presence of commercial fishing in relation to the population size of a community through fishing activity. A high rank indicates more reliance.
- Recreational fishing engagement measures the presence of recreational fishing through fishing activity estimates. A high rank indicates more engagement.
- Recreational fishing reliance measures the presence of recreational fishing in relation to the population size of a community. A high rank indicates increased reliance.

As shown on Figure 3.12-4, the coastal communities of Cape May, Atlantic City, and Barnegat Light, New Jersey have a high level of commercial fishing engagement. Cape May and Barnegat Light also have a high level of commercial fishing reliance. Within these communities that have a high level of commercial fishing engagement or reliance, Atlantic City and Cape May are determined to contain environmental justice populations (see Figure 3.12-1). Coastal communities on the northern end of Barnegat Bay (such as Bayville) and on the barrier island composing the eastern boundary of Barnegat Bay have a high level of recreational fishing engagement, as do the coastal communities of Brigantine, Atlantic City, Somers Point, Ocean City, Sea Isle City, and Cape May (see Figure 3.12-4). Within these communities that have a high level of recreational fishing engagement, Atlantic City and Cape May are determined to contain environmental justice populations. Cape May and Barnegat Light also have a high level of recreational fishing reliance (see Figure 3.12-4); of these, only Cape May contains an environmental justice population. None of the New Jersey ports that may be used for the Project are in areas with high levels of commercial or recreational fishing engagement or reliance.

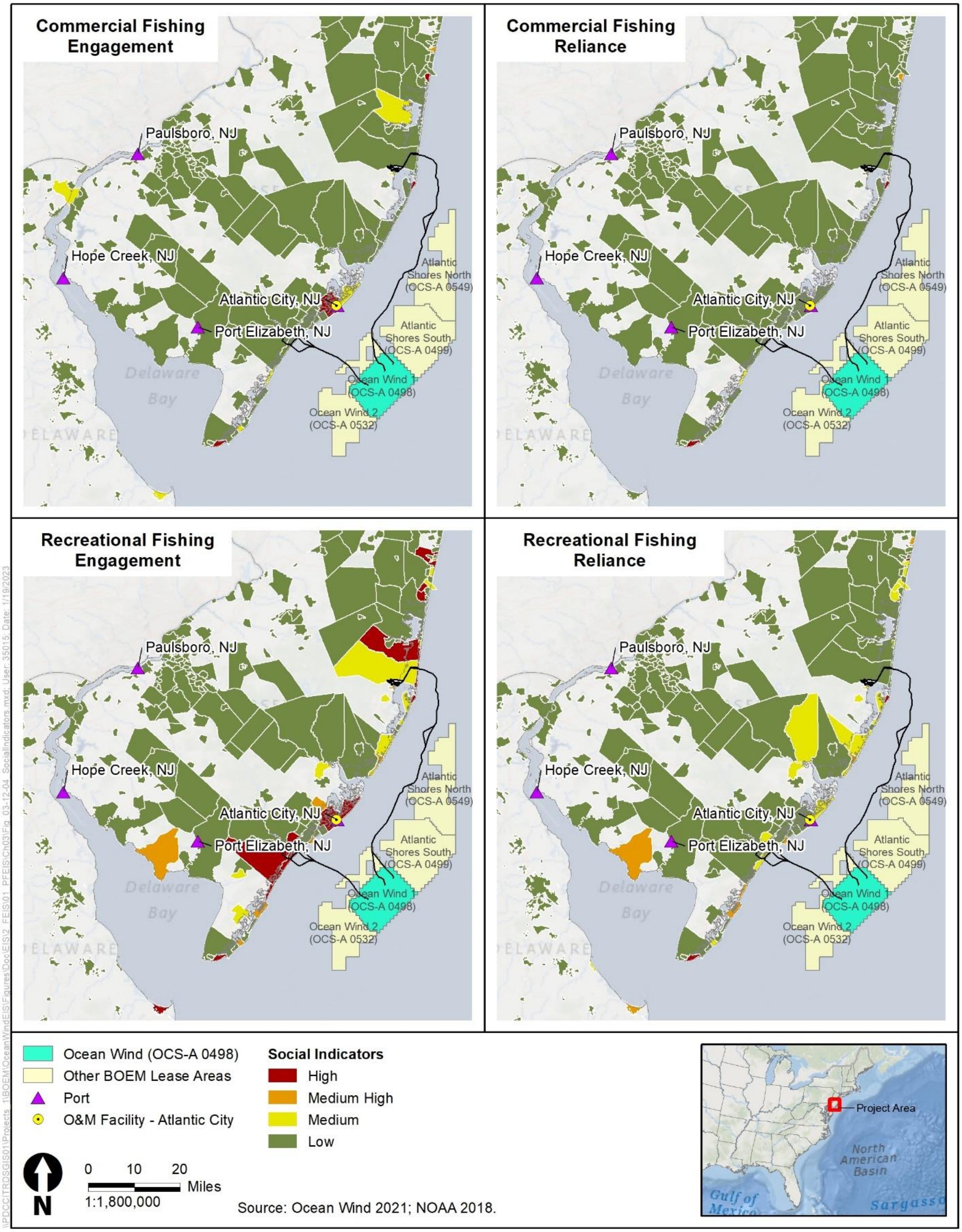

Figure 3.12-4 Commercial and Recreational Fishing Engagement or Reliance of Coastal Communities

NOAA has also developed social indicator mapping related to gentrification pressure (NOAA 2022a). The gentrification pressure indicators measure factors that, over time, may indicate a threat to the viability of a commercial or recreational working waterfront. Gentrification indicators are related to housing disruption, retiree migration, and urban spawl:

- Housing disruption represents factors that indicate a fluctuating housing market where some displacement may occur due to rising home values and rents including changes in mortgage values. A high rank means more vulnerability for those in need of affordable housing and a population more vulnerable to gentrification.
- Retiree migration characterizes communities with a higher concentration of retirees and elderly people in the population including households with inhabitants over 65 years, population receiving social security or retirement income, and level of participation in the work force. A high rank indicates a population more vulnerable to gentrification as retirees seek out the amenities of coastal living.
- Urban sprawl describes areas experiencing gentrification through increasing population density, proximity to urban centers, home values, and the cost of living. A high rank indicates a population more vulnerable to gentrification.

In a recent survey of commercial fishing crewmembers in the northeastern U.S., approximately 9 percent of participants reported annual incomes of less than $30,000 (Silva et al. 2021). Because of increasing real estate values and tax burdens in many coastal communities in the northeastern U.S. (Jimenez 2021), many crewmembers, especially those with low incomes, reside in communities far from the ports where fishing vessels are based. According to the survey results, the median distance crewmembers reported traveling from their homes to their primary ports was approximately 15 miles (Silva et al. 2021).

Mapping for gentrification indices show medium high to high levels of housing disruption and retiree migration in coastal communities along the New Jersey shore between Cape May and Barnegat Light, New Jersey, with the exception that Atlantic City has a low level of retiree migration. Urban sprawl across the same area exhibits low to medium pressure. Overall, mapping identifies lower gentrification pressure in the Atlantic City area compared to other nearby coastal areas due to low levels of retiree migration and low levels of urban sprawl.

Environmental justice analyses must also address impacts on Native American tribes. Federal agencies should evaluate "interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed agency action," and "recognize that the impacts within…Indian tribes may be different from impacts on the general population due to a community's distinct cultural practices" (CEQ 1997). Factors that could lead to a finding of significance for environmental justice populations include loss of significant cultural or historical resources and the impact's relation to other cumulatively significant impacts (USEPA 2016).

While there are no tribal lands within the geographic analysis area, BOEM has invited federally recognized tribes with ancestral associations to lands within the Project area to participate in government-to-government consultation and to participate in the NHPA Section 106 consultation process. BOEM has invited the following federally recognized tribes to participate in government-to-government consultation on the proposed Project: Eastern Shawnee Tribe of Oklahoma, Shawnee Tribe, Absentee-Shawnee Tribe of Indians of Oklahoma, Stockbridge-Munsee Community Band of Mohican Indians, Delaware Nation, Delaware Tribe of Indians, Shinnecock Indian Nation, Narragansett Indian Tribe, Rappahannock Tribe, Mashantucket Pequot Tribal Nation, and Wampanoag Tribe of Gay Head (Aquinnah).

With respect to tribal and indigenous peoples, New Jersey formally recognizes the Nanticoke Lenni-Lenape Indians, Powhatan Renape Indians, Ramapough Lenape Indian Nation, and Inter-Tribal People, none of which are federally recognized.[1] The Lenni-Lenape inhabited the Delaware River area of New Jersey long before the Europeans. The Lenni-Lenape lived near the coast, but their primary resources came from inland and the rivers (Salem County 2021).

The Commonwealth of Virginia recognizes 11 tribes, seven of which are federally recognized. None of the 11 tribes recognized by the Commonwealth of Virginia reside in the geographic analysis area. The Nansemond Indian Nation in Suffolk, Virginia, is the closest tribe to the city of Norfolk. The Nansemond Indian Nation lived in settlements along the Nansemond River fishing, harvesting oysters, hunting, and farming (Nansemond Indian Nation n.d.). The State of South Carolina recognizes 10 tribes, one of which is federally recognized. None of the 10 tribes recognized by the State of South Carolina reside in the geographic analysis area (Chesapeake Bay Program 2021; USEPA 2021b; South Carolina Commission for Minority Affairs 2021; State of New Jersey 2021).The Wassamasaw Tribe of Varnertown Indians in Summerville, South Carolina, the closest tribe to Charleston County, South Carolina, was historically a farming community (South Carolina Commission for Minority Affairs 2021; Wassamasaw Tribe of Varnertown Indians 2016).

3.12.2 Environmental Consequences

Scope of the Environmental Justice Analysis

To define the scope of the environmental justice analysis, BOEM reviewed the impact conclusions for each resource analyzed in EIS Section 3.4 through Section 3.22 to assess whether the Proposed Action and action alternatives would result in impacts that would be considered "high and adverse" and whether impacts had the potential to disproportionately affect environmental justice populations given the geographic extent of the impact relative to the locations of environmental justice populations. Impacts that were determined to be high and adverse or that had the potential to disproportionately affect environmental justice populations were further analyzed to determine if the impact on environmental justice populations would be disproportionately high and adverse. Although the environmental justice analysis considers impacts of other ongoing and planned activities, including other future offshore wind projects, determinations as to whether impacts on environmental justice populations would be disproportionately high and adverse are made for the Proposed Action and action alternatives alone.

As shown on Figure 3.12-1, onshore Project infrastructure including cable landfalls, onshore export cable routes, onshore substations, and points of interconnection are predominantly not in areas where environmental justice populations have been identified and would therefore not affect environmental justice populations. One of nine potential landfall locations, neither of the onshore substation locations, and less than 3 percent of onshore export cable routes are in areas identified as low-income or minority, and any impacts related to onshore construction would not disproportionately affect low-income or minority populations. Because onshore construction would not disproportionately affect environmental justice populations identified in the geographic analysis area, impacts associated with construction, O&M, and decommissioning of onshore Project components are not carried forward for further analysis of disproportionately high and adverse effects within the environmental justice analysis. Based on the geographic extent of onshore construction impacts relative to the location of environmental justice populations, BOEM concludes that environmental justice populations would not experience disproportionately high and adverse effects related to construction, O&M, and decommissioning of onshore infrastructure.

Ocean Wind has identified the following locations for ports that could support construction of the Project: Paulsboro, Hope Creek, and Port Elizabeth, New Jersey; Norfolk, Virginia; and Charleston, South

[1] Inter-Tribal People refers to American Indian people who reside in New Jersey but are members of federally or state-recognized tribes in other states.

Carolina. In addition, Ocean Wind plans to use an O&M facility in Atlantic City for long-term O&M of the Project. As shown on Figure 3.12-1 through Figure 3.12-3, ports in Norfolk and Charleston and the proposed location for the O&M facility in Atlantic City are all in areas where environmental justice populations have been identified. Therefore, port utilization and use of the O&M facility in Atlantic City are carried forward for analysis of disproportionately high and adverse effects in this environmental justice analysis under the port utilization and air emission IPFs.

Construction, O&M, and decommissioning of offshore structures (WTGs and OSS) could have major impacts on some commercial fishing operations that use the Lease Area, with potential for indirect impacts on employment in related industries that could affect environmental justice populations. Cable emplacement and maintenance and construction noise would also contribute to impacts on commercial fishing. The long-term presence of offshore structures (WTGs and OSS) would also have major impacts on scenic and visual resources and viewer experience from some onshore viewpoints that could affect environmental justice populations. Therefore, impacts of construction, O&M, and decommissioning of offshore Project components is carried forward for analysis of disproportionately high and adverse effects in this environmental justice analysis under the IPFs for presence of structures, cable emplacement and maintenance, and noise.

Section 3.10 determined that construction of offshore wind structures and cables could result in potentially major impacts on ancient submerged landform features if the final Project design cannot avoid known resources or if previously undiscovered resources are discovered during construction. BOEM worked with Native American tribes, the New Jersey SHPO, the lessee, and other consulting parties to develop a treatment plan to address adverse impacts on ancient submerged landform features that cannot be avoided. Implementation of the *Historic Property Treatment Plan for the Ocean Wind 1 Farm Ancient Submerged Landform Features, Federal Waters on the Outer Continental Shelf* (see Attachment 3 of Appendix N, Attachment A) would likely reduce the magnitude of unmitigated impacts on ancient submerged landforms; however, the magnitude of these impacts would remain moderate to major due to the permanent, irreversible nature of the impacts, unless these ancient submerged landforms can be avoided. Government-to-government consultation with Native American tribes is ongoing. No other tribal resources such as cultural landscapes, traditional cultural properties, burial sites, archaeological sites with tribal significance, treaty-reserved rights to usual and accustomed fishing or hunting grounds, or other potentially affected tribal resources have been identified to date.

Other resource impacts that concluded less-than-major impacts for the Proposed Action and action alternatives or were unlikely to affect environmental justice populations were excluded from further analysis of environmental justice impacts. This includes impacts related to bats; benthic resources; birds; coastal habitat and fauna; finfish, invertebrates, and EFH; land use and coastal infrastructure; marine mammals; navigation and vessel traffic; recreation and tourism; sea turtles; water quality; and wetlands. See Table S-2 for a summary of impact levels determined for each of these resource topics.

3.12.2.1. Impact Level Definitions for Environmental Justice

Definitions of potential impact levels are provided in Table 3.12-2. Determination of a “major” impact corresponds to a “high and adverse” impact for the environmental justice analysis. Major (or high and adverse) impacts will be further analyzed to determine if those impacts would be disproportionately high and adverse for low-income or minority populations.

Table 3.12-2 Impact Level Definitions for Environmental Justice

Impact Level	Impact Type	Definition
Negligible	Adverse	Adverse impacts on environmental justice populations would be small and unmeasurable.
	Beneficial	Beneficial impacts on environmental justice populations would be small and unmeasurable.
Minor	Adverse	Adverse impacts on environmental justice populations would be small and measurable but would not disrupt the normal or routine functions of the affected population.
	Beneficial	Environmental justice populations would experience a small and measurable improvement in human health, employment, facilities or community services, or other economic or quality-of-life improvement.
Moderate	Adverse	Environmental justice populations would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts.
	Beneficial	Environmental justice populations would experience a notable and measurable improvement in human health, employment, facilities or community services, or other economic or quality-of-life improvement.
Major	Adverse	Environmental justice populations would have to adjust to significant disruptions due to notable and measurable adverse impacts. The affected population may experience measurable long-term effects.
	Beneficial	Environmental justice populations would experience a substantial long-term improvement in human health, employment, facilities or community services, or other economic or quality-of-life improvement.

3.12.3 Impacts of the No Action Alternative on Environmental Justice

When analyzing the impacts of the No Action Alternative on environmental justice, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for environmental justice. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*.

3.12.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for environmental justice described in Section 3.12.1, *Description of the Affected Environment for Environmental Justice*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing activities that have the potential to affect environmental justice populations include onshore development and land uses; utilization of ports, marinas, and working waterfronts; port improvements or expansions; and commercial fishing operations. These activities support beneficial employment and also generate sources of air emissions, noise, lighting, and vehicle and vessel traffic that can adversely affect the quality of life in affected communities. There are no ongoing offshore wind activities within the geographic analysis area for environmental justice.

Coastal development that leads to gentrification of coastal communities may create space-use conflicts and reduce access to coastal areas and working waterfronts that communities rely on for recreation, employment, and commercial or subsistence fishing. Gentrification can also lead to increased tourism and recreational boating and fishing that provide employment opportunities in recreation and tourism. As described in Section 3.12.1, mapping of gentrification indices show medium high to high levels of housing disruption and retiree migration in coastal communities along the New Jersey shore between Cape May and Barnegat Light, New Jersey, with the exception that Atlantic City has a low level of retiree migration. More inland areas of the state typically have lower gentrification pressure. Housing disruption caused by rising home values and rents can displace affordable housing, with disproportionate effects for low-income populations.

See Table F1-10 for a summary of potential impacts associated with ongoing non-offshore wind activities by IPF for environmental justice.

3.12.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with other planned activities (without the Proposed Action). Planned non-offshore wind activities that may affect environmental justice populations include port utilization and expansion, construction and maintenance of coastal infrastructure (marinas, docks, and bulkheads), and onshore coastal development that can lead to gentrification of coastal communities and working waterfronts (see Section F.2 in Appendix F for a description of ongoing and planned activities).

Planned non-offshore wind activities would have impacts similar to those of ongoing non-offshore wind activities and would range from minor to moderate adverse to minor beneficial. BOEM expects that most impacts of ongoing and planned activities would be minor because while they would be measurable, they would not disrupt the normal or routine functions of the affected population. Impacts of gentrification are expected to be moderate because low-income populations would have to adjust somewhat in response to housing disruptions caused by rising home values and rents. These changes would be long term but the intensity would vary across the geographic analysis area, with higher intensity in coastal communities with waterfront access and lower intensity in more inland areas. BOEM expects that improvements related to employment for ongoing and planned activities would be measurable but small and minor beneficial. See Table F1-10 for a summary of potential impacts associated with planned non-offshore wind activities by IPF for environmental justice.

BOEM expects planned offshore wind activities to affect environmental justice populations through the following primary IPFs.

Air emissions: Increased port activity would generate short-term, variable increases in air emissions. The largest emissions for regulated air pollutants would occur during construction from diesel construction equipment, vessels, and commercial vehicles. Emissions at offshore locations would have regional impacts, with no disproportionate impacts on environmental justice populations. However, environmental justice populations near ports could experience disproportionate air quality impacts depending upon the ports that are used, ambient air quality, and the increase in emissions at any given port.

There are three planned offshore wind projects within the air quality geographic analysis area: Atlantic Shores North, Atlantic Shores South, and Ocean Wind 2 (Figure 3.4-1). Construction periods as estimated in Table F2-1 in Appendix F could result in concurrent construction of Ocean Wind 1 and Atlantic Shores South in 2024 and 2025. Ocean Wind 1 construction could be supported by two ports near environmental justice populations in Charleston, South Carolina, and Norfolk, Virginia. In addition, the O&M facility in Atlantic City, New Jersey, could be used as a construction management base. As stated in Section 3.4, *Air Quality*, during the construction phase, the total emissions of criteria pollutants and ozone precursors from offshore wind projects other than Ocean Wind 1 proposed within the air quality geographic analysis area,[2] summed over all construction years, are estimated to be 6,034 tons of carbon monoxide (CO), 27,571 tons of nitrogen oxides (NO_X), 913 tons of particulate matter smaller than 10 microns in diameter (PM_{10}), 880 tons of particulate matter smaller than 2.5 microns in diameter ($PM_{2.5}$), 181 tons of sulfur dioxide (SO_2), 618 tons of volatile organic compounds (VOC), and 1,738,387 tons of CO_2 (Table F2-4). This area is larger than the environmental justice geographic analysis area and a large portion of the emissions would be generated along the vessel transit routes and at the offshore work areas. Emissions of NO_X and CO are primarily due to diesel construction equipment, vessels, and commercial vehicles. Emissions would vary spatially and temporally during construction phases. Emissions from vessels, vehicles, and equipment operating in ports could affect environmental justice populations adjacent or close to ports in Charleston, South Carolina, or Norfolk, Virginia. Environmental justice populations are not adjacent or close to potential ports in Paulsboro, Hope Creek, or Elizabeth, New Jersey. Emissions attributable to the No Action Alternative affecting any neighborhood have not been quantified; however, it is assumed that emissions from the No Action Alternative at high-volume ports in Charleston or Norfolk would contribute a small proportion of total emissions from those facilities. Therefore, air emissions during construction would have small, short-term, variable impacts on environmental justice populations due to temporary increases in air emissions. The air emissions impacts would be greater if multiple offshore wind projects simultaneously use the same port for construction staging. If construction staging is distributed among several ports, the air emissions would not be concentrated near certain ports and impacts on proximal environmental justice populations would be lower.

As explained in Section 3.4, operational activities under the No Action Alternative within the air quality geographic analysis area would generate 121–262 tons per year of CO, 519–1,107 tons per year of NO_X, 17–36 tons per year of PM_{10}, 16–35 tons per year of $PM_{2.5}$, 1–3 tons per year of SO_2, 9–20 tons per year of VOCs, and 33,566–73,226 tons per year of CO_2 (Table F2-4). The O&M facility for Atlantic Shores South is proposed in Atlantic City, New Jersey, similar to the Proposed Action. Operational emissions would overall be intermittent and widely dispersed throughout the vessel routes from the onshore O&M facilities and would generally contribute to small and localized air quality impacts. Emissions would largely be due to vessel traffic–related to O&M and operation of emergency diesel generators. These emissions would be intermittent and widely dispersed, with small and localized air quality impacts. Only the portion of those emissions resulting from ship engines and equipment operating within and near the O&M facilities in Atlantic City would affect environmental justice populations. Therefore, during operations of offshore wind projects, the air emissions volumes resulting from O&M activities are not anticipated to be large enough to have impacts on environmental justice populations.

The power generation capacity of offshore wind development could potentially lead to lower regional air emissions by displacing fossil fuel plants for power generation, resulting in a potential reduction in regional GHG emissions, as analyzed in further detail in Section 3.4. A 2019 study found that nationally, exposure to fine particulate matter from fossil fuel electricity generation in the U.S. varied by income and by race, with average exposures highest for Black individuals, followed by non-Hispanic white individuals. Exposures for other groups (i.e., Asian, Native American, and Hispanic) were somewhat lower. Exposures were higher for lower-income populations than for higher-income populations, but disparities were larger by race than by income (Thind et al. 2019). Specific to New Jersey, a 2016 study found a higher percentage increase in mortality associated with $PM_{2.5}$ in census tracts with more Black individuals, lower home values, or lower median incomes (Wang et al. 2016).

Exposure to air pollution is linked to health impacts, including respiratory illness, increased health care costs, and mortality. A 2016 study for the Mid-Atlantic region found that offshore wind could produce

[2] The air quality geographic analysis area, depicted on Figure 3.4-1, includes the airshed with 25 miles (40 kilometers) of the Wind Farm Area (corresponding to the OCS permit area) and the airshed within 15.5 miles (25 kilometers) of onshore construction areas and ports that may be used for the Project.

measurable benefits related to health costs and reduction in loss of life due to displacement of fossil fuel power generation (Buonocore et al. 2016). Environmental justice populations tend to have disproportionately high exposure to air pollutants, likely leading to disproportionately high adverse health consequences. Accordingly, offshore wind generation analyzed under the No Action Alternative would have potential benefits for environmental justice populations through reduction or avoidance of air emissions and concomitant reduction or avoidance of adverse health impacts.

Cable emplacement and maintenance: Cable emplacement and maintenance for future offshore wind projects would result in seafloor disturbance and temporary increases in turbidity. Cable emplacement and maintenance could displace other marine activities temporarily within work areas. As described in Section 3.9, *Commercial Fisheries and For-Hire Recreational Fishing*, cable emplacement and maintenance would have localized, temporary, short-term impacts on the revenue and operating costs of commercial and for-hire fishing businesses. Commercial fishing operations may temporarily be less productive during cable installation or repair, resulting in reduced income and also leading to short-term reductions in business volumes for seafood processing and wholesaling businesses that depend upon the commercial fishing industry. Although commercial and for-hire fishing businesses could temporarily adjust their operating locations to avoid revenue loss, impacts would be greater if multiple cable installation or repair projects are underway offshore at the same time. Business impacts could affect environmental justice populations due to the potential loss of income or jobs by low-income or minority workers in the commercial fishing industry. In addition, cable installation and maintenance could temporarily disrupt subsistence fishing, resulting in short-term, localized impacts on individuals who rely on subsistence fishing as a food source.

Noise: As described in greater detail in Sections 3.9, 3.11, *Demographics, Employment, and Economics*, and 3.18, noise from G&G survey activities, pile driving, trenching, and vessels is likely to result in temporary revenue reductions for commercial fishing and for-hire recreational fishing businesses that are based in the geographic analysis area. Construction noise, especially site assessment G&G surveys and pile driving, would affect fish populations, with impacts on commercial and for-hire fishing. The severity of impacts would depend on the proximity and temporal overlap of offshore wind survey and construction activities, and the location of noise-generating activities in relation to preferred locations for commercial and for-hire fishing. The localized impacts of offshore noise on fishing could also affect subsistence fishing. In addition, noise would affect some for-hire recreational fishing businesses, as these visitor-oriented services are likely to avoid areas where noise is being generated due to the disruption for customers.

Impacts of offshore noise on marine businesses would be short term and localized, occurring during surveying and construction, with no noticeable impacts during operations and only periodic, short-term impacts during maintenance. Noise impacts during surveying and construction would be more widespread when multiple offshore wind projects are under construction at the same time. The impacts of offshore noise on marine businesses could be short term and localized on low-income and minority workers in communities with a high level of commercial or recreational fishing engagement or reliance as well as residents who practice subsistence fishing.

Port utilization: Offshore wind project construction would require port facilities for berthing, staging, and loadout. Future offshore wind development would also support planned expansions and improvements at ports in the geographic analysis area. For example, the State of New Jersey is investing in development of the New Jersey Wind Port on the eastern shore of the Delaware River in Salem County and is also investing in a manufacturing facility to build steel components for offshore wind turbines at the Port of Paulsboro (see Appendix F, Section F.2.13). Offshore wind projects that utilize ports near environmental justice populations may contribute to adverse impacts on these populations from increased air emissions, lighting, noise, and vessel and vehicle traffic generated by port utilization or expansion.

Air emissions and noise from vessels, vehicles, and equipment operating in ports; lighting of port facilities; and vessel and vehicle traffic to and from port locations could affect environmental justice populations adjacent or close to those ports. Baseline levels of air emissions, noise, lighting, and traffic at port locations and increases associated with planned offshore wind construction and decommissioning have not been quantified; however, BOEM expects that future offshore wind projects would contribute to small increases in these IPFs relative to baseline operations at major ports such as Norfolk, Virginia, and Charleston, South Carolina. At New Jersey ports planning expansions to support the offshore wind industry (such as the New Jersey Wind Port and the Port of Paulsboro), the contribution of future offshore wind projects to these IPFs would be substantially greater. Increases in air emissions, noise, lighting, and vessel and vehicle traffic from increases in port utilization would occur during the construction and decommissioning phases for each planned offshore wind project. Impacts at ports would be greater if multiple offshore wind projects use the same port(s) for construction and decommissioning simultaneously and would be reduced at each port location if construction and decommissioning for each planned offshore wind project is distributed among several ports.

Offshore wind construction and decommissioning would generate increased vessel traffic. However, none of the New Jersey ports that may be used for the Project (and for which there is potential for cumulative effects) are in areas with high levels of commercial fishing engagement or reliance (Figure 3.12-4), reducing the potential for space-use conflicts between commercial fishing vessels and vessels used for future offshore wind at ports in New Jersey. Areas adjacent to Charleston Harbor have medium to medium high levels of commercial fishing engagement, while Norfolk, Virginia, supports a medium level of commercial fishing engagement; however, the incremental contribution of future offshore wind vessel traffic to space-use conflicts with commercial fishing operations near major high-volume ports is expected to be minor.

Port use and expansion would have beneficial impacts on employment at ports. Future offshore wind projects would contribute to minor increases in employment at major ports such as Norfolk, Virginia, and Charleston, South Carolina, that are in environmental justice communities. Planned port expansions for the New Jersey Wind Port and Port of Paulsboro would have long-term, moderate beneficial impacts on employment; however, these ports are not in environmental justice communities.

Atlantic Shores South has proposed use of an O&M facility in Atlantic City. O&M of future offshore wind projects would generate vessel trips and air emissions from vessels transiting between the O&M facility and the offshore wind lease area for each planned project. Operational emissions associated with vessels would be intermittent and widely dispersed along the vessel routes and would generally contribute to small and localized air quality impacts. BOEM does not expect that O&M facilities would generate levels of air emissions, noise, lighting, or vessel and vehicle traffic that would be disruptive to nearby communities. Operation of O&M facilities would also have long-term, minor beneficial employment impacts, creating employment opportunities in the Atlantic City area.

Presence of structures: Construction, decommissioning, and, to a lesser extent, O&M of future offshore wind projects could affect employment and economic activity generated by commercial fishing and marine-based businesses. Commercial fishing vessels would need to adjust routes and fishing grounds to avoid offshore work areas during construction and to avoid WTGs and OSS during operations. Concrete cable covers and scour protection could result in gear loss and would make some fishing techniques unavailable in locations where the cable coverage exists. Future offshore wind activities would generate increased vessel traffic, which would increase navigational complexity in offshore construction areas during construction and within each project’s offshore wind lease area long term due to the presence of WTGs and OSS. For-hire recreational fishing businesses would also need to avoid construction areas and offshore structures. A decrease in revenue, employment, and income within commercial fishing and marine industries could affect low-income and minority workers in communities with a high level of commercial fishing engagement or reliance. The impacts during construction would be short term and would increase in magnitude if multiple offshore construction areas are being used at the same time. Impacts during operations would be long term but may lessen in magnitude as business operators adjust to the presence of offshore structures and as any temporary marine safety zones needed for construction are no longer needed.

In addition to the potential impacts on commercial and for-hire recreational fishing activity and supporting businesses, WTGs are anticipated to provide new opportunities for recreational fishing through fish aggregation and reef effects, and to provide attraction for recreational sightseeing businesses, potentially benefitting for-hire recreational fishing and low-income employees of fishing-dependent businesses.

The long-term presence of WTGs associated with future offshore wind may also cause major adverse impacts on scenic and visual resources in coastal communities that are within the viewshed of future offshore wind projects. The level of impact on onshore viewers would depend on the distance to the WTGs offshore, the number and height of the WTGs associated with each future offshore wind project, and the design of the aviation warning lighting system, which could introduce continuous nighttime lighting. Lighting impacts would be reduced if the emerging technology of ADLS is used. ADLS lighting would be activated only when an aircraft approaches (Section 3.20). Depending on exact location and layout of offshore wind projects, ADLS would likely limit the frequency of WTG aviation warning lighting use. This technology, if used, would significantly reduce the impacts of lighting.

3.12.3.3. Conclusions

Impacts of the No Action Alternative. Under the No Action Alternative, environmental justice populations within the geographic analysis area would continue to be influenced by regional environmental, demographic, and economic trends. While the Project would not be built under the No Action Alternative, BOEM expects ongoing activities to have continuing impacts on environmental justice populations through the following trends: ongoing coastal development and gentrification of coastal communities; ongoing commercial fishing, seafood processing, and tourism industries that provide job opportunities for low-income residents; and air emissions, noise, lighting, and traffic associated with onshore construction and land uses when these occur near environmental justice populations. BOEM anticipates that the environmental justice impacts of these ongoing activities would range from minor to moderate adverse to minor beneficial. The No Action Alternative would result in impacts on environmental justice populations that range from **minor** to **moderate** adverse to **minor beneficial**.

Cumulative Impacts of the No Action Alternative. Under the No Action Alternative, existing environmental trends and activities would continue, and environmental justice populations would continue to be affected by natural and human-caused IPFs. Reasonably foreseeable trends affecting environmental justice populations, other than offshore wind, include continued operation of commercial fishing and supporting marine businesses; growing recreational and tourism industries for coastal economies; new development that would result in increased construction and vehicle emissions; and gentrification of industrial waterfront locations and coastal communities. BOEM anticipates that the impacts of these trends and planned activities on environmental justice populations would range from minor to moderate adverse to minor beneficial. BOEM anticipates that the cumulative impacts of the No Action Alternative would be **moderate** because environmental justice populations would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts. This reflects moderate impacts on environmental justice populations from gentrification and potential loss of income for low-income and minority workers in communities with a high level of commercial fishing engagement or reliance; minor adverse impacts from air emissions, noise, lighting, and traffic associated with onshore construction, land uses, and port utilization; and minor beneficial employment benefits associated with future offshore wind construction and O&M, increased port utilization, and improved opportunities for for-hire recreational fishing.

3.12.4 Relevant Design Parameters & Potential Variances in Impacts for Action Alternatives

Effects on environmental justice populations would occur when the action alternative's adverse effects on other resources, such as air quality, commercial and for-hire recreational fishing, or scenic and visual resources, are felt disproportionately within environmental justice populations due either to the location of these communities in relation to the action alternatives or to their higher vulnerability to impacts.

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than described in the sections below. The following PDE parameters (Appendix E) would influence the magnitude of environmental justice impacts:

- Overall size of the Project (approximately 1,100 MW) and number of WTGs;
- The Project layout including the number, type, height, and placement of the WTGs and OSS, and the location of export cable routes;
- The extent to which Ocean Wind hires local residents and obtains supplies and services from local vendors;
- The port(s) selected to support construction, installation, and decommissioning and the port(s) selected to support O&M;
- Arrangement of WTGs and accessibility of the Wind Farm Area to commercial and for-hire recreational fishing; and
- The time of year during which offshore and nearshore construction occurs and the duration of offshore and nearshore construction activities.

Variability of the proposed Project design exists as outlined in Appendix E. Below is a summary of potential variances in impacts on environmental justice populations:

- WTG number and layout: More WTGs and closer spacing could increase space-use conflicts with commercial and for-hire recreational fishing vessels.
- Utilization of ports that are near or within low-income and minority populations would have greater impacts.

Ocean Wind has committed to measures to minimize impacts on other resource areas that would reduce the potential for effects on environmental justice populations. Examples include measures to minimize impacts on the commercial and for-hire recreational fishing industry (CFHFISH-01, CFHFISH-02) and reduce impacts on local tourism and businesses from onshore construction (REC-01, REC-02) (COP Volume II, Table 1.1-2; Ocean Wind 2023).

3.12.5 Impacts of the Proposed Action on Environmental Justice

3.12.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.12.7, *Impacts of Alternative E on Environmental Justice*.

The Proposed Action would affect low-income and minority populations in the geographic analysis through the primary IPFs of cable emplacement and maintenance, noise, port utilization, and presence of structures.

Air emissions: Emissions at offshore locations would have regional impacts, with no disproportionate impacts on environmental justice populations, because (1) emissions generated during construction, O&M, and decommissioning of offshore infrastructure in the Lease Area would occur 15 miles offshore, (2) emissions would be mixed and dispersed into the atmosphere, (3) the prevailing wind direction (west to east, or westerlies) would generally not direct emissions back toward shore, and (4) the pollutant concentrations generated by the Proposed Action are predicted to be within the NAAQS at all locations (see Section 3.4 and Section I.1.2 for additional information on air quality modeling results and wind conditions within the geographic analysis area).

However, environmental justice populations near ports could experience disproportionate air quality impacts, depending upon the ports that are used. Appendix N to the COP (Ocean Wind 2023) provides maximum annual construction emissions (in tons) for nonattainment/maintenance areas. Emissions are estimated for onshore construction (Year 1) and for offshore construction utilizing vessels (Year 2). Emissions reported for the Atlantic City, New Jersey Carbon Monoxide Maintenance Area can be used to estimate emissions associated with utilization of the O&M facility in Atlantic City during Project construction as shown in Table 3.12-3. While Ocean Wind has quantified estimated emissions by calendar year within the nonattainment area that includes Atlantic City, compliance with the NAAQS cannot be determined based on the emission inventory alone. Dispersion modeling would be required to characterize concentrations for comparison to the NAAQS.

Table 3.12-3 General Conformity Construction Emissions in Atlantic City, New Jersey Nonattainment Area (tons)

Year	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Year 1	0.084	1.70	0.10	0.08	0.01	-	0.12
Year 2	2.02	10.27	0.29	0.28	0.05	0.00004	0.18
Total	2.86	11.97	0.39	0.37	0.06	0.00004	0.30

The Proposed Action’s contributions to increased air emissions at the ports of Norfolk, Virginia, and Charleston, South Carolina, which are near environmental justice populations, are not quantitatively evaluated because the nonattainment/maintenance areas that include these ports are much larger and include multiple counties, which does not allow for meaningful conclusions regarding emissions at specific ports. However, as stated in Section 3.4, BOEM expects that overall air emissions impacts would be minor during Proposed Action construction, operations, and decommissioning, with the greatest quantity of emissions produced in the Lease Area and by vessels transiting between ports and the Lease Area.

Construction of the Proposed Action would use ports at Port Elizabeth, Paulsboro, and Hope Creek, New Jersey; Norfolk Virginia; or Charleston, South Carolina, staging and shipping of Project components. Increased short-term and variable emissions from Proposed Action construction and operations would have negligible to minor disproportionate, adverse impacts on the communities near the ports of Norfolk, Virginia, and Charleston, South Carolina, and at the O&M facility in Atlantic City, New Jersey. Environmental justice populations are not identified near the other ports that could be used in Port Elizabeth, Paulsboro, and Hope Creek, New Jersey, and air emissions generated at these locations would not affect environmental justice populations.Net reductions in air pollutant emissions resulting from the Proposed Action alone would result in long-term benefits to communities (regardless of environmental justice status) by displacing emissions from fossil-fuel-generated power plants. As explained in Section 3.4, by displacing fossil fuel power generation, once operational, the Proposed Action would result in annual avoided emissions of 2,362 tons of NO_X, 114 tons of $PM_{2.5}$, 5,705 tons of SO_2, and 2,989,161 tons of CO_2 (COP Volume II, Table 2.1.3-5; Ocean Wind 2023). Estimates of annual avoided health effects would range from 213 to 539 million dollars in health benefits and 21 to 48 avoided mortality cases (Section 3.4, Table 3.4-5). Environmental justice populations are disproportionately affected by emissions from fossil fuel power plants nationwide and by higher levels of air pollutants. Therefore, the Proposed Action alone could benefit environmental justice populations by displacing fossil fuel power-generating capacity within or near the geographic analysis area.

Cable emplacement and maintenance: The Proposed Action would install up to 143 miles (230 kilometers) of offshore export cable on the approach to Oyster Creek and up to 32 miles (51 kilometers) of offshore export cable on the approach to BL England, while inter-array cables would involve up to 190 miles (300 kilometers) of cable emplacement (COP Volume I, Section 4.4, Table 4.4-1; Ocean Wind 2023). Offshore cable emplacement for the Proposed Action would temporarily affect commercial and for-hire recreational fishing businesses, marine recreation, and subsistence fishing during cable installation and infrequent maintenance. As noted in Sections 3.9 and 3.11, installation of the Proposed Action's cables would have short-term, localized, minor impacts on commercial and for-hire recreational fishing businesses. Cable installation could affect fish of interest for commercial, recreational, or subsistence fishing through dredging and turbulence, although fish species would recover upon completion of installation activities (see Sections 3.9 and 3.13). Cable emplacement and maintenance for the Proposed Action could therefore have a short-term, minor impact on low-income and minority workers in businesses that support commercial and recreational fishing and on individuals that rely on subsistence fishing.

The geographic extent and intensity of subsistence fishing in the vicinity of cable routes are not well documented. Data specific to subsistence fishing are limited; however, trends in subsistence fishing are captured in recreational fishing data. As such, BOEM expects that subsistence angling by low-income or minority residents near cable routes would be predominantly shore-based or nearshore. Public fishing access points in proximity to proposed landfalls that could be used by subsistence anglers include the Holiday Harbor Marina in the vicinity of proposed landfalls for Oyster Creek, Fisherman's Walkway at Island Beach State Park, and the Ocean City Fishing Pier (NOAA 2022b). Because cable laying would occur predominantly farther offshore, BOEM expects that subsistence anglers would experience only minor, short-term disruptions during cable emplacement and maintenance.

Noise: Noise from Proposed Action construction (primarily pile driving) could temporarily affect fish near construction activity within the Wind Farm Area, and discourage some fishing businesses from operating in these areas during pile driving (see Sections 3.9 and 3.18). This would result in a localized, short-term, negligible impact on jobs supported by these businesses, as well as on subsistence fishing.

Port utilization: The Proposed Action would require port facilities for berthing, staging, fabrication, assembly, and loadout of Project components. Air emissions, lighting, noise, and vessel and vehicle traffic generated by the Proposed Action's activities at ports would affect communities near ports that may be used for the Project, including ports in Paulsboro, New Jersey, for foundation fabrication and load out; Norfolk, Virginia, or Hope Creek, New Jersey, for WTG pre-assembly and load out; and Port Elizabeth, New Jersey, or Charleston, South Carolina, for cable staging. In addition, the Proposed Action would use a location in Atlantic City, New Jersey, as a construction management base and long-term O&M facility.

As described in Appendix F, Section F.2.13, the State of New Jersey is making substantial investments in a manufacturing facility to build steel components for offshore wind turbines at the Port of Paulsboro and is also developing the New Jersey Wind Port adjacent to the Hope Creek Nuclear Generating Station on the eastern shore of the Delaware River to support the offshore wind industry. Because the State of New Jersey is investing in these ports for the purpose of supporting offshore wind, BOEM expects that these port facilities could see substantial use for Proposed Action construction. Port facilities with high levels of activity related to fabrication, staging, and assembly of WTG components could have moderate impacts on surrounding communities due to disruptions and notable adverse impacts associated with port operations (i.e., due to air emissions, noise, lighting, and vessel and vehicle traffic). However, none of the New Jersey ports proposed for use by the Project are in areas where environmental justice populations have been identified (see Figure 3.12-1), and potential use of ports in Paulsboro, Hope Creek, or Port Elizabeth, New Jersey, would not affect environmental justice populations.

The Port of Virginia in Norfolk, Virginia, and Charleston, South Carolina, are major ports that ranked in the top 50 ports in the United States for total tons of cargo shipped in 2019. The Port of Virginia ranked in the top 10 ports and shipped 61.7 million tons of cargo while Charleston, South Carolina, ranked number 27 and shipped 24.6 million tons of cargo (U.S. Department of Transportation 2021). Ports in Norfolk, Virginia, and Charleston, South Carolina, are in areas where environmental justice populations have been identified and environmental justice populations would be affected by use of vessels, vehicles, and equipment at ports that generate air emissions, noise, light, and vessel and vehicle traffic. Increased port utilization would also have beneficial impacts due to greater economic activity and increased employment at ports. The impact of Proposed Action port utilization cannot be quantitatively evaluated because port usage has not been quantified for each of the ports that could be used during construction or decommissioning of the Proposed Action. However, given the scale of ongoing operations at these ports, BOEM expects that the Proposed Action’s contribution to both adverse and beneficial impacts at ports in Norfolk, Virginia, and Charleston, South Carolina, would be minor.

Ocean Wind proposes to use an O&M facility in Atlantic City, New Jersey, as a construction management base and regional O&M center for multiple Ørsted projects in the mid-Atlantic, including for the Proposed Action. The O&M facility would contain office, warehouse, and workshop space; dockside harbor facilities; and parking facilities. In-water and upland improvements for the O&M facility are being separately reviewed and authorized by USACE and state and local agencies, and analysis of impacts related to the O&M facility in this EIS are limited to use of the O&M facility during construction, O&M, and decommissioning of the Proposed Action. Public fishing access points in proximity to the O&M facility that could be used by subsistence anglers include the Kammerman A.C. Marina, Farley State Marina, Gardiner’s Basin, Brigantine South End Beach & Jetty, and Atlantic City Jetties North and South (NOAA 2022b). BOEM expects that use of the O&M facility would involve activities consistent with working waterfronts in the area (e.g., vessel berthing, crew transfers, vessel loading and unloading) and result in minor impacts that would not disrupt the normal or routine functions of the affected community. These minor impacts would be borne by environmental justice populations present in the Atlantic City area.

Overall, BOEM expects that Proposed Action impacts of port utilization on environmental justice populations would be minor, because port locations in closest proximity to the Lease Area where dedicated facilities to support offshore wind would be located would not affect environmental justice populations. Use of more distant ports in Norfolk, Virginia, and Charleston, South Carolina, would affect environmental justice populations; however, the Proposed Action’s contribution to overall impacts at these major ports would be minor given the high volume of cargo shipped through these ports. Use of the O&M facility in Atlantic City would be typical of working waterfronts and would have minor impacts on environmental justice populations. Therefore, BOEM determined that port utilization would not result in “high and adverse” impacts for environmental justice populations. Furthermore, BOEM concludes that impacts related to port utilization would not disproportionately affect environmental justice populations because the New Jersey ports likely to see the most activity during construction and decommissioning are not in areas with environmental justice populations. Given these findings, BOEM has determined that port utilization would not result in disproportionately high and adverse effects on environmental justice populations.

Presence of structures: The Proposed Action's establishment of offshore structures, including up to 98 WTGs, three OSS, and hardcover for cables, would result in both adverse and beneficial impacts on marine businesses supporting commercial and for-hire recreational fishing. Beneficial impacts would be generated by the reef effect of offshore structures, providing additional opportunity for tour boats and for-hire recreational fishing businesses. Adverse impacts would result from navigational complexity within the Wind Farm Area, disturbance of customary routes and fishing locations, and the presence of scour protection and cable hardcover, leading to possible equipment loss and limiting certain commercial fishing methods.

As discussed in Section 3.9, BOEM anticipates that the adverse impacts of the Proposed Action on commercial fisheries and for-hire recreational fishing would vary by fishery and fishing operation due to differences in target species abundance in the Offshore Project area, gear type, and predominant location of fishing activity. It is possible that some of the small number of fishing operations that derive a large percentage of their total revenue from areas where Project facilities would be located would choose to avoid these areas once the facilities become operational. In the event that these specific fishing operations are unable to find suitable alternative fishing locations, they could experience long-term, major disruptions. However, it is estimated that the majority of fishing vessels would adjust somewhat to account for disruptions due to impacts associated with the presence of structures. In addition, the impacts of the Proposed Action could include long-term, minor beneficial impacts for some for-hire recreational fishing operations due to the artificial reef effect. Therefore, BOEM expects that impacts of the Proposed Action on commercial fishing and for-hire recreational fishing would range from negligible to major, depending on the fishery and fishing operation.

Impacts of the Proposed Action on commercial fishing and for-hire recreational fishing would have a greater impact on communities that have a high level of commercial or recreational fishing engagement or reliance. As shown on Figure 3.12-4, Atlantic City and Cape May have a high level of commercial fishing engagement and Cape May also has a high level of commercial fishing reliance. Both Atlantic City and Cape May are also determined to have environmental justice populations (see Figure 3.12-1), while other affected communities in the geographic analysis area generally have lower levels of commercial fishing engagement and reliance and are also not identified as environmental justice populations. Therefore, BOEM has determined that commercial fishing impacts on environmental justice populations in Atlantic City and Cape May would be disproportionate. Impacts of the Proposed Action on commercial fishing landings and secondary impacts for employment at onshore seafood processors and distributors would vary depending on the specific fisheries and fishing operations affected by the presence of structures in the Offshore Project area. Because onshore seafood processors and distributors process catch from a broad geographic area and because the impact on specific fishing operations would vary and would not be industry-wide, BOEM expects that secondary impacts for employment on fishing vessels and at onshore seafood processing and distribution facilities would be moderate overall and would not be "high and adverse."

Many coastal communities along the New Jersey shore have a high level of recreational fishing engagement (Figure 3.12-4) and most of these communities do not contain an environmental justice population (Figure 3.12-1). Impacts on for-hire recreational fishing are also not "high and adverse," as impacts of the Proposed Action could include long-term, minor adverse and minor beneficial impacts for some for-hire recreational fishing operations due to space-use conflicts and the artificial reef effect, respectively. Therefore, BOEM has determined that impacts of the Proposed Action on for-hire recreational fishing would not be disproportionately "high and adverse" for environmental justice populations.

Based on analysis in Section 3.20, Proposed Action WTGs would have negligible to major impacts on viewer experience within the geographic analysis area. Views of WTGs would be sustained from many coastal communities along the New Jersey shore and would not disproportionately affect environmental justice populations. Therefore, BOEM has determined that impacts of the Proposed Action on viewer experience would not be disproportionately "high and adverse" for environmental justice populations.

3.12.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned activities.

Air emissions: As noted in Appendix F, other offshore wind projects using ports within the geographic analysis area would overlap with the Project's operations phase, and short-term air quality impacts during the construction phase would be likely to vary from minor to moderate levels. The impacts at specific ports close to environmental justice populations cannot be evaluated because port usage has not been identified; however, most air emissions would occur at offshore locations rather than at the ports. Generation of offshore wind energy within offshore wind lease areas for future offshore wind projects would result in greater potential displacement of fossil fuel power generation than the Proposed Action alone. In context of reasonably foreseeable environmental trends, the incremental impacts contributed by the Proposed Action to the combined air quality impacts on environmental justice populations from ongoing and planned activities including future offshore wind would likely be negligible to minor, due to short-term emissions near ports during construction and decommissioning, or at the O&M facility during operations. The proposed Project could also have beneficial effects for environmental justice populations, due to long-term reduction in air emissions from fossil fuel power generation.

Cable emplacement and maintenance: The incremental impacts contributed by the Proposed Action to the combined offshore cable emplacement impacts on environmental justice populations from ongoing and planned activities including future offshore wind would likely be short term and minor, resulting from the impact on subsistence fishing and reduced employment and income of workers employed in industries supporting commercial fishing. Because impacts of Proposed Action cable emplacement on environmental justice populations would be short term and minor, BOEM has determined that impacts of this IPF on environmental justice populations would not be "high and adverse" for the purpose of the environmental justice analysis.

Noise: Ongoing activities and future non-offshore wind activities would occasionally generate additional pile-driving noise near ports and marinas, some of which may be near environmental justice populations. Future offshore wind activities would have similar contributions as the Proposed Action over a wider area and longer time period. The increased impacts would affect commercial and for-hire recreational fishing and supporting marine businesses, resulting in impacts on employment and income (Sections 3.9, 3.11, and 3.18). The incremental impacts contributed by the Proposed Action to the combined pile driving impacts on environmental justice populations from ongoing and planned activities including future offshore wind would be negligible to minor, based on the assessment of potential impacts of pile driving on boating, fisheries, and supporting marine businesses. Because impacts of Proposed Action noise on environmental justice populations would be negligible to minor, BOEM has determined that impacts of this IPF on environmental justice populations would not be "high and adverse" for the purpose of the environmental justice analysis.

Presence of structures: The Proposed Action in combination with other offshore wind energy projects would result in a greater number of offshore structures affecting larger offshore areas. The Proposed Action would contribute a noticeable increment to the combined impacts on environmental justice populations from ongoing and planned activities, which are anticipated to range from minor to moderate adverse to minor beneficial.

3.12.5.3. Conclusions

Impacts of the Proposed Action. During construction and operation of the Proposed Action, impacts on commercial fishing from IPFs including the presence of structures, cable emplacement, and noise would vary depending on the fishery and fishing operation. The long-term presence of structures in the offshore environment and resulting space-use conflict with commercial fishing vessels could have long-term impacts on employment on fishing vessels that utilize the Lease Area and at onshore seafood processing and distribution facilities where commercial fishermen land their catch. Environmental justice populations with a high level of commercial fishing engagement have been identified in Atlantic City and Cape May. BOEM expects that the effect of reduced employment in commercial fishing would be moderate because environmental justice populations would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts. Potentially small and measurable minor beneficial impacts on environmental justice populations could result from port utilization and the resulting employment and economic activity at ports as well as from enhanced opportunities for for-hire recreational fishing due to the artificial reef effect.

Because the populations of Atlantic City and Cape May would be disproportionately affected by adverse impacts on commercial fishing due to the high level of commercial fishing engagement in Atlantic City and Cape May (and lower levels of engagement throughout most of the geographic analysis area), BOEM has determined that commercial fishing impacts on environmental justice populations in Atlantic City and Cape May would be disproportionate. However, because impacts are expected to be moderate, BOEM has determined that impacts would not be “high and adverse” for environmental justice populations. BOEM determined that impacts on for-hire recreational fishing would not be “high and adverse” and would also not disproportionately affect environmental justice populations due to expected minor impacts and high levels of recreational fishing engagement across the geographic analysis area.

The presence of offshore structures (WTGs and OSS) would have negligible to major impacts on viewer experience within the geographic analysis area; however, high and adverse impacts would not disproportionately affect environmental justice populations because viewer experience would be affected from many locations along the New Jersey shore and would not be concentrated in areas with environmental justice populations. Therefore, BOEM has determined that impacts of the Proposed Action on viewer experience would not be disproportionately “high and adverse” for environmental justice populations.

Overall, BOEM expects that impacts of the Proposed Action on environmental justice populations would be **moderate** because environmental justice populations would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts.

Cumulative Impacts of the Proposed Action. The Proposed Action in combination with other offshore wind energy projects would result in a greater number of offshore structures affecting larger offshore areas, and additional onshore construction and port utilization within the geographic analysis area. The Proposed Action would contribute a noticeable increment to the cumulative impacts on environmental justice populations, which are anticipated to be **moderate** overall.

3.12.6 Impacts of Alternatives B, C, and D on Environmental Justice

Impacts of Alternatives B, C, and D. The impacts resulting from individual IPFs associated with construction and installation, O&M, and decommissioning of the Project under Alternatives B-1, B-2, C-1, C-2, and D would be similar to those described under the Proposed Action. The construction of Alternatives B-1 and B-2 would install fewer WTGs (up to nine fewer WTGs for Alternative B-1; up to 19 fewer WTGs for Alternative B-2) and associated inter-array cables, which would reduce the construction impact footprint for WTGs by approximately 10 to 20 percent. Alternative C-1 would relocate eight WTGs, and Alternative C-2 would compress the WTG array layout. The construction of Alternative D would install up to 15 fewer WTGs and associated inter-array cables to avoid sand ridge and trough features, which would reduce the construction impact footprint for WTGs by approximately 15 percent, with reduced impacts on commercial fishing due to WTG removal from the sand ridge and trough habitat in the northeastern portion of the Lease Area. All other design parameters and potential variability in the design would be the same as under the Proposed Action.

During construction and operations, the impacts on environmental justice populations would range from minor to moderate adverse to minor beneficial. Negligible to minor impacts would result from disruption of marine activities during offshore cable installation and maintenance, from the impacts of noise on commercial and for-hire fishing, and from port utilization. Impacts of Alternatives B-1, B-2, C-1, C-2, and D would result in moderate impacts on environmental justice populations due to the long-term presence of structures in the offshore environment and secondary impacts on employment on fishing vessels or at onshore seafood processing and distribution facilities. Potentially minor beneficial impacts on environmental justice populations would result from port utilization and the resulting employment and economic activity at ports as well as from enhanced opportunities for for-hire recreational fishing due to the artificial reef effect.

Because the populations of Atlantic City and Cape May would be disproportionately affected by adverse impacts on commercial fishing due to the high level of commercial fishing engagement in Atlantic City and Cape May (and lower levels of engagement throughout most of the geographic analysis area), BOEM has determined that commercial fishing impacts on environmental justice populations in Atlantic City and Cape May would be disproportionate. However, because impacts are expected to be moderate, BOEM has determined that impacts would not be “high and adverse” for environmental justice populations. BOEM determined that impacts on for-hire recreational fishing would not be “high and adverse” and would also not disproportionately affect environmental justice populations due to expected minor impacts and high levels of recreational fishing engagement across the geographic analysis area.

The presence of offshore structures (WTGs and OSS) would have negligible to major impacts on viewer experience within the geographic analysis area; however, “high and adverse” impacts would not disproportionately affect environmental justice populations because viewer experience would be affected from many locations along the New Jersey shore and would not be concentrated in areas with environmental justice populations. Therefore, BOEM has determined that impacts of Alternatives B-1, B-2, C-1, C-2, or D on viewer experience would not be disproportionately “high and adverse” for environmental justice populations.

Cumulative Impacts of Alternatives B, C, and D. Alternatives B-1, B-2, C-1, C-2, or D in combination with other offshore wind energy projects would result in a greater number of offshore structures affecting larger offshore areas, and additional onshore construction and port utilization within the geographic analysis area. Alternatives B-1, B-2, C-1, C-2, or D would contribute a noticeable increment to the cumulative impacts on environmental justice populations, which are anticipated to range from minor to moderate adverse to minor beneficial, and would be moderate overall.

3.12.6.1. Conclusions

Impacts of Alternatives B, C, and D. Impacts of Alternatives B-1, B-2, C-1, C-2, and D would be similar to those of the Proposed Action for environmental justice populations and would range from minor to moderate adverse to minor beneficial, and are anticipated to be **moderate** overall. These action alternatives would not result in disproportionately “high and adverse” impacts on environmental justice populations.

Cumulative Impacts of Alternatives B, C, and D. Alternatives B-1, B-2, C-1, C-2, or D in combination with other offshore wind energy projects would result in a greater number of offshore structures affecting larger offshore areas, and additional onshore construction and port utilization within the geographic analysis area. These action alternatives would contribute a noticeable increment to the cumulative impacts on environmental justice populations, which are anticipated to be **moderate** overall.

3.12.7 Impacts of Alternative E on Environmental Justice

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. Under Alternative E, the export cable route on Island Beach State Park would require installation of the export cable along 0.38 mile of Island Beach State Park. The location of additional onshore cable installation would not occur in areas with environmental justice populations. Impacts of cable installation on Island Beach State Park would be localized and short term while the cables are being installed and BOEM does not anticipate impacts to be materially different than those described under the Proposed Action. The impacts of Alternative E would be the same as those of the Proposed Action for environmental justice populations. Impacts would range from minor to moderate adverse to minor beneficial for individual IPFs, and would be moderate overall.

Cumulative Impacts of Alternative E. The cumulative impact of Alternative E would be the same as described for the Proposed Action. Alternative E would contribute a noticeable increment to the cumulative impacts on environmental justice populations, which are anticipated to range from minor to moderate adverse to minor beneficial, and would be moderate.

3.12.7.1. Conclusions

Impacts of Alternative E. Impacts of Alternative E would be the same as those of the Proposed Action for environmental justice populations and would range from minor to moderate adverse to minor beneficial and are anticipated to be **moderate** overall. Alternative E would not result in disproportionately "high and adverse" impacts on environmental justice populations.

Cumulative Impacts of Alternative E. Alternative E would contribute a noticeable increment to the cumulative impacts on environmental justice populations, which are anticipated to be **moderate** overall.

3.12.8 Proposed Mitigation Measures

No additional measures to mitigate impacts on environmental justice have been proposed for analysis.

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3.13. Finfish, Invertebrates, and Essential Fish Habitat

This section discusses potential impacts on finfish, invertebrates, and EFH from the proposed Project, alternatives, and ongoing and planned activities in the geographic analysis area. The geographic analysis area, as shown on Figure 3.13-1, includes the Northeast Continental Shelf Large Marine Ecosystem (LME),[1] which extends from the southern edge of the Scotian Shelf (in the Gulf of Maine) to Cape Hatteras, North Carolina, is likely to capture the majority of movement ranges for most invertebrates and finfish species. The entirety of the geographic analysis area includes only U.S. waters. Due to the size of the geographic analysis area, the analysis in this EIS focuses on finfish and invertebrates that would be likely to occur in the Project area and be affected by Project activities.

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 USC 1802(10)). This section provides a qualitative assessment of the impacts of each alternative on finfish, invertebrates, and EFH, which has been designated under the MSA as "essential" for the conservation and promotion of specific fish and invertebrate species. More detailed information regarding the status of all species with EFH in the Project area and impacts on species listed under the ESA, as well as on EFH, can be found in the EFH Assessment (BOEM 2022a) and the BA (BOEM 2022b). A discussion of benthic species is provided in Section 3.6, *Benthic Resources*, and a discussion of commercial fisheries and for-hire recreational fishing is provided in Section 3.9, *Commercial Fisheries and For-Hire Recreational Fishing*.

3.13.1 Description of the Affected Environment for Finfish, Invertebrates, and Essential Fish Habitat

Finfish

The geographic analysis area was selected based on the likelihood of capturing the majority of movement range for most finfish species that would be expected to pass through the Project area. This area is large and has very diverse and abundant fish assemblages that can be generally categorized based on life history and preferred habitat associations (e.g., pelagic, demersal, resident, and highly migratory species). Benthic habitats within the Project area are characterized in Section 3.6, *Benthic Resources*. In general, the Project area is relatively flat with ridge and trough features that are found throughout the mid-Atlantic OCS. Sand waves are also present as small-scale microhabitats formed by prevailing currents and winds that are generally mobile slopes of sediment on the seabed (NYSERDA 2019). Sand waves documented in the Wind Farm Area have wavelengths of up to 1,640 feet (500 meters) and heights up to 4.9 feet (1.5 meters).

[1] LMEs are delineated based on ecological criteria including bathymetry, hydrography, productivity, and trophic relationships among populations of marine species, and NOAA uses them as the basis for ecosystem-based management.

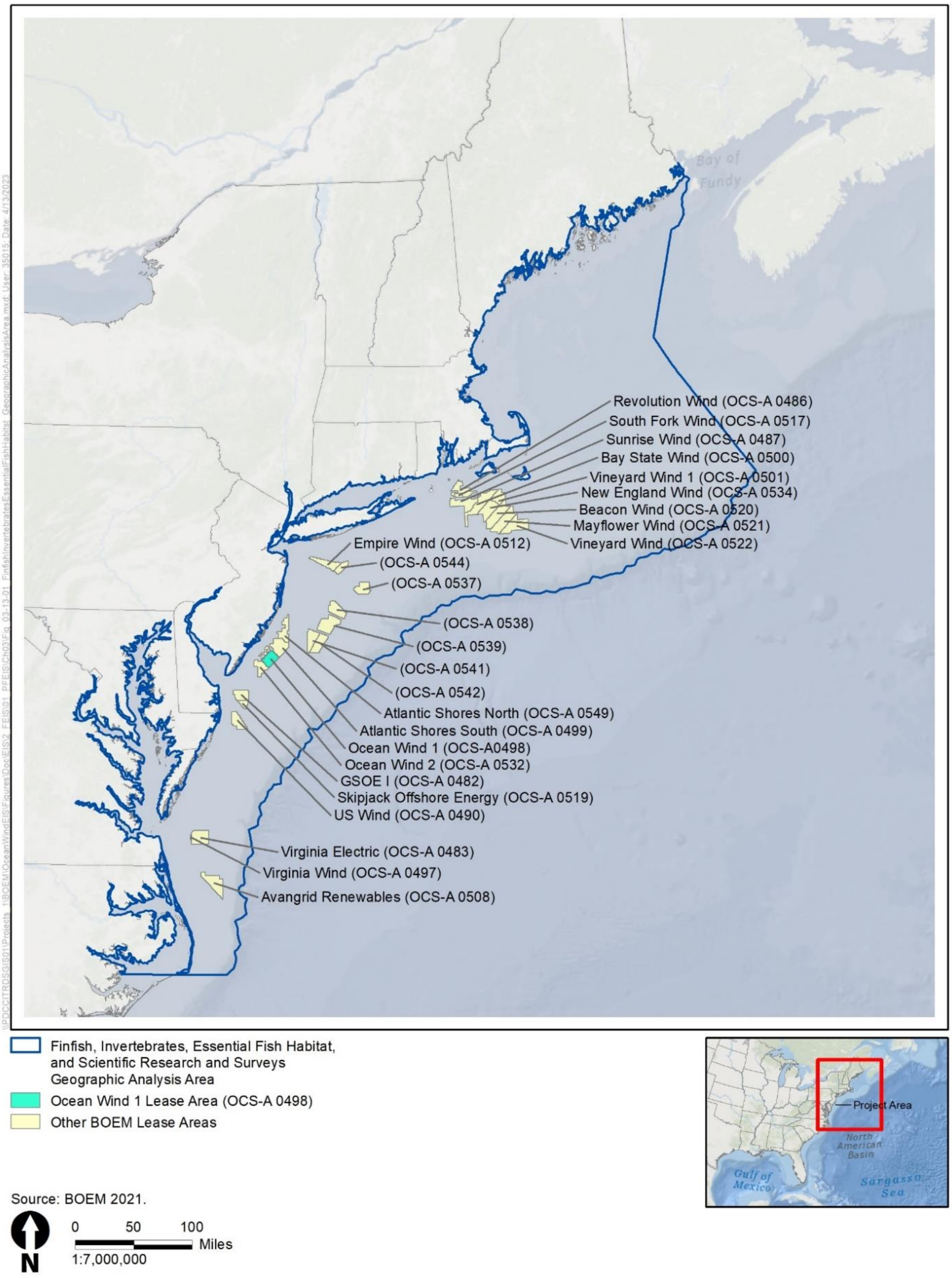

Figure 3.13-1 Finfish, Invertebrates, Essential Fish Habitat, and Scientific Research and Surveys Geographic Analysis Area

Sand ridges and troughs are closely oriented in a northeast-southwest direction, although side slopes are typically less than 1 degree (Guida et al. 2017). Ridge and trough habitat features are common in the Mid-Atlantic OCS and not unique to the Project area (Pickens et al. 2020). Sand ridge and trough features provide macroscale habitats for finfish and macro-invertebrates on the inner continental shelf of the U.S. Mid-Atlantic region and the Gulf of Mexico. These habitat complexes are described as transition zones that may enhance biological productivity and concentrate organisms at several trophic levels and are a link between the invertebrate community and the demersal fish assemblage (Byrnes et al. 2000). At a regional level, previous studies of the Mid-Atlantic Bight have found that ridge crests may be 5 meters or more higher than troughs (Byrnes et al. 2000), resulting in higher wave-generated currents and a graded substrate where much of the silt and clay have been removed, leaving a coarser substrate on the crests (when compared with the troughs). A 2022 survey (Inspire 2022a) of the ridge and trough habitats in the northeastern portion of the Lease Area indicated physical and biological differences between the crests (ridges) and troughs of these habitats that differed from the results of the previous regional study by Byrnes et al. (2000). The 2022 study found that in general, ridge crests were more homogeneous than troughs, and the sediments on the crests were primarily fine to medium sands compared with troughs that exhibited greater variation in sediments, ranging from very fine sand to sandy gravel. Sands with shells (shelly sand) were also found along the troughs.

Differences in benthic invertebrate assemblages in troughs, likely driven by differences in sediment characteristics, have been observed that include increased diversity and biomass within troughs (Rutecki et al. 2014). This may subsequently influence distribution of fish, as found by Vasslides and Able (2008) and Slacum et al. (2010), where within the large ridge and trough shoal complexes of the Mid-Atlantic Bight, there were greater fish abundance and diversity in the troughs than on the ridges. Similarly, species abundance on ridge tops was significantly lower than in areas on either side of the ridge in the southern New Jersey shoal complex (Vasslides 2007). Cutter and Diaz (2000) determined that troughs adjacent to shoals in the Mid-Atlantic Bight contained higher densities of benthic invertebrates than the shoals themselves, which likely provides greater availability of benthic forage and may be the primary reason for increased fish abundance and diversity in these habitats. Several artificial reefs are documented in the Project area. As shown on Figure 3.6-2 in Section 3.6, *Benthic Resources*, four artificial reef areas are mapped offshore, adjacent to the Oyster Creek offshore export cable corridor, and one is mapped offshore adjacent to the BL England offshore export cable corridor (COP Volume II, Section 2.2.3.1.5; Ocean Wind 2023).

Various inshore habitat types are crossed by the proposed Oyster Creek export cable, including shoals, intertidal, subtidal flats, and SAV. Intertidal and subtidal flats serve as important habitat to a diverse assemblage of infaunal and epifaunal organisms and also serve as a protective barrier against erosional impacts; additionally, intertidal and subtidal flats when submerged serve as critical grazing and predation habitat for finfish (Savarese n.d.). SAV is a highly productive habitat that is important to inshore fish production and acts as important nursery habitat for many fish species. Growth of SAV is limited by water depth/light penetration and wave/current energy (Long Island Sound Study 2003) and SAV is limited to the nearshore areas of Barnegat Bay, a back-bay estuary, and Peck Bay. Additional discussion of previously conducted studies related to SAV presence and density along the proposed export cable is provided in the EFH Assessment (BOEM 2022a) and COP Volume II, Appendix E (Ocean Wind 2023).

BOEM has funded several surveys of finfish species occurrence in the northeast WEAs, which are summarized by Guida et al. (2017). The Mid-Atlantic Bight region is identified as one of the most productive fishing areas along the East Coast of the United States, largely due to the diversity and density of finfish that occur in the region (NJDEP 2010). In this region, fish distribution is largely influenced by seasonal temperature fluctuation (NJDEP 2010). Furthermore, many recreationally and commercially important fishes thrive in the region due to coastal ecosystems such as estuaries, with features such as intertidal mudflats, salt marshes, and seagrass beds that provide nursery habitat for many of these species (NJDEP 2010).

A number of state- and federally managed fishes found within the geographic analysis area and potentially within the Project area include the following finfish species: American eel (*Anguilla rostrata*), Atlantic croaker (*Micropogonias undulatus*), Atlantic herring (*Clupea harengus*), Atlantic menhaden (*Brevoortia tyrannus*), Atlantic striped bass (*Morone saxatilis*), Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*), black drum (*Pogonias cromis*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus saltatrix*), cobia (*Rachycentron canadum*), scup (*Stenotomus chrysops*), shad (American shad [*Alosa sapidissima*] and hickory shad [*Alosa mediocris*]) and river herring (alewife [*Alosa pseudoharengus*] and blueback herring [*Alosa aestivalis*]), Spanish mackerel (*Scomberomorus maculatus*), monkfish (*Lophius* spp.), spiny dogfish (*Squalus acanthias*), spot (*Leiostomus xanthurus*), summer flounder (*Paralichthys dentatus*), tautog (*Tautoga onitis*), weakfish (*Cynoscion regalis*), winter flounder (*Pseudopleuronectes americanus*), and coastal shark species. The Project area is also host to important forage species such as sand lance (*Ammodytes* spp.), which have been found to be prey species to at least 45 species of fish in the northwest Atlantic Ocean (Staudinger et al. 2020). The Project area includes a portion of Barnegat Bay, an Estuary of National Importance under the National Estuary Program,[2] which is a regionally important estuary providing unique and diverse habitats, especially for early life stage development and survival. A recent study investigating the fish community and potential impacts from rapid urbanization around Barnegat Bay found 69 fish species within the bay throughout the spring, summer, and fall over a period of 3 years (Valenti et al. 2017). Moreover, this study determined that urbanization did not appear to be affecting fish populations; however, annual variation in recruitment and biotic factors could have cumulative impacts, masking the potential impacts of urbanization around Barnegat Bay (Valenti et al. 2017).

The outlook for finfish species throughout the geographic analysis area includes presumed increased anthropogenic pressure as human population size along the northeastern seaboard increases (Ecosystem Assessment Program 2012). Based on a 2021 MAFMC stock assessment document, most fishery stocks for the region are not overfished and ecosystem biomass trends are stable (NOAA 2021). However, ASMFC's most recent stock reports (those available) indicate that 13 of the total 26 species managed by ASMFC are currently overfished (ASMFC 2022). Species-selective harvesting has led to shifts in fish community composition, with dominant populations comprising small pelagic fish, skates, and small sharks, which are of relatively low economic value (NOAA 2009). To establish a general baseline of population conditions, the following discussion relates to fishery stocks for finfish species either known or considered likely to occur within the Project area; this is not an exhaustive list but is meant to provide context related to current fishery stocks. It is important to note that the population analysis is specific to the NEFMC management area, which extends to the Gulf of Maine, Georges Bank, and southern New England. The following species are identified as having populations above target population levels: monkfish, haddock, Atlantic pollock, Acadian redfish, red hake, and silver hake. Species identified as having populations either below or significantly below target population levels include Atlantic herring, Atlantic spiny dogfish, Atlantic cod, winter flounder, yellowtail flounder, Atlantic halibut, and white hake (NEFMC 2021).

Invasive species are those organisms introduced to new habitats from various vectors that produce harmful impacts on the natural marine ecosystem. While there have been no studies in offshore waters encompassing the geographic analysis area, invasive species are known to inhabit nearshore waters in this region and include species such as green crab, Asian shore crab, Chinese mitten crab, common periwinkle (*Littorina littorea*), and lionfish. In addition to these inshore or nearshore invasive species, there are few

[2] The National Estuary Program is a non-regulatory program established by Congress and authorized by Section 320 of the CWA in 1987.

instances of invasive offshore species; one of the most successful offshore invasive species is the colonial tunicate, *Didemnum* sp., which is not among the most dominant species in estuarine and coastal waters of the New England states (Pederson et al. 2005).

Warming of coastal and shelf waters is resulting in a northward shift in the distributions of some fish species that prefer cooler waters; based on future increases in surface water temperatures, it is expected that this trend would continue (Morley et al. 2018; Ecosystem Assessment Program 2012). Fish species managed by the NMFS Southeast Regional Office that may experience a northward shift toward the Project area and could ultimately be affected by the Project during operation and decommissioning include mahi mahi (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*), black sea bass, and Spanish mackerel (*Scomberomorus maculatus*). Trends of fish populations shifting toward the northeast and generally into deeper waters alter both species interactions and fishery interactions (Hare et al. 2016; NOAA 2021). Recent habitat climate vulnerability analyses link black sea bass, scup, and summer flounder to several highly vulnerable nearshore habitats including estuarine systems, suggesting that populations are facing additional pressures that could lead to further population decline (Hare et al. 2016; NOAA 2021). Multiple drivers interact with each fish species differently; however, underlying climate change is likely linked to these changes. Most notably, fishes such as striped bass and flounder species may be affected due to increased predation levels at early life stages, where warmer average winters may be affected fishery resources during critical life stages. Striped bass surveys suggest that recruitment success has decreased dramatically relative to the long-term average. Low recruitment could be caused by a mismatch in striped bass larval and prey abundance as a result of warm winter conditions, leading to decreased larval survival rates (NOAA 2021). Moreover, warm winters trigger early phytoplankton and zooplankton blooms, including key prey species for juvenile striped bass (NOAA 2021).

Many species of finfish belonging to pelagic, demersal, shark, resident, or highly migratory assemblages occur in the geographic analysis area, suggesting that these species could potentially occur within or pass through the Project area. Moreover, several species with potential to occur within the Project area have designated EFH either within or in the vicinity of the Project area (see BOEM 2022a). In addition to those species with designated EFH, several species of commercial and recreational importance would be expected to occur within the geographic analysis area and Project area, including but not limited to striped bass, which are discussed in further detail in Section I.2 of Appendix I.

Pelagic finfish species are generally schooling fish that occupy the surface to midwater depths (0 to 3,281 feet [0 to 1,000 meters]) from the shoreline to the continental shelf and beyond as juveniles and adults. Some species are highly migratory and may be present in the near-coastal and shelf surface waters of the Mid-Atlantic Bight in the summer, taking advantage of the abundant prey in the warm surface waters. Demersal fishes spend their adult life on or close to the ocean bottom. Common species of this assemblage include skates, summer flounder, and black sea bass. Highly migratory finfish species travel long distances and often cross domestic and international boundaries. Table 2.2.6-1 of the COP Volume II provides a summary of finfish species that could occur within the Project area and would therefore occur within the greater geographic analysis area (Ocean Wind 2023).

Finfish species are characterized as estuarine, marine, or anadromous species. Estuarine species generally reside in nearshore areas where waters have lower salinity levels than ocean waters (e.g., where rivers meet the ocean) and include species such as white perch (*Morone americana*) and juvenile bluefish (*Pomatomus saltatrix*). Marine finfish species are found offshore in deeper waters and utilize the open water column; examples of marine finfish include Atlantic menhaden (*Brevoortia tyrannus*) and Atlantic herring (*Clupea harengus*). Anadromous fish species prefer both nearshore and offshore waters but annually migrate up rivers to lower-salinity environments for spawning. Juvenile anadromous species leave coastal rivers and estuaries to enter the ocean, where they grow to sexual maturity prior to returning to freshwater environments for spawning. Several species of anadromous fish are present in the geographic analysis area and thus could occur in the Project area, including American shad, alewife, and striped bass. In addition to estuarine, marine, and anadromous fish species, less common are the catadromous species, which are fish species that behave in the opposite fashion of anadromous fish, where adults migrate from freshwater to spawn in the sea, such as the American eel (*Anguilla rostrata*), which are known to occur in riverine systems throughout New Jersey and make their way to the Atlantic Ocean to spawn (Able et al. 2015).

The only ESA-listed fish species considered for analysis in the BA (BOEM 2022b) for the Ocean Wind 1 Project is the federally listed as endangered Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). There are five distinct population segments (DPS) of Atlantic sturgeon present or likely to be present in the geographic analysis area. Four ESA-listed fish species that may occur in the Project area but eliminated from analysis due to their unlikely presence in the Project area and corresponding unlikely potential for adverse impacts were the endangered Gulf of Maine DPS of Atlantic salmon (*Salmo salar*), threatened giant manta ray (*Manta birostris*), threatened oceanic whitetip shark (*Carcharhinus longimanus*), and endangered shortnose sturgeon (*Acipenser brevirostrum*). Each of these species and rationale for elimination from further analysis are provided in the NMFS BA (BOEM 2022b). The findings presented in the BA for the Atlantic sturgeon are summarized here.

The Atlantic sturgeon has suffered significant population declines across its range as a result of historical overfishing and degradation of freshwater and estuarine habitats by human development (ASSRT 2007). Bycatch mortality, water quality degradation, and dredging activities remain persistent threats. Some populations are affected by unique stressors, such as habitat impediments and apparent ship strikes (ASSRT 2007). Critical habitat has been designated for the New York Bight DPS in the Delaware River that begins where the main stem of the river discharges into Delaware Bay at approximately river mile 48.5 (river kilometer 78) and stretches upriver to the Trenton-Morrisville Route 1 Toll Bridge at approximately river mile 132.5 (river kilometer 213.5) (NMFS 2021a).

Historical levels of abundance within the New York Bight DPS of Atlantic sturgeon sharply declined by the early 1900s as a result of a sharp increase in harvest. Based on harvest from 1880–1901, estimated 180,000 adult females were supported by the Delaware River prior to 1890. All DPSs of Atlantic sturgeon are considered depleted relative to historical levels, although all DPSs have demonstrated qualitative signs of improving populations such as increased presence of Atlantic sturgeon, including in rivers where species interactions had not been reported in recent years, and the discovery of spawning in rivers where it had not been previously documented (ASSRT 2007). The estimate of the 2014 Hudson River Atlantic sturgeon spawning run was 450 individuals; the annual run estimate of Atlantic sturgeon, accounting for skipped spawning, was found to be similar to the total adult population (873) (Kahnle et al. 2007) for the last decade of the commercial fishery.

More recently, however, the estimated number of adults in the Delaware River was believed to have declined to fewer than 300 individuals in 2007 (ASSRT 2007). Based on 1880–1901 harvest rates from New York, abundance was estimated at 6,000 spawning females in the Hudson River. The Atlantic Sturgeon Status Review Team (2007) estimated an abundance (using fishery-dependent data [1985–1995 for females and 1968–1995 for males] and sex-specific exploitation) of approximately 863 spawning adults in the Hudson River (267 mature females and 596 mature males). The Atlantic Sturgeon Status Review Team review reported that more recent estimates of recruitment have focused on river-specific (i.e., natal) populations to examine how populations have responded to the significant decline in biomass associated with directed harvest, bycatch, and habitat degradation/loss. Previous population estimates of age-1 Atlantic sturgeon in the Hudson River estimated the 1976 cohort at 25,647 individuals and 4,314 individuals in 1995, suggesting decline in recruitment. The Atlantic Sturgeon Status Review Team reported on several study estimates, including estimating the abundance of Delaware River age 0–1 Atlantic sturgeon at 3,656 individuals in 2014, which is similar in magnitude to the age-1 estimates in the Hudson River in 1995.

Invertebrates

Invertebrate resources assessed in this section include the planktonic zooplankton community and megafauna species that have benthic, demersal, or planktonic life stages. Macrofaunal and meiofaunal invertebrates associated with benthic resources are assessed in Section 3.6. The description of invertebrate resources is supported by studies conducted by Ocean Wind as well as other studies reviewed in the literature listed in Section I.3 of Appendix I. Benthic invertebrates within the geographic analysis area include polychaetas, crustaceans (e.g., amphipods, crabs, lobsters), mollusks (e.g., gastropods, bivalves), echinoderms (e.g., sand dollars, brittle stars, sea cucumbers), and various other groups (e.g., sea squirts, burrowing anemones) (Guida et al. 2017). Benthic invertebrates are commonly characterized by size (i.e., megafauna, macrofauna, or meiofauna). Macrofaunal and meiofaunal invertebrates associated with benthic resources are assessed in Section 3.6, *Benthic Resources*. In this section, the description of invertebrate resources focuses on the planktonic zooplankton community and megafauna species that have one or more of the following life stages: benthic, demersal, or planktonic.

Zooplankton

Zooplankton are a type of heterotrophic plankton in the marine environment that range from small, microscopic organisms to large species, such as jellyfish. These invertebrates play an important role in marine food webs and include both organisms that spend their whole life cycles in the water column and those that spend only certain life stages (larvae) in the water column (meroplankton). In the marine environment, zooplankton dispersion patterns vary on a large spatial scale (from meters to thousands of kilometers) and over time (hours to years). Zooplankton exhibit diel vertical migrations up to hundreds of meters; however, horizontal largescale distributions over large distances are dependent on ocean currents and the suitability of prevailing hydrographic regimes. Historical information is available for zooplankton in the vicinity of the offshore Project area, along with information from ongoing data collection surveys (e.g., the NEFSC Ecosystem Monitoring program surveys of the OCS and slope of the northeastern United States, i.e., the Mid-Atlantic Bight, Southern New England, Georges Bank, and the Gulf of Maine).

In the vicinity of the Offshore Project area, the zooplankton community tends to be dominated by copepods (NJDEP 2010). Zooplankton productivity, spatial distribution, and species composition are regulated by seasonal water changes off the New Jersey coast. Strong seasonal patterns with increased zooplankton biomass are observed in spring within the upper few hundred meters of the water column (NJDEP 2010). Maximum abundance tends to occur between April and May on the OCS and in August and September on the inner shelf. The lowest zooplankton densities occur in February (NJDEP 2010). Thermal stratification is seasonal, and when it breaks down, nutrients are released to the surface waters, driving seasonal patterns. High productivity is typical of the Northeast Continental Shelf LME, but productivity varies both spatially and seasonally. Large seasonal changes in water temperature occur in the Project area due to the influence of the Gulf Stream and ocean circulation patterns, which strongly regulate the productivity, species composition, and spatial distribution of zooplankton (NJDEP 2010). In 2021, for example, increasing zooplankton diversity in the Mid-Atlantic Bight was attributed to the declining dominance of a calanoid copepod (*C. typicus*), while the zooplankton community maintained a similar composition of other species (NOAA 2021). The temporal and spatial patterns of *Calanus* copepods (zooplankton) have been linked to the phases of the North Atlantic Oscillation, which has a direct effect on the position and strength of important North Atlantic Ocean currents (Fromentin and Planque 1996; Taylor and Stephens 1998). Shifts in copepod patterns can influence reproduction in marine mammals that depend on these zooplankton as a food resource (Greene et al. 2010).

A recent 3-year study of zooplankton in Barnegat Bay to characterize the zooplankton community found that the abundance and diversity of the estuarine zooplankton community was subject to spatial, seasonal, and interannual trends (Howson et al. 2017). The study concluded that bay zooplankton abundance can be sensitive to direct and indirect effects of weather and climate, such that climate change has the potential to result in long-term shifts in the zooplankton community. Changes in the nutrient status in areas of Barnegat Bay and habitat alteration have also resulted in an increase in gelatinous zooplankton and the development of resident populations of the Atlantic sea nettle (*Chrysaora quinquecirrha*) in the bay (Bologna et al. 2017), which can influence zooplankton communities.

Megafaunal Invertebrates Associated with Soft and Hard Substrates

Some megafaunal invertebrates found in the geographic analysis area are migratory (e.g., American lobster, Jonah crab, longfin inshore squid, and northern shortfin squid [*Illex illecebrosus*]), while others are sessile or have more limited mobility, meaning they would be expected to reside in the Project area (e.g., Atlantic scallop [*Placopecten magellanicus*], Atlantic surfclam [*Spisula solidissima*], ocean quahog [*Arctica islandica*], some crab species) (Section I.3 of Appendix I). Atlantic sea scallop, Atlantic surfclam, and ocean quahog were identified as shellfish species of concern for the New Jersey WEA by Guida et al. (2017). NEFSC seasonal trawl survey catches within the New Jersey WEA between 2003 and 2016 found that longfin squid were one of the dominant species in the warmer seasons along with some finfish species. In the colder seasons, finfish species were dominant (Guida et al. 2017). Notable seasonal temperature changes within the Northeast Continental Shelf LME influence the distribution and movement of invertebrates with latitudinal (north-south) seasonal migrations and longitudinal (inshore-offshore) seasonal migrations (NJDEP 2010). Resident species often exhibit adaptations to the changing environment within the New Jersey Continental Shelf and the Northeast Continental Shelf LMEs.

Highly mobile invertebrates with broad habitat requirements have more flexibility to respond to disturbance and anthropogenic impacts compared to other invertebrates that are more sensitive because they have limited mobility or require specific habitats during one or more life stages. This category includes commercially valuable shellfish species with limited mobility as juveniles and adults: Atlantic sea scallops, Atlantic surfclams, and ocean quahogs. Economically and ecologically important species associated with soft sediments in the vicinity of the Lease Area include Atlantic sea scallop, bay scallop (*Argopecten irradians*), horseshoe crab (*Limulus polyphemus*), Atlantic surfclam, squid, and ocean quahog. Sea scallops are widespread in the New Jersey WEA but were trawled up in small numbers in surveys summarized in Guida et al. (2017) and were not found to be abundant.

Other soft-sediment invertebrates include decapod crab species, sand dollars, starfish, and sea urchins. The majority of the Lease Area comprises soft-sediment habitats; however, hard substrates may also occur (NJDEP 2010). Hard substrates provide important nursery habitat for juvenile lobster and areas where squid species can attach egg masses, called mops (NJDEP 2010). Both squid and American lobster (*Homarus americanus*) are of economic importance. The commercial importance of other species, such as Jonah crab (*Cancer borealis*), has increased with the decline of the American lobster fishery. Jonah crabs are typically associated with rocky habitats as well as soft sediment, while lobsters prefer hard-bottom habitats.

Ecologically sensitive cobble and boulder habitat that can act as nursery areas for juvenile lobster and is preferable habitat for squid egg deposition was not observed within the Offshore Project area (Inspire 2021). Squid were documented at a few sampling stations within the Lease Area, and squid eggs were found at one offshore export cable corridor station. Live Atlantic surfclams and scallops were found within the Lease Area but were not observed within either export cable route corridor. A lobster was observed at one of the stations surveyed across the offshore Lease Area (Inspire 2021).

Blue crab and hard clam (quahog) (*Mercenaria mercenaria*) are recreationally and commercially harvested species that also have ecological importance in estuarine environments such as Barnegat Bay. Blue crabs are known to use both shallow and deeper habitats within Barnegat Bay, including shallow areas with SAV. Jivoff et al. (2017) found that SAV habitat was important for both adult male and female blue crabs but was particularly important for female crabs. The hard clam population has been in significant decline in the Barnegat Bay—Little Egg Harbor Estuary for decades, such that clams are absent from substantial areas of Little Egg Harbor. Bricelj et al. (2017) found no evidence that eutrophication and hypoxia were directly responsible for the decline and concluded an increase in clam mortality rate due to unknown cause(s) may have been a significant factor. The authors also acknowledged that there was a lack of documentation on historical fishing pressure. In a related study, Fantasia et al. (2017) found that algal food quality appeared to be more important for clam growth than total algal biomass.

General Biological Trends in Primary Invertebrate Species

The most recent trends in primary invertebrate species have been summarized by NOAA (2021, 2022) in the 2021 and 2022 State of the Ecosystem reports for the mid-Atlantic and recent information about individual invertebrate stock assessment is available through Stock SMART data records (www.st.nmfs.noaa.gov/stocksmart). For both information sources, the most recent invertebrate information was typically available for the years 2019, 2020, and 2021 but there was a delay in some analyses due to COVID-19.

- Climate-related stress is increasing, which is expected to affect stock distributions and is a warning sign for the potential for ecosystem-level changes. The mid-Atlantic has incurred more frequent and intense marine heatwaves and a less stable Gulf Stream. The cold pool is becoming warmer and smaller and occurs for a shorter time period, which can affect invertebrate species distributions.
- In general, finfish and invertebrate stocks are changing throughout the Northeast U.S. LME, with a general movement of stocks in a northeasterly direction and into deeper areas.
- Combined landings of surfclam and ocean quahog decreased in 2020, while landings of combined squid species increased. Since 2017 northern shortfin squid has been more available in the mid-Atlantic, with a higher fishery catch per unit effort.
- The analysis by NOAA (2022) concluded that the decline in surfclam and ocean quahog was not likely due to major shifts in feeding guilds, shifts in ecosystem trophic structure, stock status, or management restrictions. NOAA (2022) noted that climate change appears to be affecting distributions of surfclam and ocean quahog because both species are sensitive to warmer temperatures and acidification, although acidification in surfclam summer habitat is approaching (and not at) conditions that could potentially affect clam growth.

The diversity of zooplankton was found to be increasing in 2019 in the Mid-Atlantic Bight, driven by the decreasing dominance of a calanoid species. Krill and large gelatinous zooplankton are increasing over time.

Essential Fish Habitat

The MSA requires federal agencies to consult with NMFS on activities that could adversely affect EFH. NOAA defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NOAA 2004, 2013). NMFS, NEFMC, and MAFMC have defined EFH for various species in the Northeastern United States offshore and nearshore coastal waters. EFH designations have been described based on 10- by 10-foot (3- by 3-meter) squares of latitude and longitude along the coast. The majority of EFH for species occurring in the waters of the New England and Mid-Atlantic OCS and nearshore coastal waters is managed under federal FMPs developed by NEFMC and MAFMC (MAFMC 2020; NEFMC 2021). In addition to these species, several highly migratory species managed through an FMP developed by NMFS (NMFS 2021b) are known or likely to occur in the geographic analysis area.

BOEM has prepared an EFH Assessment for the Project (BOEM 2022a). In summary, EFH has been designated for the following species or management groups that occur in the New England and Mid-Atlantic OCS and nearshore coastal waters (NMFS 2021c):

- Atlantic herring (*Clupea harengus*)
- Bluefish (*Pomatomus saltatrix*)
- Highly migratory species (e.g., tunas [Thunnini], swordfish [*Xiphias gladius*], and sharks [Selachimorpha])
- Mackerel (*Scomber scombrus*), squids (Decapodiformes), and butterfish (*Peprilus triacanthus*)
- Monkfish (*Lophius americanus*)
- Northeast multispecies (large mesh) (e.g., Atlantic cod [*Gadus morhua*], Atlantic pollock [*Pollachius virens*], and windowpane flounder [*Scophthalmus aquosus*])
- Northeast multispecies (small mesh) (e.g., red hake [*Urophycis chuss*] and silver hake [*Merluccius bilinearis*])
- Shellfish, Atlantic sea scallop (*Placopecten magellanicus*), Atlantic surfclam (*Spisula solidissima*), and ocean quahog (*Arctica islandica*)
- Skates (Rajidae)
- Spiny dogfish (*Squalus acanthias*)
- Summer founder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*) and black sea bass (*Centropristis striata*)

NOAA, NEFMC, and MAFMC also identified HAPCs as a component of EFH. HAPCs are high-priority areas for conservation and exhibit one or more of the following characteristics: rare, sensitive, stressed by development, provide important ecological functions for federally managed species, or especially vulnerable to anthropogenic degradation. HAPCs can cover specific localities or cover habitat types that could be found at many locations (NOAA 2004). HAPCs that could be directly affected by Project activities include specific habitat for both juvenile and adult summer flounder. The summer flounder HAPC includes all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes (i.e., SAV) in any size bed, as well as loose aggregations, within currently designated adult and juvenile summer flounder EFH (MAFMC 2016). In New Jersey, sandbar shark HAPC is in the Mullica River estuary (Great Bay/Little Egg Harbor) and in Delaware Bay. The BL England export cable route would pass within 3.9 miles of the southernmost point of the Great Bay/Little Egg Harbor HAPC but would not overlap it.

In addition to SAV being an EFH HAPC, it is also a Special Aquatic Site under the CWA. SAV is an important inshore habitat component for many marine species. Once affected, SAV can be difficult to replace and such efforts are often deemed unsuccessful (Lefcheck et al. 2019). Seagrass loss has been attributed primarily to indirect impacts of anthropogenic activities, including global warming (e.g., seagrass wasting disease), sea-level rise, CO_2 and ultraviolet increase (Duarte 2002), degraded water quality and increased turbidity, shading, altered currents, resuspension of contaminated sediments, contamination from spills and discharges, and altered food webs and competition (Nascimento et al. 2019; Waycott et al. 2022). Therefore, avoidance and minimization of impacts on these habitats are important. SAV is discussed further in Section 3.6, *Benthic Resources*.

Although not yet approved by NOAA, NEFMC approved a new HAPC designation (July 20, 2022) that includes the entire geographic analysis area. The proposed Southern New England HAPC comprises all large-grained complex and complex benthic habitats used by Atlantic herring, Atlantic sea scallop, little skate, monkfish, ocean pout, red hake, silver hake, windowpane flounder, winter flounder, winter skate, and yellowtail flounder, wherever present within the area bounded by a 10-kilometer (6.2-mile) buffer around the Rhode Island/Massachusetts and Massachusetts WEAs (Plante 2022). The designation is intended to protect high-value complex habitats within this area, emphasizing currently known and potentially suitable areas used by Atlantic cod (*Gadus morhua*) for spawning, and is based a recent acoustic survey and other data sources (Bachman and Couture 2022; NEFMC 2022a). The proposed HAPC was considered necessary to provide conservation focus for specific NEFMC-managed species with EFH in the area due to concerns about impacts from offshore development, specifically offshore wind in the near term, and possible offshore aquaculture in the future (NEFMC 2022a). If approved by NOAA, the HAPC would include all areas in Southern New England with complex habitats, defined by NEFMC (2022b) as:

- Hard-bottom substrates, defined by the Coastal and Marine Ecological Classification Standard as Substrate Class Rock Substrate and by the four Substrate Groups: Gravels, Gravel Mixes, Gravelly, and Shell. This Coastal and Marine Ecological Classification Standard modifier was developed by NOAA Fisheries for its habitat mapping recommendations, including both large-grained and small-grained hard habitats.
- Hard-bottom substrates with epifauna or macroalgae cover.
- Vegetated habitats (e.g., SAV and tidal wetlands).

The proposed HAPC designation would apply within EFH designated for the following species and life stages with stock boundaries within the Southern New England area: Atlantic cod juveniles and adults; Atlantic herring eggs; Atlantic sea scallop eggs, juveniles, and adults; little skate juveniles and adults; monkfish juveniles and adults; ocean pout eggs, juveniles, and adults; red hake juveniles and adults; winter flounder eggs, juveniles, and adults; and winter skate juveniles and adults.

In addition to identifying, protecting, and restoring EFH and HAPC, to help maintain productive fisheries and rebuild depleted fish stocks in the United States, NOAA also conducts stock assessments to monitor the condition of federally managed fish stocks and provide the science information necessary for resource managers to sustainably manage commercial and recreational fisheries. Stock assessments for federally managed species potentially affected by the Project can be found on NMFS's Stock Status, Management, Assessment, and Resource Trends website (www.st.nmfs.noaa.gov/stocksmart) and NMFS's NEFSC Stock Assessment Review Index website (NEFSC 2021) and summaries are provided in the EFH Assessment (BOEM 2022a). Fishing regulations ensure that fishery removals are sustainable over the long term.

3.13.2 Environmental Consequences

3.13.2.1. Impact Level Definitions for Finfish, Invertebrates, and Essential Fish Habitat

Definitions of potential impact levels are provided in Table 3.13-1.

Table 3.13-1 Impact Level Definitions for Finfish, Invertebrates, and Essential Fish Habitat

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts on species or habitat would be so small as to be unmeasurable.
	Beneficial	Impacts on species or habitat would be beneficial but so small as to be unmeasurable.
Minor	Adverse	Most impacts on species would be avoided; if impacts occur, they may result in the loss of a few individuals. Impacts on sensitive habitats would be avoided; impacts that do occur would be temporary or short term in nature.
	Beneficial	If beneficial impacts occur, they may result in a benefit to some individuals and would be temporary to short term in nature.
Moderate	Adverse	Impacts on species would be unavoidable but would not result in population-level effects. Impacts on habitat may be short term, long term, or permanent and may include impacts on sensitive habitats but would not result in population-level effects on species that rely on them.
	Beneficial	Beneficial impacts on species would not result in population-level effects. Beneficial impacts on habitat may be short term, long term, or permanent but would not result in population-level benefits to species that rely on them.
Major	Adverse	Impacts would affect the viability of the population and would not be fully recoverable. Impacts on habitats would result in population-level impacts on species that rely on them.
	Beneficial	Beneficial impacts would promote the viability of the affected population or increase population resiliency. Beneficial impacts on habitats would result in population-level benefits to species that rely on them.

3.13.3 Impacts of the No Action Alternative on Finfish, Invertebrates, and Essential Fish Habitat

Section 3.1 of the Final EIS explains the approach to predicting impacts related to the No Action Alternative. When analyzing the impacts of the No Action Alternative on finfish, invertebrates, and EFH, BOEM considered the impacts of past and ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for finfish, invertebrates, and EFH. BOEM separately analyzes how resource conditions will be affected over time as reasonably foreseeable activities are implemented. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*. Separate impact conclusions are presented for both scenarios.

3.13.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for finfish, invertebrates, and EFH described in Section 3.13.1, *Description of the Affected Environment for Finfish, Invertebrates, and Essential Fish Habitat*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing activities within the geographic analysis area that contribute to impacts on finfish, invertebrates, and EFH are generally associated with commercial harvesting and fishing activities, fisheries bycatch, water quality degradation and pollution, effects on benthic habitat dredging and bottom trawling, accidental fuel leaks or spills, and climate change.

The effects of approved projects have been evaluated through previous NEPA review and are incorporated by reference. Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on finfish, invertebrates, and EFH include:

- Continued O&M of the Block Island project (five WTGs) installed in state waters;
- Continued O&M of the Coastal Virginia Offshore Wind project (two WTGs) installed in OCS-A 0497; and
- Ongoing construction of two offshore wind projects, the Vineyard Wind 1 project (62 WTGs and 1 OSS) in OCS-A 0501 and the South Fork project (12 WTGs and 1 OSS) in OCS-A 0517.

Ongoing O&M of the Block Island and Coastal Virginia Offshore Wind projects and ongoing construction of the Vineyard Wind 1 and South Fork projects would affect finfish, invertebrates, and EFH through the primary IPFs of accidental releases, anchoring, EMF, lighting, cable emplacement and maintenance, noise, port utilization, presence of structures, gear utilization, traffic (vessel strikes), and discharges. Ongoing offshore wind activities would have the same type of impacts from accidental releases, anchoring, EMF, lighting, cable emplacement and maintenance, noise, port utilization, presence of structures, gear utilization, traffic (vessel strikes), and discharges that are described in detail in Section 3.13.3.2 for planned offshore wind activities but the impacts would be of lower intensity.

Some mobile invertebrates can migrate long distances and encounter a wide range of stressors over broad geographical scales (e.g., longfin and shortfin squid). Their mobility and broad range of habitat requirements may also mean that limited disturbance may not have measurable effects on their stocks (populations). This would apply to finfish, where populations are composed largely of long-range migratory species; it would be expected that their mobility and broad ranges would preclude many temporary and short-term impacts associated with ongoing offshore impacts throughout the geographic analysis area. Invertebrates with more restricted geographical ranges or sessile invertebrates or life stages can be subject to the above stressors over time and can be more sensitive (Guida et al. 2017).

Seafloor habitat is routinely disturbed through dredging (for navigation, marine minerals extraction, and military purposes) and commercial fishing use of bottom trawls and dredge fishing methods. Abandoned or lost fishing gear remains in the aquatic environment for extended time periods, often entangling or trapping mobile invertebrate and fish species. Based on data from NOAA, bycatch affects many species throughout the geographic analysis area—most notably, windowpane flounder, blueback herring, shark species, and hake species; the majority of bycatch is a result of open area scallop trawls, large-mesh otter trawls, conch pots, and fish traps (NOAA 2019). Water-quality impacts from ongoing onshore and offshore activities affect nearshore habitats, and accidental spills can occur from pipeline or marine shipping. Invasive species can be accidentally released in the discharge of ballast water and bilge water from marine vessels. The resulting impacts on invertebrates and finfish depend on many factors but can be widespread and permanent, especially if the invasive species becomes established and outcompetes native species.

Regulated fishing effort: Fishing activity in the geographic analysis area is considered an ongoing activity that affects finfish and invertebrates through intensity of fishing and, potentially, distribution of finfish and invertebrates. Regulated fishing results in substantial removal of biomass of commercially regulated finfish and invertebrate populations, as well as impacts through bycatch and ghost fishing by abandoned and lost fishing gear. Fish regulations may also limit the removal of resources but would not necessarily eliminate the removal or lead to an increase in fisheries biomass. Changes to the management of commercial fisheries enforced by states, municipalities, or NOAA (depending on jurisdiction) could result in changes to the distribution and intensity of fishing-related impacts on finfish and invertebrate populations. However, the commercial fisheries buffer zone regulations and recreational catch limits are not expected to change or result in any population decline. Fishing regulations are not an IPF associated with the Proposed Action and positive and negative effects are therefore not analyzed here.

Traffic (vessel strikes): The presence of vessels introduces the risk of vessel collision with marine life, and vessel collisions with marine life are an ongoing threat in the geographic analysis area due to vessels from numerous industries such as trade, tourism, resource development, and offshore wind development. Marine species that spend a significant time near the water surface or in areas where vessel routes overlap with migration, feeding, or breeding grounds have the potential to be struck by vessels. Vessel collisions may result in blunt-force and sharp-force trauma, both of which can result in death, but are likely to be underrepresented due to a lack of reporting awareness and because not all struck marine animals are recoverable for documentation. Vessel speed reductions and route restrictions have shown to be effective mitigation measures for reducing the probability of injury and mortality related to vessel collisions. Impacts of vessel collisions can result in injury and mortality and may affect populations in some ESA-listed species.

Noise: In-water noise is transmitted through the water column and seabed would continue to occur as a result of ongoing activities in the geographic analysis area. Noise impacts for offshore wind projects would include short-term stress and behavioral changes as well as injury to and mortality of finfish and invertebrates, primarily in the vicinity of pilings. Sound transmission depends on many environmental parameters, such as the sound speeds in the water and substrates. It also depends on the sound production parameters of a pile and how it is driven, including the pile material, size (length, diameter, and thickness), and make and energy of the hammer (COP Volume III, Appendix R-2; Ocean Wind 2023). Fish response would be highest near impact pile driving (within tens of meters), moderate at intermediate distances (within hundreds of meters), and low far from the pile (within thousands of meters) (COP Volume III, Appendix R-2; Ocean Wind 2023). During active pile-driving activities, highly mobile finfish likely would be displaced from the area, most likely showing a behavioral response; however, fish in the immediate area of pile-driving activities could suffer injury or mortality. Affected areas would likely be recolonized by finfish in the short term following completion of pile-driving activity. Early life stages of finfish, including eggs and larvae, could experience mortality or developmental issues as a result of noise; however, thresholds of exposure for these life stages are not well studied (Weilgart 2018).

UXO interactions: UXO interactions would be expected to continue due to ongoing development of aquaculture, fishing, wind farms, power cables, and oil or gas pipeline development, as well as increasing ship traffic in general, resulting in an overall increase in the potential for interactions with UXO and the associated corrosion of UXO and subsequent release of their constituents to the marine environment and adverse impacts on marine habitats. Therefore, the potential for disturbance, injury, or mortality to fish and loss of habitat would also persist.

Climate change: Global climate change has the potential to affect the distribution and abundance of invertebrates and their food sources, primarily through increased water temperatures but also through changes to ocean currents and increased acidity. The New Jersey shelf has experienced increasingly elevated temperatures in both surface and bottom depths (NOAA 2021). Finfish and invertebrate migration patterns can be influenced by warmer waters, as can the frequency or magnitude of disease (Hare et al. 2016). Regional water temperatures that increasingly exceed the thermal stress threshold may affect the recovery of the American lobster fishery off the East Coast of the United States (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, northeastern 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, SAC, kelp, coral, and sponge habitats 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, SAV, 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 SAV habitats (Farr et al. 2021). As invertebrate habitat, finfish habitat, and EFH may overlap with these habitat types, this study suggests that marine life and habitats could experience dramatic changes and decline over time as impacts from climate change continue.

Table F1-11 in Appendix F provides additional information on finfish, invertebrates, and EFH impacts associated with ongoing activities.

3.13.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with planned activities (without the Proposed Action). Impacts of planned non-offshore wind projects are considered although cumulative impacts are attributable to primarily planned offshore wind projects. Planned non-offshore wind activities within the geographic analysis area that contribute to cumulative impacts on finfish, invertebrates, and EFH include new submarine cables and pipelines, tidal energy projects, marine minerals extraction, dredging, military use, marine transportation, fisheries use and management, global climate change, and oil and gas activities (see Section F.2 in Appendix F for a complete description of planned activities and Table F1-11 for additional information on finfish, invertebrates, and EFH impacts associated with planned activities).

BOEM expects planned offshore wind activities to affect finfish, invertebrates, and EFH through the primary IPFs of accidental releases, anchoring, EMF, lighting, presence of structures, cable emplacement and maintenance, noise, vessel traffic, and discharges.

Accidental releases: Offshore wind energy development could result in the accidental release of contaminants or trash/debris that could affect water quality. The risk of any type of accidental release would increase, primarily during construction but also during operations and decommissioning of offshore wind facilities (Section A.8.2 in Appendix A discusses the nature of releases anticipated). Hazardous materials that could be released include coolant fluids, oils and lubricants, and diesel fuels and other petroleum products. These materials tend to float in seawater, so they are less likely to directly contact the benthic environment; however, zooplankton communities and planktonic stages of invertebrates would be more likely to be exposed. Accidental release of contaminants such as trash and debris can also affect fish and invertebrates. Accidental release in the water column could also affect finfish species through consumption of material and smothering, both of which could result in mortality. Accidental releases could thus potentially result in lethal or sublethal effects, particularly on finfish and invertebrates, especially sensitive life stages such as planktonic larvae. Any accidental releases are expected to be localized and subject to mitigation to minimize environmental impacts. In most cases, the corresponding impacts on benthic habitats are unlikely to be detectable unless there is a catastrophic spill (e.g., an accident involving a tanker ship) or the spill involves heavy fuel oil that would sink to the seabed and persist in the aquatic environment for a longer time period. Compliance with USCG regulations would minimize the risk of accidental release of trash or debris. Therefore, with mitigation measures in place, the total volume of contaminants and trash or debris from accidental releases would be negligible and not measurably contribute to potential adverse impacts in the geographic analysis area.

A wide variety of marine vessels utilize anti-fouling and anti-corrosion paints to protect hulls from biofouling and corrosive processes induced by the marine environment in order to improve vessel longevity. Moreover, subsurface components of WTGs and OSS may also utilize anti-fouling and anti-corrosion coatings to prevent degradation of project components. Potential chemical leaching from anti-fouling and anti-corrosion coatings may cause toxic effects on finfish, invertebrates, and EFH. Increased offshore wind development could increase the potential toxic effect of anti-fouling and anti-corrosion coatings on marine organisms.

Epoxied resins and polyurethane-based coatings are a state-of-the-art technique for corrosion protection in a wide range of marine applications and are an artificial barrier to separate the steel from the corrosive environment (Lyon et al. 2017; Price and Figueira 2017). Organic compounds and Bisphenol A, common components of epoxied resins used in marine applications, were seen to leach from epoxy coatings in a laboratory setting (Bruchet et al. 2014; Rajasärkkä et al. 2016). Copper-based anti-fouling paints are also used in many marine applications and have replaced previous anti-fouling paints such as Tributyltin paints, which were found to have toxic effects on marine organisms (Alzieu et al. 1986; Michel and Averty 1999). Katranitsas et al. 2003 found copper-based anti-fouling paint to be substantially toxic to *Artemia nauplii.* Although the extent of emissions from anti-fouling and anti-corrosion coatings are currently unknown at scales such as the Wind Farm Area and greater WEA, increased usage of such coatings due to future wind generation activities may be a point source of toxic chemicals potentially affecting finfish, invertebrates, and EFH.

The overall impacts of anti-fouling and anti-corrosion paints on finfish, invertebrates, and EFH at the scale of the Wind Farm Area and greater WEA require further evaluation and are difficult to adequately quantify; however, impacts are likely to be negligible, resulting in little change to these resources. As such, anti-fouling and anti-corrosion paints used during offshore wind development processes would not be expected to appreciably contribute to population-level impacts on these resources.

Another potential impact related to vessels and vessel traffic is the accidental release of invasive species, especially during ballast water and bilge water discharges from marine vessels. Increasing vessel traffic related to the offshore wind industry would increase the risk of accidental releases of invasive species, primarily during construction. Vessels are required to adhere to existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR 151.2025) and USEPA National Pollutant Discharge Elimination System Vessel General Permit standards, both of which aim at least in part to prevent the release and movement of invasive species. Adherence to these regulations would reduce the likelihood of discharge of ballast or bilge water contaminated with invasive species. Although the likelihood of invasive species becoming established due to offshore wind activities is low, the impacts of invasive species invertebrates could be strongly adverse, widespread, and permanent if the species were to become established and out-compete native fauna. The increase in this risk related to the offshore wind industry would be small in comparison to the risk from ongoing activities (e.g., trans-oceanic shipping).

The cumulative impacts of accidental releases on finfish, invertebrates, and EFH are likely to be localized and short term, resulting in little change to these resources. As such, accidental releases from offshore wind development would not be expected to appreciably contribute to cumulative impacts on these resources, and impacts would be minor.

Anchoring: There would be increased vessel anchoring during survey activities and during the construction, installation, maintenance, and decommissioning of offshore components associated with planned offshore wind activities. In addition, anchoring/mooring of meteorological towers or buoys could be increased. Anchoring causes temporary disturbance to seafloor, which would be considered temporary, short-term impacts that occur regularly throughout the geographic analysis area. These activities would increase turbidity and could result in direct mortality of benthic, finfish, and invertebrate resources or degradation of sensitive hard-bottom habitats, including EFH. Anchoring would cause increased turbidity levels and would have the potential for physical contact to cause lethal or sublethal effects on invertebrates. Planned offshore wind projects could disturb up to 3,057 acres (12.4 km^2) of seafloor habitat, increasing turbidity and potentially disturbing, displacing, or injuring benthic habitat, finfish, and invertebrates. This disturbance would be localized and temporary, representing considerably less than 1 percent of the total available benthic habitat within the geographic analysis area. Potential impacts would be minimized by the implementation of mitigation measures. For finfish specifically, it is unlikely that adult fish would be directly affected by anchoring and impacts would be negligible. However, less-mobile life stages such as eggs and larvae could experience direct mortality or smothering from turbidity with impacts occurring at a local, small scale, not at population or species level, and they would be temporary, minor, and localized. It would be expected that recovery of any affected species would occur in the short term, although degradation of sensitive habitats could persist in the long term.

Physical seabed disturbance due to anchoring would generally result in localized and temporary impacts on invertebrate resources, with recovery in the short term, with the exception of sensitive inshore habitats such as areas where SAV is present. Anchoring in SAV could cause loss of sensitive habitat, resulting in long-term impacts. Studies related to the impacts of recreational boating in the Mediterranean Sea indicate that anchoring (and chains associated with anchors) was the largest human-related impact affecting sensitive habitats, which include seagrass meadows (Carreno and Lloret 2021). Mobile invertebrates would be temporarily displaced, whereas sessile and slow-moving invertebrates could be subject to localized lethal and sublethal impacts. Demersal eggs and larvae would be particularly vulnerable to sediment disturbance and resettlement. High rates of mortality can occur in longfin squid egg masses if exposed to abrasion.

Impacts would be expected to be localized, turbidity would be temporary, and mortality of sessile invertebrate and life stages from contact would be recovered in the short term. Degradation of sensitive habitats, such as eelgrass beds and hard-bottom habitats, if it occurs, could be long term to permanent. The cumulative impacts of anchoring on finfish, invertebrates, and EFH are likely to be minor, localized, and short term.

EMF: The marine environment continuously generates a variable ambient EMF. Additional EMF would also emanate from new offshore export cables and inter-array cables constructed for offshore wind projects. Up to 10,953 miles (17,627 kilometers) of cable would be added in the geographic analysis area from planned offshore wind activities, producing EMF in the immediate vicinity of each cable during operations. BOEM would require future submarine power cables to have appropriate shielding and burial depth to minimize potential EMF effects from cable operation. EMF effects from these planned projects on finfish, invertebrates, and EFH would vary in extent and significance depending on overall cable length, the proportion of buried versus exposed cable segments, and project-specific transmission design (e.g., HVAC or HVDC, transmission voltage). EMF strength diminishes rapidly with distance, and EMF that could elicit a behavioral response in an organism would likely extend less than 50 feet (15.2 meters) from each cable. When submarine cables are laid, installers typically maintain a minimum separation distance of at least 330 feet (100 meters) from other known cables to avoid inadvertent damage during installation, which also precludes any additive EMF effects from adjacent cables.

Population-level impacts on finfish have not been documented for EMF from alternating current cables (CSA Ocean Sciences, Inc. and Exponent 2019). There is no evidence to indicate that EMF from undersea alternating current power cables adversely affects commercially and recreationally important fish species within the southern New England area (CSA Ocean Sciences, Inc. and Exponent 2019). A more recent review by Gill and Desender (2020) supports these findings, where fish were found to be affected by EMF at high intensity for a small number of individual finfish species; however, response in finfish was not found to occur at the EMF intensities associated with marine renewable energy projects. For example, behavioral impacts have been documented for benthic species such as skates near operating direct current cables (BOEM 2018; Hutchison et al. 2020). Skates exhibited changes in behavior in the form of increased exploratory searching and slower movement speeds near the EMF source, but EMFs did not appear to present a barrier to animal movement.

To date, the effects of EMF on invertebrate species have not been extensively studied, and studies of the effects of EMF on marine animals have mostly been limited to commercially important species such as lobster and crab (e.g., Love et al. 2017; Hutchison et al. 2020). Burrowing infauna may be exposed to stronger EMFs, but scientific data are limited. Recent reviews by Gill and Desender (2020), Albert et al. (2020), and CSA Ocean Sciences, Inc. and Exponent (2019) of the effects of EMF on marine invertebrates in field and laboratory studies concluded that measurable effects can occur for some species, but not at the relatively low EMF intensities representative of marine renewable energy projects. For example, behavioral impacts were documented for lobsters near a direct current cable (BOEM 2018) and a domestic electrical power cable (Hutchison et al. 2020), including subtle changes in activity (e.g., broader search areas, subtle effects on positioning, and a tendency to cluster near the EMF source), and only when the lobsters were within the EMF. There was no evidence of the cable acting as a barrier to lobster movement and no effects were observed for lobster movement speed or distance traveled. Additionally, faunal responses to EMF by marine invertebrates, including crustaceans and mollusks (BOEM 2018; Taormina et al. 2018; Normandeau et al. 2011), include interfering with navigation that relies on natural magnetic fields, predator/prey interactions, avoidance or attraction behaviors, and physiological and developmental effects (Taormina et al. 2018).

Other studies have found that EMF does not affect invertebrate behavior. For example, Schultz et al. (2010) and Woodruff et al. (2012, 2013) conducted experiments exposing American lobster and Dungeness crab (*Metacarcinus magister*) to EMF ranging from 3,000 to 10,000 milligauss and found that EMF did not affect their behavior. Assuming the other wind projects with HVAC cables in the geographic analysis area have similar array and export cable voltages as the Proposed Action, the induced magnetic field levels expected for the offshore wind projects are two to three orders of magnitude lower than those tested by Schultz et al. (2010) and Woodruff et al. (2012, 2013). Similarly, a field experiment in Southern California and Puget Sound, Washington, found no evidence that the catchability of two crab species was influenced by the animals crossing an energized low-frequency submarine alternating current power cable (35 and 69 kV, respectively) to enter a baited trap. Whether the cables were unburied or lightly buried did not influence the crab responses (Love et al. 2017). While these voltages are between two and eight times lower than those proposed for the Project, the array and export cables for the Project would be shielded and buried at depth to reduce potential EMF from cable operation.

Impacts of EMF on benthic habitats is an emerging field of study; as a result, there is a high degree of uncertainty regarding the nature and magnitude of effects on all potential receptors (Gill and Desender 2020). Recent reviews by Bilinski (2021), Gill and Desender (2020), Albert et al. (2020), and Snyder et al. (2019) of the effects of EMF on marine organisms in field and laboratory studies concluded that measurable, though minimal, effects can occur for some species, but not at the relatively low EMF intensities representative of marine renewable energy projects. Behavioral impacts from EMF, though observed at higher levels than are representative of offshore wind projects, were documented for lobsters near a direct current cable (BOEM 2018) and a domestic electrical power cable (Hutchison et al. 2020), including subtle changes in activity (e.g., broader search areas, subtle effects on positioning, and a tendency to cluster near the EMF source). There was no evidence of the cable acting as a barrier to lobster movement and no effects were observed for lobster movement speed or distance traveled. Additionally, faunal responses to EMF by marine fauna, including crustaceans and mollusks, include attraction to the source, interference with navigation that relies on natural magnetic fields, predator/prey interactions, avoidance or attraction behaviors, increased burrowing by polychaetes, increased exploratory and foraging behavior, and physiological and developmental effects (Bilinski 2021; Jakubowska et al. 2019; BOEM 2018; Taormina et al. 2018; Normandeau et al. 2011). Burrowing infauna and finfish may be exposed to stronger EMF, but little information is available regarding the potential consequences. Non-mobile infauna would be unable to move to avoid EMF. A recent study concludes that impacts on finfish from EMF are minor or short term, specifically for species that are known to sense EMF more acutely than pelagic fish species, such as elasmobranchs and benthic species (Bilinski 2021). This study indicated that impacts were limited to minor responses in elasmobranchs and benthic species, which included attraction to cabled areas. It is important to reiterate that EMF impacts on finfish have not been extensively studied and it remains unknown if finfish experience physiological impacts, what life stages of finfish are most affected by EMF, and if long-term impacts develop later in life (Bilinski 2021). Any effects, however, would be localized and would not have population-level impacts due to the small spatial scale of the impact relative to the available benthic habitat in the geographic analysis area.

EMF levels would be highest at the seabed and in the water column above cable segments that cannot be fully buried and are laid on the bed surface under protective rock or concrete blankets. Invertebrates in proximity to these areas could experience detectable EMF levels and minimal associated behavioral effects. These unburied cable segments would be short and widely dispersed. CSA Ocean Sciences, Inc. and Exponent in 2019 found that offshore wind energy development as currently proposed would have negligible effects, if any, on bottom-dwelling finfish and invertebrates residing within the southern New England area. For pelagic species within the same area, no negative effects were expected from offshore wind energy development as currently proposed because of their preference for habitats located at a distance from the seabed.

The information summarized above indicates that EMF impacts on finfish, invertebrates, and EFH would be biologically insignificant, highly localized, and limited to the immediate vicinity of cables and would be undetectable beyond a short distance; however, localized impacts would persist as long as cables are in operation. Most exposure is expected to be of short duration, and the affected area would represent an insignificant portion of the available habitat for finfish and mobile invertebrate species; therefore, cumulative impacts on finfish, invertebrates, and EFH would be expected to be negligible.

Lighting: Light can attract finfish and invertebrates, including potential prey for finfish, further acting as an attractant for finfish. As such, light could potentially affect finfish movement in highly localized areas. Light can also affect natural reproductive cycles for finfish, e.g., spawning; however, light would need to be persistent and present for long periods of time to influence natural reproductive cycles (Longcore and Rich 2004). Light is important in guiding the settlement of invertebrate larvae, and artificial light can change the behavior of aquatic invertebrates such as squid, although the direction of response can be species and life stage specific. Planned activities include up to 2,952 offshore WTGs in the geographic analysis area. Construction and O&M of these structures would introduce short-term and long-term sources of artificial light to the offshore environment in the form of vessel lighting and navigation and safety lighting on offshore WTGs. Zooplankton diel migration and movement may be also influenced by changes in light exposure. Offshore wind development would result in increased light from offshore structures and vessels. Vessels would be lit during construction, maintenance, and decommissioning. Impacts from vessel lighting would likely be insignificant relative to activities not related to offshore wind that occur throughout the geographic analysis area. Furthermore, potential impacts from lighting would be anticipated to have little impact on finfish and invertebrates during daylight hours and would be limited by the depth of the water in the offshore wind lease areas.

The cumulative impacts of light on finfish, invertebrates, and EFH are likely to be negligible, localized, and short term, resulting in little change to these resources. As such, light from offshore wind development would not be expected to appreciably contribute to cumulative impacts on these resources and impacts would be negligible.

Cable emplacement and maintenance: Dredging for cable emplacement results in short-term, localized impacts, such as habitat alteration and change in complexity, on finfish, invertebrates, and EFH such as SAV. Dredging would be expected to occur most often in areas of sand waves where jet plowing would not be sufficient to meet target burial depths for cables. It would be expected that plumes of sediment resulting from dredging activities would redeposit to areas composed of similar sediments, due to the sandy nature of the seafloor throughout much of the geographic analysis area. Sandy or silty habitats, which are abundant in the geographic analysis area, are quick to recover from dredging disturbance. According to Newcombe and MacDonald (1991), impacts from settlement of resuspended sediment plumes increase with the concentration of resuspension and the duration over which invertebrates are exposed to that plume. When studying the dredge plume dynamics of New York/New Jersey Harbor, USACE (2015) noted that sediment concentrations decreased exponentially with time and distance in the down-current direction (within 15 minutes of release, concentrations were noted to be less than 50 milligrams per liter [mg/L]). Resuspension of coarse-grained sands within the offshore wind lease areas is expected to be limited in duration, resulting in a relatively short exposure of finfish and invertebrates to the plume. Seabed profile alterations could cause long-term or permanent impacts on EFH. Mechanical trenching, used in more resistant sediments (e.g., gravel, cobble), causes seabed profile alterations during use, although the seabed is typically restored to its original profile after utility line installation in the trench. Habitat function in most of these areas would be expected to recover in the short term following dredging activities.

Cable installation through SAV beds would be expected to result in long-term, potentially permanent habitat loss due to the slow rate of recovery in seagrasses. A study of 33 seagrass restorations ranging in age from 3 to 32 years found that 88 percent of restoration projects continued to support seagrass, although restored percentage cover values were 37 percent lower than references (Rezek et al. 2019). Restoration from vessel damage recovered to reference conditions, while beds with sediment modification had significantly lower diversity than reference beds. The authors concluded that restored seagrass beds, once established, often exhibit long-term persistence, but survival of seagrass in the early stages of projects is important to success. Therefore, it would be anticipated that habitat alterations resulting from dredging would have negligible to minor impacts on finfish and invertebrates that would be temporary or short term; however, long-term or permanent impacts on EFH (e.g., SAV) are possible.

Dredging activities result in plumes of sediments into the water column that will eventually settle on the seafloor (estimated to last 1 to 6 hours at a time, after which the sediment is deposited on the seafloor). Additional activities such as trenching for new cables, as well as maintenance activities, also periodically disturb sediments. In general, sediment plumes are localized, which results in larger and coarser sediment falling out of the water column and settling on the seafloor in the area near or immediately adjacent to the activity, while smaller, fine sediments may remain suspended in the water column for a longer time period before settling potentially at a greater distance from the disturbance. In addition to dredging, pile-driving activities can produce sediment plumes that would result in sediment deposition and burial of invertebrates and non-motile organisms and life stages, such as benthic eggs and larvae. Additional discussion related to effects from turbidity and sedimentation is provided in the EFH Assessment (BOEM 2022a).

Finfish are unlikely to be affected by sediment deposition or burial; however, sessile life stages of some finfish such as eggs and larvae could be smothered by sediments, causing mortality. Impacts would be expected to vary by time of year, based on when any finfish species may spawn. Additionally, visual predators and suspension feeders could be affected by sediment plumes on a short-term and temporary basis where hunting/foraging success could decrease; however, it would be expected that sediment deposition would occur relatively quickly due to the mostly coarse nature of sediments in the geographic analysis area. Impacts due to sediment deposition and burial would be considered negligible to minor, localized, and temporary or short term.

Dredging activities associated with cable installation could affect the Atlantic sturgeon through impingement, entrainment, and capture associated with mechanical and hydraulic dredging techniques. Impacts on the Atlantic sturgeon from cable emplacement and maintenance may include temporary habitat disturbance, turbidity, and loss of prey. Adult Atlantic sturgeon are expected to be well distributed throughout the Project area (Dunton et al. 2010). Ingram et al. (2019) tagged Atlantic sturgeon off the New York WEA using acoustic tags to track the movement of fish seasonally from November 2016 through February 2018. Their study showed that offshore migrations peaked from November through January and were uncommon or entirely absent during July to September. While Atlantic sturgeon are known to be struck and killed by vessels in rivers and estuaries, there are no reports of vessel strikes in the marine environment, likely due to the space between bottom-oriented sturgeon and the propellers and hulls of vessels (BOEM 2021). Dunton et al. (2010) reported that approximately 95 percent of all Atlantic sturgeon captured in sampling off New Jersey occurred in depths less than 66 feet (20 meters), with the highest catch per unit of effort at depths of 33 to 49 feet (10 to 15 meters). At these depths in open coastal and marine environments, which would not constrain the distribution or movement of Atlantic sturgeon, they are not likely to be struck by vessels.

Sturgeon forage at the sediment (Dadswell 2006). This behavior may increase the susceptibility of capture with a dredge bucket. For entrapment to occur, an individual sturgeon would have to be present directly below the dredge bucket at the time of operation. As such, entrapment of sturgeon during the temporary performance of mechanical dredging operations is unlikely. Due to their bottom foraging and swimming behavior, adult Atlantic sturgeon have been known to become entrained in hydraulic-cutterhead dredges as they move across the seabed (Novak et al. 2017; Balazik et al. 2020; NMFS 2022). Given the need for a sturgeon to approach within 1 meter of the dredge head to become entrained and the lack of attraction or deterrence relationship observed between Atlantic sturgeon and dredges, the likelihood of effects on Atlantic sturgeon from dredging is low (Balazik et al. 2020; NMFS 2022). Therefore, an Atlantic sturgeon becoming entrained in a mechanical dredge is considered unlikely to occur.

Atlantic sturgeon prey upon small, bottom-oriented fish such as the sand lance, mollusks, polychaete worms, amphipods, isopods, and shrimp, with polychaetes and isopods being the primary and important groups consumed in the Project area (Smith 1985; Johnson et al. 1997; Dadswell 2006). Sand lances could become entrained in a hydraulic dredge due to their bottom orientation and burrowing within sandy sediments that require clearing. Reine and Clarke (1998) found that not all fish entrained in a hydraulic dredge are expected to die. Studies summarized in Reine and Clarke (1998) indicate a mortality rate of 37.6 percent for entrained fish. It is expected that dredging in sandwaves to allow for cable installation would result in the entrainment and mortality of some sand lances. However, it is expected any impact of the loss of Atlantic sturgeon prey items to be so small that it cannot be meaningfully measured, evaluated, or detected.

Prior to cable emplacement, seabed preparation often requires mapping and subsequent removal of obstructions along the cable route. UXO (e.g., bombs, bullets, shells, grenades, mines) is often present on the ocean floor (as described in Section 3.6, *Benthic Resources*). If UXO cannot be avoided, removal or detonation may be required. UXOs that are exploded in place disturb the ocean floor and can result in habitat loss, reduced water quality, and physical disturbance, harm, and mortality in fish and marine invertebrates. A UXO blast in a Scotland offshore wind farm mobilized sediments into the water column in the vicinity of the explosion, although high sediment suspension was reportedly short lived and smaller in magnitude than the effects of a storm event (Beatrice Offshore Windfarm 2016). Other effects reported for the same offshore wind farm included loss of benthic habitat due to sediment suspension and deposition in addition to the seafloor disturbance, although the recovery of the seafloor due to inputs from surrounding unaffected areas was anticipated to be rapid. An assessment of the sediments found no raised levels of any hydrocarbon or metals across the wind farm and concluded the potential effects of resuspended sediment contaminants on benthic resources were negligible.

UXO clearance activities during critical periods can affect spawning or migration behavior in fish. At the Beatrice Offshore Windfarm, UXO clearance was undertaken outside the spawning window and no impacts on cod spawning were anticipated. UXO clearance activities may result in temporary loss or disturbance of spawning, nursery, or feeding habitat. The clearance of UXO has the potential to result in the loss of benthic habitat in the vicinity of the blast site that is of importance to fish species. This impact is, however, predicted to be highly localized and therefore would not result in substantial areas of seabed being disturbed. Following disturbance, levels of suspended sediment in the water column are not expected to be substantially higher than background levels and the sandy and coarse sand sediments would settle back to the seabed relatively rapidly. Given the relatively high susceptibility of eggs and larvae to suspended and resettling sediment, there is the potential for early life stages to be affected.

Dredging and mechanical trenching used in the course of cable installation could cause localized, short-term impacts (habitat alteration, lethal and sublethal effects) on invertebrates through sediment deposition and seabed profile alterations. Sediment deposition could result in adverse impacts on invertebrates, including smothering. The tolerance of invertebrates to being covered by sediment (sedimentation) varies among species and life stage. Some sessile shellfish may only tolerate 0.4 to 0.8 inch (1 to 2 centimeters), while other benthic organisms can survive burial in upward of 7.9 inches (20 centimeters) (Essink 1999). Demersal eggs and larvae would be particularly vulnerable to sediment disturbance and resettlement. For example, high rates of mortality can occur in longfin squid egg masses if exposed to abrasion. For migratory invertebrate species, impacts would be expected to vary by time of year, based on the species' presence in the vicinity of the dredge area. Dredged material disposal during construction, if any occurs in the geographic analysis area, would cause localized, temporary turbidity increases and long-term sedimentation or burial of invertebrates at the immediate disposal site. The impacts of burial would be mostly short term with less potential for long-term impacts.

Cable emplacement and maintenance activities (including dredging) would disturb sediments and cause sediment suspension, which could disturb, displace, and directly injure finfish species and EFH. Short-term disturbance of seafloor habitats could disturb, displace, and directly injure or result in mortality of invertebrates in the immediate vicinity of the cable-emplacement activities. Sediment disturbance and resettlement could also affect eggs and larvae, particularly demersal eggs such as longfin squid eggs, which have high rates of mortality if egg masses are exposed to abrasion. When new cable emplacement and maintenance cause resuspension of sediments, increased turbidity could have an adverse impact on filter-feeding fauna such as bivalves. Depending on the substrate being disturbed, invertebrates could be exposed to contaminants via the water column or resuspended sediments, but effects would depend on the degree of exposure.

Cable emplacement and maintenance activities could result in short-term, temporary impacts and over time may result in long-term habitat alterations. The intensity of impacts would be dependent on multiple factors, including time of year, sediment type, and habitat type being affected where activities occur. For example, sand is the predominant sediment type within the New Jersey WEA (Guida et al. 2017), so disturbed sediments would be expected to settle out of the water column relatively quickly and travel shorter distances than if the seabed was dominated by finer sediments (mud). The impact of increased turbidity on invertebrates depends on both the concentration of suspended sediment and the duration of exposure. Plume modeling completed for other wind development projects within the region and with similar sediment characteristics (Vineyard Wind 1, Block Island Wind Farm, and Virginia Offshore Wind Technology Advancement) predict that suspended sediment would usually settle well before 12 hours have elapsed (COP Volume II, Section 2.1.2.2.1; Ocean Wind 2023). BOEM, therefore, expects relatively little impact from increased turbidity (separate from the impact of direct sediment deposition) due to cable-emplacement and maintenance activities. The cable routes for other offshore wind projects are under review and have not been fully determined at this time. This IPF could cause impacts during construction and maintenance activities. Assuming projects use installation procedures similar to those proposed in Appendix E, the extent of impacts would be limited to approximately 6 feet (0.9 meter) to either side of each cable. Therefore, the duration and extent of impacts would be limited and short term, and it would be expected that finfish and invertebrates would recover following this disturbance; however, EFH and other habitats such as eelgrass or hard-bottom habitats, discussed further in Section 3.6, may remain permanently altered (Hemery 2020), as eelgrass would be expected to require a greater amount of time to recover. Long-term loss of eelgrass and other complex habitats could affect finfish and invertebrate species that utilize these habitats, potentially resulting in increased predation pressure due to loss of refuge habitat as well as decreased hunting success, again due to loss of cover habitat. These impacts would be expected to primarily affect inshore species, particularly those in Barnegat Bay, including summer flounder. Affected hard-bottom habitat would not be expected to recover but the extent of hard-bottom habitat that could potentially be affected is assumed to be low relative to the amount of this habitat available throughout the geographic analysis area.

Some types of cable installation equipment use water withdrawals, which can entrain planktonic invertebrate larvae (e.g., squid, crab, lobster) with assumed 100-percent mortality of entrained individuals (COP Volume II, Section 2.2.5.2.1; Ocean Wind 2023). Due to the surface-oriented intake, water withdrawal could entrain pelagic eggs and larvae but would not affect resources on the seafloor. However, the rate of egg and larval survival to adulthood for many species is very low (MMS 2009). Due to the limited volume of water withdrawn, BOEM does not expect population-level impacts on any given species.

Based on the assumptions provided in Appendix F, offshore cables associated with wind projects would be similar to those of the Project, including inter-array cables, substation interconnection cables, and offshore export cables. The geographic analysis area for finfish and invertebrates is over 16 million acres (64,750 km^2) in size. The total seafloor disturbance would represent less than 0.1 percent of the geographic analysis area, and suspended sediment should settle well before 12 hours.

Cable routes that intersect sensitive EFH such as eelgrass beds or rocky bottom and other more complex habitats may cause long-term or permanent impacts; otherwise, impacts of habitat disturbance and mortality from physical contact with finfish and invertebrates would be recovered in the short term, and overall impacts would be expected to be minor to moderate.

Noise: Noise impacts caused by offshore construction, G&G, and O&M activities, cable laying/trenching, and pile driving could affect finfish and invertebrates. Of these noise-producing factors, noise from pile driving would likely have the greatest impact. Pile-driving noise is a temporary impact that occurs during installation of foundations for offshore wind structures. Pile-driving noise is produced intermittently during construction for a period of 4 to 6 hours per day. Pile driving for construction of more than one offshore wind project may occur concurrently within the geographic analysis area over an 8-year period.

Impacts from pile-driving noise on finfish would also depend on other factors that affect local fish populations, including time of year. Impacts from noise would be greater if occurring during spawning periods or in spawning habitat, particularly for species that are known to aggregate in specific locations to spawn, use sound to communicate, or spawn once in their lifetime. Prolonged localized behavioral impacts on specific finfish populations over the course of years could reduce reproductive success for multiple spawning seasons for those populations, which could result in long-term decline in local populations. However, based on behavioral studies of black sea bass (Jones et al. 2020), fish behavior returns to a pre-exposure state following completion of noise impacts. Additionally, as acoustic impacts decline with distance, it is unlikely that impacts of pile driving from wind farms outside of a certain threshold distance would result in any local population being subject to multiple years of acoustic impacts that would result in long-term impacts on the population. Therefore, impacts on finfish from pile driving are anticipated to be temporary and intermittent during periods when pile driving is actively occurring. It is important to note that no planned non-offshore wind pile-driving activities have been identified within the geographic analysis area for this resource other than current ongoing activities.

Marine invertebrates lack internal air spaces and gas-filled organs needed to detect sound pressure and so are considered less likely to experience injury from over-expansion or rupturing of internal organs, the typical cause of lethal noise-related injury in vertebrates (Popper et al. 2001). Noise thresholds for adult invertebrates have not been developed because of a lack of available data, but some invertebrates are responsive to particle motion and are therefore capable of vibration reception (e.g., crustaceans, squid) (Mooney et al. 2020). This is supported by other studies that found American lobster and shore crabs (*Carcinus maenas*) to have some capability to detect and respond to sound (Jézéquel et al. 2021; Aimon et al. 2021). Noise has also been shown to affect bivalves based on reactions where bivalves close their valves and burrow deeper when subjected to noise and vibration stimuli (Roberts and Elliott 2017). Prolonged valve closure could result in reduced respiration and growth in bivalves, prevent expulsion of wastes, and lead to mortality at a local level.

The longfin squid has been found to exhibit an initial startle response, comparable to that of a predation threat, to pile-driving impulses recorded from a wind farm installation, but upon exposure to additional impulses, the squid's startle response diminished quickly, indicating potential habituation to the noise stimulus (Jones et al. 2020). After a 24-hour period, the squid seem to re-sensitize to the noise, which is an expected response to natural stimuli, as well. Squid schooling and shoaling behavior could be interrupted when exposed to pile-driving impulse noises, which could affect predation risk. Feeding behavior in longfin squid was disrupted by exposure to playbacks of pile-driving noise, resulting in increased failure of predation attempts on killfish (*Fundulus heteroclitus*). Regardless of whether they were hunting, squids exhibited comparable alarm responses to noise. Hearing measurements confirmed the noise was detected by the squid (Jones et al. 2021).

Noise transmitted through water and through the seabed can cause a disturbance response in invertebrates within a limited area around each pile and short-term stress and behavioral changes in individuals over a greater area (e.g., discontinuation of feeding activity). The extent depends on pile size, hammer energy, and local acoustic conditions, with the affected areas recolonized in the short term. These impacts are therefore anticipated to be temporary and intermittent, occurring only during active impact and vibratory pile driving.

Noise impacts from G&G activities are anticipated to occur annually for the foreseeable future but will be localized. Seismic surveys that are used for oil and gas exploration create high-intensity impulsive noise that penetrate the seabed and could potentially cause injury or behavioral impacts on finfish and invertebrates (BOEM 2012). It is important to note that seismic surveys for the purposes of offshore wind are generally used to investigate shallow hazards and hard-bottom areas for the purposes of evaluating the feasibility of turbine installation; as such, seismic surveys for offshore wind do not require use of seismic air guns (used for oil and gas exploration), which penetrate miles into the seabed. Consequently, seismic surveys for offshore wind have far fewer impacts than those for oil and gas exploration. Oil and gas exploration on the Atlantic OCS is currently unlikely. These impacts would be highly localized around the sound source and would be short term in duration. Finfish and invertebrates in the general area but not in the immediate vicinity of the sound source could experience short-term stress and temporary behavioral changes in a larger area affected by the sound. HRG surveys would be anticipated to occur within the geographic analysis area for the purpose of collecting data on conditions at the seafloor and the shallow subsurface. HRG surveys require the use of sparkers and boomers, which generally operate within discrete frequency bands for short durations (relative to seismic airguns). Sparkers and boomers put out less energy relative to seismic airguns and operate in smaller areas and would only be expected to potentially affect finfish and invertebrates close to the activity. During HRG activities, finfish and invertebrates close to sparkers and boomers may experience short-term and very localized impacts that could include displacement.

Noise from trenching equipment for placement of new or expanded submarine cables and pipelines is likely to occur within the geographic analysis area. It is assumed that while these disturbances are likely to occur, they would be infrequent over the next 35 years. Trenching noise is dependent on the substrate being trenched, where sandy sediments would be expected to create lower noise levels compared to rocky substrate or larger cobbles. In a study by Subacoustech, noise from trenching was found to be composed of broadband noise, tonal machinery noise, and transients, likely associated with rock breakage; a source level of 178 dB re 1 µPa at 1 meter distance was measured during the study (Nedwell et al. 2007), which is lower than the thresholds where injury to fish would be expected but above the threshold where behavioral changes may occur. As such, noise impacts from trenching would be expected to alter fish behavior at close range. Noise impacts associated with submarine cables and pipelines would be temporary and localized and extend only a short distance beyond the emplacement corridor. Impacts from noise would be lower than impacts from the trenching and disturbance to the seafloor; regardless, the most prominent noise-producing activities would be related to trenching and seafloor excavation, if burial of pipeline or cables is determined to be necessary. Noise from trenching could result in injury or mortality for finfish in the immediate vicinity of the activity and would likely result in temporary behavioral changes in a broader area. These impacts would be short term, and finfish would be expected to return to the areas of impact following any cable or pipeline activities.

Noise from aircraft, vessels, and WTG O&M is expected to occur within the geographic analysis area, but it is anticipated that these activities would have little impact on finfish and invertebrates. Offshore wind projects may require use of aircraft for crew transport during construction and maintenance; however, little noise from aircraft propagates through the water column. Therefore, impacts on finfish from aircraft use are not likely to occur. Future activities related to offshore wind presumably would be related to increased vessel traffic associated with both construction and maintenance of WTGs and associated facilities. Vessels associated with construction were found to be loud enough at a distance of up to 10 feet (3 meters) to induce avoidance of finfish and invertebrates but not cause physical harm to the fish (MMS 2009). The behavioral avoidance impacts would be short term. WTGs are known to produce ambient noise that barely exceeds ambient noise levels at 164 feet (50 meters) from the base of the WTG (Thomsen et al. 2015); this noise would persist for the life of any offshore wind project.

Underwater explosions from UXO generate high pressure levels that could kill, injure, or disturb marine fish. Injury to fish from exposures to blast pressure waves is attributed to compressive damage to tissue surrounding the swim bladder and gastrointestinal tract, which may contain small gas bubbles. Hannay and Zykov (2022) describe the effects of detonation pressure exposures to fish as assessed according to the peak sound level limits for onset of mortality or injury leading to mortality due to explosives, as recommended by the American National Standards Institute expert working group (Popper et al. 2014). Their review indicates injurious effects thresholds for all fish species groups are the same: peak sound level = 229–234 dB re 1 µPa. For fish species that use swim bladders for hearing, Popper et al. suggest a high likelihood of hearing loss, measured as TTS, and recoverable injury at near and intermediate distances, where *near* refers to within a few tens of meters and *intermediate* refers to a few hundreds of meters. For fish species with swim bladders not used for hearing, the guidelines indicate high likelihood of recoverable impairment at near and intermediate distances but low levels of TTS at intermediate distances. For fish without swim bladders, the guidelines indicate low likelihood of recoverable injury at intermediate distances and moderate likelihood of TTS at intermediate distances and low levels of both effects at far distances of a few kilometers. The resulting impacts on invertebrates and finfish can be localized or widespread and temporary or permanent.

Impacts of noise on finfish, invertebrates, and EFH are likely to be negligible to minor, localized, and temporary or short term. As such, the cumulative impacts of noise from offshore wind development would be expected to be moderate.

Port utilization: It is possible that Ports along the eastern seaboard within the geographic analysis area will be upgraded at some time in the future, which would affect offshore habitat. The Northeast Regional Planning Body anticipates that major vessel traffic routes will be relatively stable in the region for the foreseeable future; however, coastal developments and market demands that are unknown at this time could affect them (Northeast Regional Planning Body 2016). The general trend along the East Coast of the United States from Virginia to Maine indicates that port activity will increase modestly in the foreseeable future. These increases in port activity may require port modifications that could cause localized, minor impacts on finfish and EFH, likely resulting in temporary displacement of finfish. Existing ports within the geographic analysis area have already affected finfish, invertebrates, and EFH. It is anticipated that modifications of ports would cause temporary and localized impacts on finfish, invertebrates, and EFH, likely resulting in behavioral responses, such as avoiding the area during port modification activities. These impacts would be limited to the short term and would not be expected to affect finfish and invertebrate species at a population level; however, mortality at less-mobile life stages such as eggs and larvae could occur if individuals were present in the immediate vicinity of port modification activity. The overall impacts of port utilization on finfish, invertebrates, and EFH are likely to be negligible to minor, localized, and temporary or short term. As such, the impacts from offshore wind development would be expected to be minor.

Presence of structures: Presence of structures could lead to impacts on finfish, invertebrates, and EFH through entanglement, gear loss or damage, hydrodynamic disturbance, fish aggregation, habitat conversion, and migration disturbances. These impacts could occur through addition of buoys, meteorological towers, WTG foundations, scour/cable protection, and transmission cable infrastructure. Over the next 35 years, development is expected to continue within the geographic analysis area, providing additional structures on the seafloor. Based on assumptions of development for other offshore wind projects, 3,109 foundations would be developed in the geographic analysis area (Appendix F). BOEM assumes that offshore wind projects would include similar components for construction, i.e., WTGs, offshore and onshore cable systems, OSS, onshore O&M facilities, and onshore interconnection facilities, all of which would increase the total number of structures within the geographic analysis area over the next 35 years. In the geographic analysis area, structures are anticipated predominantly on sandy bottom, except for cable protection, which is more likely to be needed where cables pass through hard-bottom habitats. The potential locations of cable protection for planned activities have not been fully determined at this time; however, any addition of scour protection/hard-bottom habitat would represent substantial new hard-bottom habitat, as the geographic analysis area is predominantly composed of sand, mud, and gravel substrates.

Hydrodynamic disturbance is an emerging topic of concern because of potential effects on the Mid-Atlantic Bight cold pool, a seasonal oceanographic feature that influences regional biological oceanography. Changes in the size and seasonal duration of the cold pool over the past five decades have been associated with shifts in the fish community composition of the Mid-Atlantic Bight. The cold pool is a mass of relatively cool water that forms in the spring and is maintained through the summer by stratification. It supports a diversity of fish and other marine species that are usually farther north but thrive in the cooler waters it provides (Chen 2018; Lentz 2017). Structures may reduce wind-forced mixing of surface waters, whereas water flowing around the foundations may increase vertical mixing (Carpenter et al. 2016). During summer, when water is more stratified, increased mixing could increase pelagic primary productivity near the structure, increasing the algal food source for zooplankton and filter feeders. Increased mixing may also result in warmer bottom temperatures, increasing stress on some shellfish and fish at the southern or inshore extent of the range of suitable temperatures. Changes in cold pool dynamics resulting from future activities, should they occur, could conceivably result in changes in habitat suitability and fish community structure, but the extent and significance of these potential effects are unknown. Changes to the cold pool size, distribution, and timing may negatively affect thermal habitats preferred by some species (e.g., Atlantic mackerel, Illex squid) and may affect the availability of nearshore spawning habitats for some species (longfin squid) and sources of prey for other species. For example, a northward expansion of the longfin squid population may be related to warming Newfoundland nearshore waters (Dawe et al. 2007).

The presence of WTGs is likely to create localized hydrodynamic effects that could have localized impacts on food web productivity and pelagic eggs and larvae. Addition of vertical structure that spans the water column could alter vertical and horizontal water velocity and circulation. The geographic analysis area is considered seasonally stratified, with warmer waters and high salinity leading to strong stratification in the late summer and early fall. Presence of the monopiles in the water column can introduce small-scale mixing and turbulence that also results in some loss of stratification (Carpenter et al. 2016; Floeter et al. 2017; Schultze et al. 2020). In strongly stratified locations, the mixing seen at monopiles is often masked by processes forcing toward stratification (Schultze et al. 2020), but the introduction of nutrients from depth into the surface mixed layer can lead to a local increase in primary production (Floeter et al. 2017).

Monopiles can also influence current speed and direction. Monopile wakes have been observed and modeled at the kilometer scale (Cazenave et al. 2016; Vanhellemont and Ruddick 2014). While impacts on current speed and direction decrease rapidly around monopiles, there is evidence of hydrodynamic effects out to a kilometer from a monopile (Li et al. 2014). However, other work suggests the influence of a monopile is primarily limited to within 328 to 656 feet (100 to 200 meters) of the pile (Schultze et al. 2020). The discrepancy is likely related to local conditions, wind farm scale, and sensitivity of the analysis. NOAA consensus on other projects in the region is that effects would be limited to within a few hundred meters of the monopile (NOAA 2019).

Hydrodynamic effects could have localized effects on food web productivity and pelagic eggs and larvae. Given the planktonic nature of pelagic eggs and larvae, altered circulation patterns could transport pelagic eggs and larvae out of suitable habitat, altering their survivability. Additionally, pelagic juveniles and adults utilizing water column habitat may experience localized hydrodynamic effects down-current of each monopile. These effects may be limited to decreased current speeds but could also include minor changes to seasonal stratification regimes. Adults and juveniles are expected to exhibit an avoidance behavioral response away from potential unsuitable habitat due to hydrodynamic effects from monopiles.

No future activities were specifically identified within the geographic analysis area specific to entanglement and gear loss and damage; however, it is reasonable to assume that fishing activities (both commercial and recreational) may increase over time in the vicinity of structures due to the likelihood of fish and crustacean aggregation. Damaged and lost fishing gear caught on structures may result in ghost fishing[3] or other disturbances, potentially leading to finfish mortality. Impacts from fishing gear would be localized; however, the risk of occurrence would remain as long as the structures are present. The presence of structures in an otherwise primarily sandy benthic environment would provide a more complex environment, likely to attract finfish and invertebrates such as mobile crustaceans of commercial value. As such, entanglement and gear loss may cause increased impacts on finfish, including mortality and alteration of habitats. These impacts would be localized and short term; however, they would likely persist intermittently as long as structures remain in place.

The presence of structures results in the addition of new hard surfaces and structures to a mostly sandy seafloor, including WTG foundations, scour protection, and hard protection on top of cables, which would create a more complex habitat. Structure-oriented finfish species such as black sea bass, striped bass, and Atlantic cod (among others) would be attracted to these more complex structures. The structures would create an “artificial reef effect,” whereby more sessile and benthic organisms would likely colonize the structures over time (e.g., sponges, algae, mussels, shellfish, sea anemones). Higher densities of filter feeders, such as mussels that colonize the structure surfaces, could consume much of the increased primary productivity but also provide a food source and habitat to crustaceans such as crabs (Dannheim et al. 2020). Mussels have been found to be the preferred food source of Jonah crabs in the Gulf of Maine by Donahue et al. (2009). These impacts would likely be permanent or remain as long as the structure remains. It is important to note that increases in biomass to any specific region due to presence of hard substrates (WTGs in this case) are not necessarily ecosystem benefits; rather, the long-term impacts of the

[3] “Ghost fishing” refers to entrapment, entanglement, or mortality of marine life in discarded, lost, or abandoned fishing gear, which can also smother habitat and act as a hazard to navigation.

artificial reef effect are unknown. Moreover, increased fish aggregation could result in increased regulated fishing, potentially leading to higher biomass removal if the artificial reef effect results in greater fish aggregation without a related increase in fish production.

In contrast to the potential beneficial effects of WTG foundations creating an artificial reef effect, these structures could also facilitate introduction and spread of nonnative species through the stepping-stone effect. New hard substrate structures in the environment could provide opportunity for nonnative species to colonize in an area that would otherwise be unable to settle due to lack of hard substrate habitat or structures. If established, new networks of hard substrate structures (WTG foundations in this case) could serve as new environments on which nonnative species could propagate and expand. Studies of WTGs in the North Sea of Scotland found that nonnative species were thriving on offshore structures, confirming that the stepping-stone effect can occur in offshore environments if nonnative species are present and introduced (Mesel et al. 2015). Expansion of nonnative species in offshore environments can cause ecological impacts on an area if allowed to propagate and expand.

Finfish aggregation around structures could be perceived as beneficial, adverse, or neutral for finfish and invertebrates. Aggregation and colonization would likely lead to increased fishing pressure at structures and may result in adverse predation pressures; however, complex structures generally provide protection and potential habitat for egg laying and larvae recruitment, which would be considered beneficial to finfish species and some invertebrate species. On the other hand, species that rely on soft-bottom habitat, such as surfclams and longfin squid, would experience a reduction in habitat, but not to the extent that population-level impacts would be expected (Guida et al. 2017). The addition of structures in the geographic analysis area would not be expected to impede migratory fish or invertebrate movement through these areas.

Considering the above information, BOEM anticipates that the cumulative impacts associated with the presence of structures may be negligible to moderate and long term. The impacts on finfish, invertebrates, and EFH resulting from the presence of structures would persist for the duration for which the structures remain.

Gear utilization: Impacts from gear utilization would likely be negligible, because impacts from Project fisheries surveys are expected to be localized and finfish are highly mobile and would be expected to avoid capture by active survey gear. However, capture of Atlantic sturgeon in trawl gear has the potential to result in injury and mortality, reduced fecundity, and delayed or aborted spawning migration. The time period for recovery would depend on the mobility and life stage of each species, with sessile organisms less able to avoid impacts and mobile organisms more able to avoid impacts. The effects of gear utilization are expected to contribute an undetectable increment to the cumulative impacts (disturbance, displacement, injury, and mortality) on invertebrates and EFH, which would likely be negligible and short term, as impacts from surveys are expected to be localized and would often occur along transects already included in fisheries surveys.

Vessel traffic: The presence of vessels introduces the risk of vessel collision with marine life, and vessel collisions with marine life are an ongoing threat in the Project area due to vessels from numerous industries such as trade, tourism, resource development, and offshore wind development. An increase in vessel traffic would be expected due to industries such as aquaculture, fishing, wind farms, power cables, tourism, and oil or gas pipelines, as well as increasing ship traffic in general. Marine species that spend a significant time near the water surface or in areas where vessel routes overlap with migration, feeding, or breeding grounds have the potential to be struck by vessels (SEER 2022). Vessel collisions may result in blunt force and sharp force trauma, both of which can result in death, but are likely to be underrepresented due to a lack of reporting awareness and because not all struck marine animals are recoverable for documentation. Vessel speed reductions and route restrictions have shown to be effective mitigation measures for reducing the probability of injury and mortality related to vessel collisions.

Impacts of vessel collisions can result in injury or mortality and may affect populations in some ESA-listed species such as the Atlantic sturgeon. However, the risk of vessel strikes to sturgeon would be limited to shallower nearshore areas during sturgeon migration into rivers. While Atlantic sturgeon are known to be struck and killed by vessels in rivers and estuaries, there are no reports of vessel strikes in the marine environment, likely due to the space between bottom-oriented sturgeon and the propellers and hulls of vessels (BOEM 2021). Dunton et al. (2010) reported that approximately 95 percent of all Atlantic sturgeon captured in sampling off New Jersey occurred in depths less than 66 feet (20 meters), with the highest catch per unit of effort at depths of 33 to 49 feet (10 to 15 meters). At these depths in open coastal and marine environments, which would not constrain the distribution or movement of Atlantic sturgeon, they are not likely to be struck by Project-related vessels. Atlantic sturgeon would rarely occur within the Offshore Project area (Stein et al. 2004; Eyler et al. 2009; Dunton et al. 2010; Erickson et al. 2011) and are unlikely to be affected by seabed disturbance. Effects of displacement of Atlantic sturgeon and their prey from physical disturbance of sediment are anticipated to be negligible and are further addressed in the BA (BOEM 2022b). Cumulative impacts of vessel traffic are expected to be minor.

Discharges: There would be increased potential for discharges from vessels during construction, O&M, and decommissioning. Offshore permitted discharges would include uncontaminated bilge water and treated liquid wastes. There would be an increase in discharges, particularly during construction and decommissioning, with localized discharges staggered over time. There does not appear to be evidence that the volumes and extents anticipated would have additional water-quality impacts on finfish or invertebrates, above what they would experience without offshore wind development, and cumulative impacts would be expected to be negligible.

3.13.3.3. Conclusions

Impacts of the No Action Alternative. Under the No Action Alternative, finfish and invertebrates would continue to follow current regional trends throughout the geographic analysis area. Finfish and invertebrate populations are expected to respond to ongoing activities, including regulated fishing and climate change. Ongoing non-offshore wind activities would likely have minor to moderate impacts on finfish and invertebrates. Ongoing offshore wind activities are anticipated to affect finfish, invertebrates, and EFH through primary IPFs that include cable emplacement and maintenance, noise (specifically, pile-driving activities), and presence of structures. Under the No Action Alternative, fisheries monitoring proposed by Ocean Wind would not be implemented and these efforts to increase the understanding of the effects of offshore wind development that would otherwise benefit future management of finfish and inform planning of other offshore developments would not occur. Other ongoing and future monitoring would not be affected. Ongoing activities, especially continued fishing, dredging, and climate change, would result in moderate impacts on finfish, invertebrates, and EFH. The No Action Alternative would result in **moderate** impacts on finfish, invertebrates, and EFH.

Cumulative Impacts of the No Action Alternative. Planned non-offshore wind activities would affect finfish, invertebrates, and EFH through both temporary and permanent impacts. Other reasonably foreseeable activities such as increased vessel traffic, new subsea cables and pipelines, onshore construction (including ports), channel maintenance, and installation of permanent non-offshore wind-related structures would be expected to affect finfish and invertebrate populations, as well as EFH. Impacts of planned activities (e.g., increased vessel traffic) other than offshore wind would be minor and result primarily from ongoing fishing activities. Impacts of planned offshore wind activities are expected primarily from the presence of structures due to foundations and scour/cable protection. However, regardless of offshore wind-related activities within the geographic analysis area, it is anticipated that the greatest impact on finfish and invertebrates would be caused by regulated fishing activity and climate change. BOEM anticipates that cumulative impacts of the No Action Alternative would be **moderate** for finfish, invertebrates, and EFH.

3.13.4 Relevant Design Parameters & Potential Variances in Impacts for the Action Alternatives

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than those described in the sections below. The following proposed PDE parameters (Appendix E) would influence the magnitude of impacts on finfish, invertebrates, and EFH.

- The number, size, and locations of WTGs;
- Total length of inter-array cables;
- Total length of offshore export cables;
- Number and locations of OSS;
- Total length of OSS interconnector cable; and
- The time of year during which construction occurs.

Variability of the proposed Project design exists as outlined in Appendix E. Below is a summary of potential variances for impacts:

- WTG number and locations: The level of hazard related to WTGs is proportional to the number of WTGs installed, with fewer WTGs requiring fewer foundations resulting in fewer construction-related impacts on finfish, invertebrates, and EFH.
- Offshore cable routes and OSS footprints: The route chosen (including variants within the general route) and OSS footprints would determine the type and amount of seafloor habitat impacts.
- Season of construction: Finfish vary in their migration movements, meaning that certain species may be present at different times of year, and their chosen depth in the water column may also be influenced by time of year and water temperature. Some mobile invertebrates also vary in their migration movements, and sensitive life stages are present at certain times of the year. Any construction window would affect finfish species; however, certain windows may avoid larger migratory movements and potential impacts on sensitive fish species such as Atlantic sturgeon and cusk, both of which may occur within the Project area and are either listed, or candidates for listing, under the ESA.

Although some variation is expected in the design parameters, the assessment of impacts on finfish, invertebrates and EFH in this section considers the maximum-case scenario.

Ocean Wind has committed to measures to minimize impacts on finfish, invertebrates, and EFH by conducting and evaluating G&G surveys to identify sensitive habitats (FISH-01), as well as coordinating with NJDEP, NMFS, and USACE regarding time-of-year restrictions (FISH-02) (COP Volume II, Table 1.1-2; Ocean Wind 2023). Applicant-committed measures in the COP Protected Species Mitigation and Monitoring Plan (COP Appendix AA; Ocean Wind 2023) would further minimize impacts on ESA-listed fish species, including establishing vessel speed restrictions, noise mitigation systems and soft starts during pile driving, and varied species monitoring and reporting (refer to Table H-1 in Appendix H).

Ocean Wind has developed a Submerged Aquatic Vegetation Monitoring Plan (Inspire 2022b) to conduct baseline delineations and document conditions of SAV beds, assess potential impacts on these SAV beds as a result of the construction and operation of the inshore export cable(s) associated with the Project, and track recovery of these SAV beds over time to inform potential mitigation strategies. SAV impacts from construction and installation of the Oyster Creek inshore export cables will be restored or mitigated to the greatest extent practicable, as described in the Ocean Wind 1 Submerged Aquatic Vegetation Preliminary

Mitigation Plan (Ocean Wind 2022). Additional detail regarding the Submerged Aquatic Vegetation Preliminary Mitigation Plan (Ocean Wind 2022) is provided in Section 3.6, *Benthic Resources.*

3.13.5 Impacts of the Proposed Action on Finfish, Invertebrates, and Essential Fish Habitat

3.13.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.13.6, *Impacts of Alternatives B, C, D, and E on Finfish, Invertebrates, and Essential Fish Habitat*.

The following sections summarize potential impacts of the Proposed Action on finfish, invertebrates, and EFH during construction and installation, O&M, and conceptual decommissioning of the Project, as described in Chapter 2, *Alternatives*.

Accidental releases: As discussed in Section 3.13.3.2, non-routine events such as accidental oil or chemical spills can have adverse or lethal effects on marine life; however, APMs such as a spill prevention and a response plan would be developed and implemented during all phases of the Proposed Action. The risk of any type of accidental release would be increased, primarily during construction, but also during O&M and decommissioning of offshore wind facilities (Section A.8.2 in Appendix A discusses the nature of releases anticipated). Modeling by Bejarano et al. (2013) predicted that the impact of smaller spills on benthic invertebrates would be low, and any accidental releases from the Project are expected to be localized. Larger spills are unlikely but could have a larger impact on benthic fauna due to adverse effects on water quality (see Section 3.21, *Water Quality*). Studies conducted by Almeda et al. (2014) indicate that chemical dispersants as well as petroleum-based products such as crude oil are highly toxic to marine zooplankton in low concentrations and the synergistic effects of these chemicals increase the toxicity to marine zooplankton (Almeda et al. 2014; Rico-Martinez et al. 2013). Compliance with USCG regulations would minimize the risk of accidental release of trash or debris. Another potential impact related to vessels and vessel traffic is the accidental release of invasive species, especially during ballast water and bilge water discharges from marine vessels. Vessels are required to adhere to existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR 151.2025) and USEPA National Pollutant Discharge Elimination System Vessel General Permit standards, both of which aim at least in part to prevent the release and movement of invasive species. Adherence to these regulations would reduce the likelihood of discharge of ballast or bilge water contaminated with invasive species. The risk of accidental releases would be increased by the additional vessel traffic associated with the Proposed Action, especially traffic from foreign ports, primarily during construction. The potential impacts on benthic resources are described in Section 3.6. Releases may occur from anti-fouling paints and anti-corrosives that may leach into surface waters. Anti-corrosion and anti-biofouling contamination substances necessary to maintain offshore infrastructures can result in contamination due to galvanic anodes emitting substantial amounts of metals and organic coatings may release organic substances due to weathering or leaching (Kirchgeorg et al. 2018). Contaminations from chemical emissions may include organic compounds such as bisphenol A and metals such as aluminum, zinc, and indium from corrosion and biofouling protection measures and sacrificial anodes (Lloret et al. 2022). Lloret et al. (2022) report that these substances are presently considered to have a low environmental impact but monitoring data are not sufficient to assess the environmental impact of this new source. Impacts would be negligible because there does not appear to be evidence that the volumes and extents anticipated would have any impact on benthic resources.

Accidental releases of substances such as fuel, hazardous materials, and trash are a risk during the construction, operation, and maintenance of the Proposed Action. Some substances may persist in the environment and result in injury to individual animals but are not expected to have population impacts. Adverse impacts on finfish, including the Atlantic sturgeon, and invertebrates and EFH are expected to be short term and negligible.

Discharges: There would be increased potential for discharges from vessels during construction, O&M, and decommissioning of the Proposed Action. Offshore permitted discharges would include uncontaminated bilge water and treated liquid wastes. There would be an increase in discharges, particularly during construction and decommissioning, with localized discharges staggered over time. The volumes of anticipated discharges would be unlikely to have additional water-quality impacts on finfish or invertebrates above what they would experience without the Proposed Action, and impacts would be expected to be negligible.

Anchoring: Vessel anchoring would cause short-term impacts on finfish and invertebrates in the immediate area where anchors and chains meet the seafloor in offshore sandy environments. Impacts would include turbidity affecting finfish and invertebrates, and injury, mortality, and habitat degradation, primarily of invertebrates. All impacts would be localized, turbidity would be temporary, and displacement and mortality from physical contact would be recovered in the short term. Impacts may be higher within sensitive habitats (e.g., eelgrass beds, hard-bottom habitats) and other EFH. Degradation of EFH and other sensitive habitats such as SAV or hard-bottom habitats, if it occurs, could be long term to permanent. As of early 2023, Ocean Wind is developing an anchoring plan, potentially in combination with additional habitat characterization. Such a plan could reduce the area of sensitive habitats affected by anchoring, but avoidance of all sensitive habitats is not likely feasible. During installation of array and substation interconnection cables, Ocean Wind anticipates a maximum of 20 vessels operating during a typical workday in the Wind Farm Area. For offshore export cable installation, Ocean Wind anticipates a maximum of 26 vessels operating during a typical workday. Additional impact discussion related to anchoring is provided in the EFH Assessment (BOEM 2022a).

Atlantic sturgeon would likely depart or avoid unfavorable water quality conditions they may encounter. Suspended sediment and turbidity could result in some temporary avoidance of turbid areas. Any effects from elevated levels of turbidity from the project on Atlantic sturgeon or their prey are considered so small that they could not be measured, detected, or evaluated and are therefore short term and negligible**.**

EMF: During operation, powered transmission cables would produce EMF (Taormina et al. 2018). To minimize EMF generated by cables, all cabling under the Proposed Action would include electric shielding (BENTH-02; COP Volume II Table 1.1-2; Ocean Wind 2023). The strength of the EMF rapidly decreases with distance from the cable (Taormina et al. 2018). Ocean Wind proposes to bury cables to a target burial depth of up to 4 to 6 feet (1.2 to 1.8 meters) below the surface, well below the aerobic sediment layer where most benthic infauna live. Final burial depths will be determined following detailed design and the CBRA (COP Volume I, Section 6.1.1.6; Ocean Wind 2023).

The scientific literature provides some evidence of responses to EMF by fish and mobile invertebrate species (BOEM 2018; Taormina et al. 2018; Normandeau et al. 2011), although recent reviews (CSA Ocean Sciences, Inc. and Exponent 2019; Gill and Desender 2020; Albert et al. 2020) indicate the relatively low intensity of EMF associated with marine renewable projects would not result in impacts. Effects of EMF may include interference with navigation that relies on natural magnetic fields, predator/prey interactions, avoidance or attraction behaviors, and physiological and developmental effects (Taormina et al. 2018).

Atlantic sturgeon are electrosensitive but appear to have relatively low sensitivity to magnetic fields based on studies of other sturgeon species. Magnetic fields associated with the operation of the transmission line could affect benthic organisms that serve as sturgeon prey. Effects on forage fish, jellyfish, copepods, and krill are extremely unlikely to occur given the limited distance into the water column that any magnetic field associated with the transmission line is detectable.

The evidence for magnetic field sensitivity in sharks and rays is more variable. Orr (2016) exposed the benthic draughts board shark (*Cephaloscyllium isabellum*) to a 50-Hz magnetic field operating at 14,300 milligauss and found no observable effects on foraging behavior. In contrast, BOEM (2018) and Hutchison et al. (2020) observed behavioral responses in little skate to induced magnetic fields on the order of 650 milligauss. The available research indicates that while the minimum magnet sensitivity of elasmobranchs is unknown, some species have exhibited observable behavioral responses to anthropogenic EMF at field strengths ranging between 250 and 1,000 milligauss (BOEM 2018; Hutchison et al. 2020; Normandeau et al. 2011). The induced electrical fields generated in even the largest individuals potentially exposed to these effects are less than those generated by muscular and nervous activity in living animals (approximately 10 megavolts per meter) and are therefore likely indetectable (Adair 1998). It is reasonable to conclude that the EMF effects of the inter-array cable on EFH used by epibenthic and demersal pelagic skates and sharks would be insignificant. The 60-Hz electrical fields generated by the cable are above the known detection frequency limit of 20 Hz, while the maximum induced magnetic field and induced electrical field effects are orders of magnitude below the known or probable detection limits of these species. Further detail can be found in the EFH Assessment. CSA Ocean Sciences, Inc. and Exponent (2019) found that offshore wind energy development as currently proposed would have negligible effects, if any, on bottom-dwelling finfish and invertebrates residing within the southern New England area. Although demersal biota would be most likely to be exposed to EMF from power cables, potential exposure would be minimized because EMF quickly decays with distance from the cable source (CSA Ocean Sciences, Inc. and Exponent 2019). In the case of mobile species, an individual exposed to EMF would cease to be affected when it leaves the affected area. An individual may be affected more than once during long-distance movements; however, there is no information on whether previous exposure to EMF would influence the impacts of future exposure. For pelagic species within the southern New England area, no negative effects were expected from offshore wind energy development as currently proposed because of their preference for habitats located at a distance from the seabed. Therefore, BOEM expects localized and long-term, though not measurable, impacts on finfish, invertebrates, and EFH from EMF from the Proposed Action. Section 5.1.4.1 of the EFH Assessment provides a detailed discussion of EMF impacts on EFH and EFH-designated species from the Proposed Action (BOEM 2022a).

Species that use bottom or near-bottom habitats along the potential cable paths during one or more life stages may be exposed to EMF effects. The significance of these potential effects is dependent on habitat use (i.e., likelihood of exposure) and species-specific sensitivity to magnetic and electrical fields and heating effects. Species-specific data on finfish egg and larval sensitivity to EMF effects are lacking. However, general research on fish sensitivity to magnetic and electrical fields suggests that the effects of EMF from the inter-array cable on benthic egg and larval EFH would be insignificant. For example, Cameron et al. (1985) determined that magnetic fields on the order of 1,000 milligauss are required to produce observable developmental delay on the eggs of euryhaline Japanese rice fish. Brouard et al. (1996) exposed rainbow trout embryos to electrical fields ranging as high as 5,000 megavolts per meter and observed no evident effects on development or subsequent survival. These test exposures are orders of magnitude higher than the largest potential EMF effect on benthic habitats likely to result from inter-array cable operation. These findings indicate that the EMF effects of the Project component on benthic EFH for the eggs and larvae of the following species would be insignificant.

Available data for a variety of fish species (e.g., Armstrong et al. 2015; Bevelhimer et al. 2013; Orpwood et al. 2015) indicate that the minimum magnetic field exposure threshold for observable effects on behavior exceeds 1,000 milligauss for most fish species. The minimum threshold for observable detection of electrical fields in electrosensitive fish species is on the order of 20 megavolts per meter (Basov 1999). Each of these thresholds is an order of magnitude or greater than the maximum potential EMF effect likely to result from inter-array cable operation. In a review of EMF effects produced by offshore wind energy, Copping et al. (2016) concluded that induced electrical fields on the order of those generated in fish in close proximity to the inter-array cable would have no observable effects on physiology or behavior.

On this basis, the EMF effects of inter-array cable operation on benthic and epibenthic habitats used by finfish species and finfish prey organisms would be insignificant.

Lighting: Activities associated with the Proposed Action that could cause impacts from lighting on finfish and invertebrates include presence of vessels throughout construction, operation, and decommissioning. Transiting and working vessels associated with construction would use artificial lighting during any operations outside of daylight hours. Light is generally considered an attractant to finfish (Marchesan et al. 2005); therefore, it would be expected that areas where artificial light strikes and penetrates the ocean surface would experience increased fish activity. Lighting may result in impacts on normal behavior of fish and pelagic eggs and larvae by altering their movement and potentially causing temporary increases in predation pressure and disruption of normal swimming behavior, where light may be an attractant to finfish. Light sources from the Proposed Action would involve obstruction lights on the nacelle and mid-mast, which are characterized by intermittent flashes of red hues, and marine navigational lights, which are characterized by intermittent flashes of yellow hues, neither of which present a continuous light source. Artificial light would be minimized to the extent practicable through use of BMPs. No impacts on Atlantic sturgeon from lighting are anticipated.

Cable emplacement and maintenance: The Proposed Action would entail approximately 384 miles of new cable installation, which includes inter-array cables (194 miles) and offshore export cables (190 miles) and impacts (disturbance, displacement, injury, and mortality) of cable emplacement and maintenance under the Proposed Action are estimated to affect up to 172 acres (0.7 km^2) of seafloor within the export cable route corridors and 221 acres (0.9 km^2) in the Wind Farm Area. The primary impact on finfish, invertebrates, and EFH associated with cable emplacement is related to sediment resuspension during burial of cables and cable placement. Nearshore/inshore environments such as back bays where cable installation would occur would likely cause temporary displacement of finfish and mobile invertebrates due to sediment resuspension in the water column. In general, nearshore environments have finer sediments that take longer to settle back to the seafloor, thus potentially causing impacts on EFH.

Sediment within the Wind Farm Area is generally medium to coarse grained with areas of gravelly sand and gravel deposits near the Wind Farm Area (COP Volume II, Section 2.1.2.2.1; Ocean Wind 2023). Based on the grain sizes evaluated for similar projects in Massachusetts, Rhode Island, and Virginia, the medium- to coarse-grained sand deposits near the Wind Farm Area are likely to settle to the bottom of the water column quickly and sand re-deposition would be minimal and close, estimated within 525 feet (160 meters) of the trench centerline (COP Volume II, Section 2.1.2.2.1; Ocean Wind 2023). Based on USACE dredging projects in New York Harbor, dredging sediment with a high percentage of fine-grained particles dissipates quickly over distance within 656 feet (200 meters) to levels that are not detectable against background conditions. Furthermore, modeling for a similar project (BOEM 2015) indicated maximum deposition would still be anticipated nearest the disturbance and within 328 feet (100 meters) of the trench deposition and would not be expected to exceed 0.04 inch (1 millimeter). Even though invertebrates have a range of susceptibility to sedimentation based on life stage, mobility, and feeding mechanisms, invertebrates in this area would be expected to recover in the short term, resulting in minor impacts. Based on Wilber and Clarke (2007), full recovery of the benthic faunal assemblage may take several years. Mechanical trenching, used in more-resistant sediment (e.g., gravel, cobble), causes seabed profile alterations during use, although the seabed is typically restored to its original profile after utility line installation in the trench. Sand and gravel substrates typically take longer to recover to pre-disturbance conditions than habitats with finer grain sizes (Wilber and Clarke 2007). Sediment plumes in the water column would likely cause temporary displacement of finfish and mobile invertebrates, but they would be expected to return following settlement of sediments.

Sand wave clearance may be required in order to install cables at a sufficient depth that they would not be uncovered as a result of sand wave mobility. Cable emplacement and maintenance activities may flatten depressions and small sand waves, temporarily reducing benthic habitat suitability for species such as red and silver hake within the cable footprint. Prey organisms that use these habitats would also be displaced, potentially affecting habitat suitability for fish species. Trenching may leave behind temporary depressions. The extent of these natural features is difficult to quantify, as they are continually reshaped by natural sediment transport processes. Natural recovery from anthropogenic disturbance is likely to occur within several months of the disturbance, depending on timing relative to winter storm events. Due to their mobility, it is expected that the sand wave profiles would rapidly return after cable installation. Although it is anticipated that hydrodynamics would be altered by the presence of structures, it is not expected that this would be to a degree that prevents the processes of sand wave formation and migration.

Larger-scale ridge and trough morphology present in the Wind Farm Area is considered to be more stable and permanent when compared with sand waves, with associated slopes generally less than 1 degree, although vertical relief may be as much as 49 feet (15 meters). During construction, seabed alterations resulting from the Proposed Action could lead to short-term impacts for invertebrates, including habitat alteration, injury, and mortality. Under the Proposed Action, the impacts on benthic resources from seabed alteration, including injury, mortality, and short-term habitat disturbance, would be negligible to minor. Ridges and troughs, sand waves, and boulders are all features present in the Wind Farm Area and export cable route corridors; however, disturbance for cable emplacement would be temporary and short term.

Despite unavoidable mortality, damage, or displacement of invertebrate organisms during sand wave and boulder clearance, the area affected by the construction footprint within the Wind Farm Area and export cable route corridor (393 acres [1.6 km^2] total of export and inter-array cables, substation connector cables, and export cables) would be a fraction of available benthic habitat. Contractors and engineers for Ocean Wind would perform additional surveys and evaluation of geological conditions in the surface and shallow subsurface layers as a part of the CBRA (COP Volume I, Section 6.1.1.6; Ocean Wind 2023) prior to developing the precise route. This process would minimize impacts on complex bottom and maximize the likelihood of sufficient cable burial. BOEM does not expect population-level impacts on benthic invertebrates (i.e., generally accepted ecological and fisheries methods would be unable to detect a change in population, which is the number of individuals of a particular species that live within the geographic analysis area) as a result of the Proposed Action. Invertebrates would recolonize disturbed areas that have not been displaced by new structures, as discussed in Section 3.6, *Benthic Resources*.

Prey species consumed by EFH fish and invertebrate species are also a component of EFH and include forage fish such as Atlantic menhaden, bay anchovy (*Anchoa mitchilli*), and sand eel/sand lance (*Ammodytes americanus*) and invertebrates such as clams, crabs, and worms. Impacts on prey species may lead to indirect impacts on EFH and EFH species and life stages due to lost foraging opportunities. Adverse impacts on these species may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. The EFH final rule also states that the loss of prey may have an adverse effect on EFH and managed species. As a result, actions that reduce the availability of prey species, either through direct harm or capture or through adverse impacts on the prey species' habitat, may also be considered adverse effects on EFH. Adverse effects on EFH may result from actions occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions. For example, a prey species such as the sand lance may be affected by cable placement activities; loss of sand habitat due to scour protection and potential entrainment from hydraulic dredging of the ocean bottom are both likely to have localized and temporary impacts on the species. However, suitable habitat is present throughout the New Jersey continental shelf outside the Project area and the population would not be affected. Additional information on the sand lance can be found in the EFH Assessment (BOEM 2022a).

Array cables would be installed via hydroplow where possible, with alternative methods to include surface lay, trenching, jetting, plowing and pre-plowing, vertical injection, and controlled-flow excavation as necessary. Several of these methods use water withdrawals that can entrain invertebrate larvae (MMS 2009; USEPA 2003). Minor impacts would result from the unavoidable entrainment of benthic organisms or their planktonic larvae during cable installation. Due to the limited time and area involved, BOEM does not expect population-level impacts. The consequences of increased turbidity caused by this IPF are discussed in Section 3.13.3.2.

Impacts on SAV would be minimized during export cable installation, where practicable, using trenchless (e.g., HDD) cable installation. During HDD, there is the potential for inadvertent returns of drilling muds and subsequent impacts on benthic resources. An Inadvertent Return Plan would be implemented to prevent and minimize impacts (COP, Volume II, Table 1.1-2; Ocean Wind 2023). Open-cut trenching is being considered for landfalls not under the USACE beach nourishment program, including the west side of Island Beach State Park (Prior Channel Route) and the west side of Barnegat Bay at the Farm/Holtec landfall due to elevated risks of inadvertent returns of drilling mud occurring during HDD. HDD installation at the southern cable option at Island Beach State Park would be limited by engineering constraints to a length of approximately 1,181 feet (360 meters) into Barnegat Bay. As a result, the HDD exit pits would be within intact SAV beds. Open-cut trenching for the northern cable option allows for reduced cable separation (66 feet [20 meters]), which minimizes impacts on the intact SAV beds to the north and south of the prior channel (Ocean Wind 2023). Table 3.13-2 presents a comparison of short-term SAV impacts for HDD and open-cut trenching for Oyster Creek landfall options. Ocean Wind has committed to restoration of SAV at a ratio of 3:1 for affected SAV if the Project is approved, consisting of mapping efforts, monitoring activities, restoration of documented impacts at an in-situ 1:1 ratio, as well as additional research to improve SAV mitigation in the future. A 4-year monitoring program (2023–2027) would implement surveys to quantify the actual impacts of construction activities to better identify the extent of area required for mitigation.

Impacts from seabed disturbance due to open-cut trenching and HDD are anticipated to be localized and short term due to their temporary nature. Mobile life stages would move out of the area to avoid potential impacts. However, demersal non-mobile life stages would be affected due to removal of the sediment on which they occur. Most juvenile and adult finfish would actively avoid all construction activities. Immobile finfish life stages such as demersal eggs and larvae and sessile organisms may also experience mortality as a result of being crushed or buried during trenching or HDD.

Applicable to construction, O&M, and decommissioning impacts, Ocean Wind has committed to a benthic monitoring plan (APM Gen-06) and submerged aquatic vegetation monitoring plan. Monitoring would be implemented so that environmental conditions are monitored during construction, O&M, and decommissioning phases.

Dredging may also be required in the shallow areas of Barnegat Bay to allow vessel access for export cable installation. Locations include the prior channel (west side of Island Beach State Park/east side of Barnegat Bay), the west side of Barnegat Bay at the export cable landfall, and the Oyster Creek section of the federal channel in Barnegat Bay if USACE is unable to conduct dredging in this area as part of the federal channel dredging that is currently under contract. In 2020, USACE completed an environmental assessment, Section 7 ESA consultation, and EFH Assessment for maintenance dredging of the Barnegat

Inlet Federal Navigation Project and use of maintenance material for shoreline protection and habitat creation/restoration in Barnegat Bay. This analysis concluded that dredging Oyster Creek channel and beneficial use placement operations were not anticipated to result in significant direct, indirect, or cumulative adverse impacts on federally or state-listed threatened or endangered species (USACE 2020). NMFS concurred that the action was not likely to adversely affect listed species or critical habitat.

As discussed in Section 3.13.3.2, dredging activities associated with cable installation could affect the Atlantic sturgeon through impingement, entrainment, and capture associated with mechanical and hydraulic dredging techniques. The risk of interactions between sturgeon and mechanical dredges is thought to be highest in areas where large numbers of sturgeon are known to aggregate; however, there are no known areas of sturgeon aggregations within the proposed areas for dredging for the Project. The likelihood of an Atlantic sturgeon becoming entrained and entrapped in a mechanical dredge associated with the Proposed Action is considered extremely low due to the rarity of sturgeon in the area to be dredged and the lack of attraction observed between Atlantic sturgeon and dredges.

Juvenile Atlantic sturgeon are known to inhabit estuarine environments for up to a year before migrating out into the ocean (ASMFC 2012). Although the presence of SAV has been recorded in Barnegat Bay, no known strong association has been documented between juvenile Atlantic sturgeon and SAV (ASMFC 1997). Additionally, no juvenile or adult Atlantic sturgeon were recorded during a 3-year trawl survey of Barnegat Bay that spanned all four seasons (Valenti et al. 2017). It is not anticipated that dredging in Barnegat Bay due to inshore export cable installation would affect juvenile Atlantic sturgeon.

Dredging in sand waves to allow for cable installation is anticipated to result in the entrainment and mortality of some sand lances, as discussed in Section 3.13.3.2. However, given the opportunistic feeding nature of Atlantic sturgeon, the size of the area where dredging would occur, and the short duration of the dredging, the loss of benthic invertebrates and sand lance would be small, temporary, and localized. It is expected any impact of the loss of Atlantic sturgeon prey items to be so small that it cannot be meaningfully measured, evaluated, or detected.

Ocean Wind’s conservative estimate of detonation in place of up to 10 UXOs would result in habitat loss, reduced water quality, and physical disturbance, harm, and mortality in fish and marine invertebrates as described in Section 3.13.3.2. UXO detonations would occur on different days, such that only one UXO would be detonated within a 24-hour period. If demolition is necessary, APMs including a dual noise-mitigation system with 10-dB attenuation, seasonal restrictions between January and April, and post-detonation monitoring for injured or dead fish would be implemented. Impacts on finfish are expected to be adverse, but localized and short term, and therefore negligible. Atlantic sturgeons are unlikely to be affected by seabed disturbance in offshore areas or in Barnegat Bay. Effects of displacement of Atlantic sturgeon and its prey from physical disturbance of sediment are anticipated to be negligible and are further addressed in the BA (BOEM 2022b).

Table 3.13-2 Short-Term SAV Impacts by Installation Method for Oyster Creek Inshore Export Cable Route Corridor Landfall Options[1]

Data	Island Beach State Park – Base Case (Acres		Island Beach State Park – Prior Channel (Acres)		Holtec/The Farm (Acres)		Bay Parkway One Shot (Acres)		Bay Parkway (Acres)		Nautilus (Acres)		Lighthouse (Acres)		Marina (Acres)	
	HDD[2]	Open Cut[3]	HDD[4]	Open Cut	HDD	Open Cut	HDD	Open Cut	HDD	Open Cut	HDD	Open Cut	HDD	Open Cut	HDD	Open Cut
1979 Data	15.25	-	-	0.89	0	1.49	0.09	1.19	0	1.49	0	0.20	0	1.19	0	2.09
1985–1987 Data	13.17	-	-	14.01	0	0	0.87	1.99	0.57	2.39	0	1.29	0.25	1.49	0.15	2.98
2009 Data	11.78	-	-	1.80	0	1.59	1.86	2.98	0.22	2.09	0	0.99	0	0.80	0	0.50
Ocean Wind Survey Data	13.86	-	-	8.35	0	1.89	0.32	0.89	0	0.99	0	0.70	0	0.90	0	0.30

[1] Assumes 82-foot disturbance corridor width for open-cut trenching installation method and cable installation and seafloor preparation.
[2] HDD area calculated using boundary of HDD pit trench.
[3] Open-cut trenching installation not proposed for Island Beach State Park southern cable route option.
[4] HDD installation not proposed for Island Beach State Park northern cable route option.

Noise: Activities associated with the Proposed Action that could cause underwater noise effects on finfish and invertebrates are pile driving, drilling, vessel traffic, aircraft, geophysical surveys (HRG surveys and geotechnical drilling surveys), WTG operation, jet-plowing/cable installation, and seabed preparation activities. Pile driving would produce the most-intense underwater noise impacts with the greatest potential to cause injury-level and behavioral effects on finfish and invertebrates and operational WTG noise would occur over the longest duration; therefore, these effects are the focus of the Proposed Action assessment below. Further discussion of impacts from noise on finfish and invertebrates from Project-related activities is provided in the EFH Assessment and BA (BOEM 2022a and 2022b, respectively). Additionally, discussion specific to G&G-related noise impacts is presented in the BA (BOEM 2022b) and Appendix C of the acoustic modeling report (Küsel et al. 2021).

Impacts from sound vary based on the intensity of the noise and the method of sound detection used by the animal. However, severe impacts could include physiological reactions such as ruptured capillaries in fins, hemorrhaging of major organs, or burst swim bladders (Popper et al. 2014), which could lead to mortality or behavioral reactions such as temporary displacement or temporary disruption of normal activities such as feeding or movement. Assessment of the potential for underwater noise to injure or disturb a fish or invertebrate requires acoustic thresholds against which received sound levels can be compared. The most conservative available injury thresholds for fish were developed by the Fisheries Hydroacoustic Working Group (2008) and Popper et al. (2014) and are provided in Table 3.13-3. The current threshold classification considers effects on fish mainly through sound pressure without taking into consideration the effect of particle motion. Popper et al. (2014) and Popper and Hawkins (2018) suggest that extreme levels of particle motion induced by various impulsive sources may also have the potential to affect fish tissues and that proper attention needs to be paid to particle motion as a stimulus when evaluating the effects of sound on aquatic life. However, lack of evidence for any source due to extreme difficulty of measuring particle motion and determining fish sensitivity to particle motion currently renders establishing guidelines or thresholds for particle motion exposure not possible (Popper et al. 2014, 2022; Popper and Hawkins 2018).

Table 3.13-3 Acoustic Metrics and Thresholds for Fish Currently Used by NMFS and BOEM for Impulsive Pile Driving

Faunal Group	Injury		Impairment		Behavior
	Physical Injury		TTS		L_p
	L_{pk}	$L_{E, 24hr}$	L_{pk}	$L_{E, 24hr}$	
Fish equal to or greater than 2 grams	206	187	--	--	150
Fish less than 2 grams		183	--	--	
Fish without swim bladder	213	216	--	--	--
Fish with swim bladder not involved in hearing	207	203	--	--	--
Fish with swim bladder involved in hearing	207	203	--	--	--

Source: Küsel et al. 2021; FHWG 2008; Popper et al. 2014.
L_E = sound exposure level (decibel re 1 micropascal square second); L_p = root-mean-square sound pressure (decibel re 1 micropascal); L_{pk} = peak sound pressure (decibel re 1 micropascal); PTS = permanent threshold shift

Very few studies have measured the underwater particle motion of turbines. The results of Sigray and Andersson (2011) suggested that the effects of wind turbine underwater noise are restricted to the immediate vicinity of the wind turbine; they also identified the correlation between the mechanical vibrations of the turbine tower and the sound pressure between the vibrations and the particle motion in the water column. Results of laboratory studies provide evidence of the negative effects of offshore wind facility construction sounds on the common cuttlefish (*Sepia officinalis*), the most abundant cephalopod in the northeast Atlantic (Sole et al. 2022). The severity of the effects was dependent on distance from the sound source and was considered acute only in the very vicinity of the sound source where they have the potential to affect cephalopod populations and their offspring.

There is no available information on the hearing capabilities of Atlantic sturgeon specifically, although the hearing of other species of sturgeon have been studied. Meyer et al. (2010) and Lovell et al. (2005) studied the auditory system morphology and hearing ability of lake sturgeon (*Acipenser fulvescens*), a closely related species. The Acipenseridae (sturgeon family) have a well-developed inner ear that is independent of the swim bladder and therefore it appears that sturgeon rely directly on their ears to hear. The results of these studies indicate a generalized hearing range from 50 to approximately 700 Hz, with greatest sensitivity between 100 and 300 Hz. Popper (2005) summarized studies measuring the physiological responses of the ear of European sturgeon (*Acipenser sturio*). These results suggest sturgeon are likely capable of detecting sounds from below 100 Hz to about 1 kilohertz. Noise impacts may occur due to impact pile driving for WTGs and OSS foundations and effects of exposure that may result in physiological injury and behavior disturbance; UXO detonations, which generate high pressure levels that could kill, injure, or disturb Atlantic sturgeon; and non-impulsive noise from vibratory pile driving associated with HRG surveys, vessels, aircraft, cable laying and trenching, dredging, and WTG operations that may result in injury or behavioral changes. The Programmatic BA prepared to evaluate impacts from geotechnical and HRG surveys on the OCS (NMFS 2021d) concluded that no impacts on ESA-listed species, including the Atlantic sturgeon, from these activities are likely to occur.

Currently, there are no underwater noise thresholds for invertebrates. Marine invertebrates lack internal air spaces and gas-filled organs needed to detect sound pressure and so are considered less likely to experience injury from over-expansion or rupturing of internal organs, the typical cause of lethal noise-related injury in vertebrates (Popper et al. 2001). Noise thresholds for adult invertebrates have not been developed because of a lack of available data, but some invertebrates are responsive to particle motion and are therefore capable of vibration reception (e.g., crustaceans, squid) (Mooney et al. 2020). This is supported by other studies that found American lobster and shore crabs (*Carcinus maenas*) to have some capability to detect and respond to sound (Jézéquel et al. 2021; Aimon et al. 2021). Noise has also been shown to affect bivalves based on reactions where bivalves close their valves and burrow deeper when subjected to noise and vibration stimuli (Roberts and Elliott 2017). Prolonged valve closure could result in reduced respiration and growth in bivalves, prevent expulsion of wastes, and lead to mortality at a local level. These studies provide evidence to suggest that vibrations from pile driving adversely affect benthic invertebrates. A recent study (Roberts and Elliott 2017) demonstrated that blue mussels exhibited behavioral and physiological changes compared to control animals, including variation in valve gape and oxygen demand. Vibration may be used by marine species for the detection of biotic and abiotic cues and, consequently, exposure to additional vibration may elicit behavioral or physiological change, or even physical damage at high amplitudes or particular frequencies.

The longfin squid has been found to exhibit an initial startle response, comparable to that of a predation threat, to pile-driving impulses recorded from a wind farm installation but, upon exposure to additional impulses, the squid's startle response diminished quickly, indicating potential habituation to the noise stimulus (Jones et al. 2020, 2021; Mooney et al. 2020). After a 24-hour period, the squid seem to re-sensitize to the noise, which is an expected response to natural stimuli, as well. Squid schooling and shoaling behavior could be interrupted when exposed to pile-driving impulse noises, which could affect predation risk. Feeding behavior in longfin squid was disrupted by exposure to playbacks of pile-driving noise, resulting in increased failure of predation attempts on killfish. Regardless of whether they were hunting, squids exhibited comparable alarm responses to noise. Hearing measurements confirmed the noise was detected by the squid (Jones et al. 2021).

Fish communicate acoustically and are therefore subject to external, potentially masking, noise arising from abiotic sources including wind, rain, and waves, as well as biotic noise such as chorusing from conspecifics or heterospecifics (Mooney et al. 2020). Radford et al. (2014) report that acoustic communication in fish, including during territorial disputes and competition for food, predatory attacks, courtship interactions, and spawning aggregation, demonstrate the importance of communication and the potential impacts on survival and reproductive success of fish. However, acoustic masking is an environmental stressor that ceases as soon as the noise source stops; unlike other stressors, there is no lingering effect. The highest levels of noise from offshore wind occur during construction and are associated with pile driving for fixed-bottom turbine installation; noise produced during operation of the wind farm is expected to be lower than during construction (SEER 2022). However, several studies have reported negative environmental impacts associated with both the construction and operational stages of offshore wind farms (Siddagangaiah et al. 2021). The long-term effects of noise from offshore wind facility operation may be inferred from other long-term noise sources such as shipping, boat, and aquaculture noise, which include stress and corresponding physiological impacts, avoidance, and masking effects in fish; however physical injury due to turbine noise is unlikely (Mooney et al. 2020). Noise from UXO detonations also has the potential to kill, injure, or disturb Atlantic sturgeon (the only ESA-listed fish anticipated, as described in Section 3.13.1), but impacts on the sturgeon would effectively be eliminated by seasonal restriction of UXO detonations from January through April (described later in this section). The primary impacts of noise on finfish and invertebrates are therefore expected to occur during offshore construction activities associated with the Proposed Action. Research has shown that finfish can suffer behavioral and physiological effects based on received sound levels, distance from the noise, and variables related to the noise-producing impact (e.g., materials, size of hammer). Results from studies that examined the potential negative effects of exposure to pile driving on various marine species reviewed by Mooney et al. (2020) show diverse impacts on a range of taxa that indicate physical damage of barotrauma in striped bass, hogchoker, lake sturgeon, Chinook salmon, and Nile tilapia; loss of auditory hair cell loss in hybrid striped bass exposed to pile-driving noise; increased oxygen consumption in response to pile-driving noise; and behavioral escape and predator avoidance in longfin squid. Recent studies of the impacts of noise on black sea bass indicate its auditory detection bandwidth, and the most sensitive frequencies, directly overlap with high-amplitude noise such as underwater construction and suggest the most sensitive range of this species’ sound detection capabilities directly overlaps with the highest sound energy created from pile-driving activity (Stanley et al. 2020). A study of the impacts of both pile driving and wind turbine operation in Taiwan waters (Siddagangaiah et al. 2021) found changes in fish chorusing due to both pile driving and operations.

As explained above, any response from invertebrates would be of lower magnitude than that of fish because they tend to be less sensitive to noise exposure. Noise from impact pile driving for the installation of WTGs and OSS foundations would occur intermittently during the installation of offshore structures. A total of 98 WTGs are anticipated for the Proposed Action. Each WTG requires one monopile and each pile requires 4 to 6 hours of driving to install. This would occur over a maximum-case scenario of a total of 98 days over 2 years. Acoustic propagation modeling of the impact pile-driving activities for the Proposed Action was undertaken by JASCO Applied Sciences to determine distances to the established injury and disturbance thresholds for fish (Küsel et al. 2021). Two types of piles were considered: 8- and 11-meter tapered monopiles (26 feet [8 meters] at the waterline and 36 feet [11 meters] at the mudline) and 2.44-meter pin piles. The tapered monopiles for WTG foundations under the Proposed Action would be 11 meters (37 feet) in diameter at the seabed and 8 meters (26 feet) in diameter at the sea surface (Ocean Wind 2023); however, Project development has carried forward a monopile with a maximum outer diameter of 11 meters (37 feet) (Ocean Wind 2023). Impact hammer installation of the monopile foundations would produce the most-intense underwater noise impacts with the greatest potential to cause injury-level effects on fish; therefore, these effects are the focus of the assessment below. Sound fields from 8- and 11-meter monopiles were modeled at one representative location in the Offshore Project area using IHC S-4000 and IHC S-2500 impact hammers. The modeling also used a 10-dB-per-hammer-strike noise attenuation to incorporate the use of a single noise-abatement system[4] (e.g., one or multiple bubble curtain[s]). This attenuation is considered achievable with currently available technologies (Bellmann et al. 2020). The resulting values represent a radius extending around each pile where potential injurious-level or behavioral effects could occur and are presented in Table 3.13-4. Soft start during impact pile driving is a mitigation technique that involves the gradual increase in hammer blow energy to allow marine life to leave the area. Soft starts would be employed prior to commencement of any impact pile driving. Soft starts would include at least 20 minutes of four to six strikes per minute at 10 to 20 percent of the maximum hammer energy (COP Volume III, Appendix AA; Ocean Wind 2023). Additional discussion related to impacts on finfish and invertebrate species is provided in the BA and the EFH Assessment (BOEM 2022a, 2022b).

Table 3.13-4 Summary of Acoustic Radial Distances (R_{max} in kilometers) for Fish during Monopile Impact Pile Installation

Threshold Type	Threshold Level	Acoustic radial distances (R_{max} in km) during summer	Acoustic radial distances (R_{max} in km) during winter
Behavioral (all fish)	150 dB re 1 μPa SPL_{RMS}	5.18	7.54
Injury (all fish)	206 dB re 1 μPa SPL_{peak}	0.07	0.07
Injury (fish over 2 grams)	187 dB re 1 $μPa^2$s SEL_{cum}	4.93	6.85
Injury (fish under 2 grams)	183 dB re 1 $μPa^2$s SEL_{cum}	6.06	9.35

Source: Küsel et al. 2021.
Notes: Cumulative sound exposure level values were calculated for a 24-hour period for the installation of a single 8- and 11-meter tapered monopile using a IHC S-4000 hammer.
dB re 1 μPa SPL_{peak} = decibel re 1 micropascal peak sound pressure level; dB re 1 μPa SPL_{RMS} = decibels re 1 micropascal root-mean-square sound pressure level; dB re 1 $μPa^2$s SEL_{cum} = decibel re 1 micropascal squared second cumulative sound exposure level; km = kilometers; R_{max} = maximum range

The single-strike (or peak sound pressure level [SPL_{peak}]) injury distances represent how close a fish would have to be to the source to be instantly injured by a single pile strike. The cumulative injury distances consider total estimated daily exposure, meaning a fish would have to remain within that threshold distance over an entire day of exposure to experience injury. The exposure distances for behavioral effects are instantaneous values, meaning that any animal within the effect radius is assumed to have experienced behavioral effects.

The likelihood of injury from monopile installation depends on proximity to the noise source, intensity of the source, effectiveness of noise-attenuation measures, and duration of noise exposure. Results from the modeling show that injury from a single strike is limited to 70 meters from the pile for both winter and summer seasons and injury from prolonged cumulative exposure (over 24 hours) extends as far as 9.35 kilometers from the pile during the winter water profile. Modeling indicates that behavioral effects on fish could occur up to 7.54 kilometers from the pile source during the winter and 5.18 kilometers from the pile source during the summer. Within this area, it is likely that some level of behavioral reaction is expected and could include startle responses or migration out of areas exposed to underwater noise (Hastings and Popper 2005). Behavioral disturbance to fish from pile driving noise is therefore considered temporary for the duration of the activity. To mitigate impacts to the extent practicable, the Project would employ either a double big bubble curtain or a single big bubble curtain in combination with a hydrodamper to achieve a minimum of 10 dB of noise reduction. Additionally, the Project would employ soft starts during impact pile driving, allowing a gradual increase of hammer blow energy, thus allowing mobile marine life to

[4] Note that the noise-abatement system implemented must be chosen, tailored, and optimized for site-specific conditions.

leave the area. Soft starts would be employed on the Project such that, prior to the commencement of any impact pile driving (and any time following a cessation of 30 minutes or more), soft-start techniques would be implemented and would include at least 20 minutes of four to six strikes per minute at between 10 and 20 percent of the maximum hammer energy.

Fish response would be highest near impact pile driving (within tens of meters), moderate at intermediate distances (within hundreds of meters), and low at farther distances (within thousands of meters) (Küsel et al. 2022). During active pile-driving activities, highly mobile finfish likely would be displaced from the area, most likely showing a behavioral response; however, fish in the immediate area of pile-driving activities could suffer injury or mortality. The soft-start mitigation measure would minimize impacts by inducing fish to leave the immediate vicinity of the pile-driving activity. Affected areas would likely be recolonized by finfish in the short term following completion of pile-driving activity. Early sessile life stages of finfish, including eggs and larvae, could experience mortality or developmental issues as a result of noise; however, thresholds of exposure for these life stages are not well studied (Weilgart 2018).

Species occurring in the Wind Farm Area most sensitive to noise associated with pile-driving activities would be fishes that have a swim bladder involved with hearing such as the Atlantic herring (Küsel et al. 2022). Previous studies have demonstrated both mortality and no mortality in this group of fish due to pile driving. The least-affected species with designated EFH in the Lease Area include invertebrates, sharks, rays, flounders, and some tunas. These species do not have an air bladder and rely on particle motion for hearing, reducing any damage induced by sound pressure (Popper et al. 2014). This group also includes sessile species (Atlantic surfclam and ocean quahog). Although these species are less sensitive to sound pressure, they are similar to eggs and larvae in that they cannot avoid or retreat from potentially damaging sound pressure and would be subject to injury and mortality when sound pressure occurs within a certain radial distance from pile driving. A dual noise-mitigation system would be deployed for all impact pile-driving events, which would be a combination of two devices (e.g., bubble curtain, hydro-damper) to achieve 10 dB noise attenuation, to reduce noise propagation during monopile foundation pile driving (COP Appendix AA; Ocean Wind 2023). The soft-start mitigation measure would minimize impacts by inducing fish to leave the immediate vicinity of the pile-driving activity, while the noise mitigation system would minimize behavioral and physical impacts resulting from pile driving on any fish that remain in the area.

Pile driving during site preparation activities is anticipated to adversely affect habitat for both pelagic and demersal life stages; however, this impact would be short term and habitat is expected to return to pre-pile driving conditions, allowing fish and invertebrates to return. It is important to note that there is potential that concurrent pile-driving activities are possible from the nearby Atlantic Shores South offshore wind lease area. If pile-driving activities occur within 9.35 kilometers (the maximum distance where injury to finfish could occur if the pile driving occurs for a period of over 24 hours), it is possible that finfish could experience continuous cumulative exposure to noise exceeding 24 hours, which could potentially result in injury to finfish. The pile-driving plan and timing for pile-driving activities for the Atlantic Shores South offshore wind lease area are unknown, thus this impact can be considered; however, a determination regarding cumulative exposure cannot be made.

Other studies have concluded that operational noise from WTGs is detected by and affects behavior in finfish. For example, the particle motion generated at a WTG foundation from the turbine operation was found to generate relatively strong broadband sounds as well as tones likely to induce behavioral responses by fishes such as cod and plaice in the Baltic Sea (Hawkins 2020). As reported by Mooney et al. (2020), there was increased catchability of cod and roach (*Rutilus rutilus*) within 100 meters of a stopped WTG (i.e., no noise) compared to an operating WTG, and delayed metamorphosis of crab megalopae (larval stage) in response to operating turbine noise. WTG noise frequency and level were found to overlap with the auditory sensitivity of the marbled rockfish (*Sebastiscus marmoratus*), indicating the turbine noise could be detected by fish and may have a masking effect on their acoustic communication (Zhang et al. 2021).

Offshore WTGs produce continuous, non-impulsive underwater noise during operation, mostly in lower-frequency bands below 8 kilohertz. Operation of the Project would include continuous noise from 98 WTGs over 30 years. There are several recent studies that present sound properties of similar turbines in environments comparable to that of the Proposed Action. These are presented in detail in the marine mammal section (Section 3.15). Studies indicate that operating turbines (e.g., both older-generation, geared turbine designs and quieter, modern, direct-drive systems like those proposed for the Wind Farm Area) produce underwater noise on the order of 110 to 125 dB re 1 µPa root-mean-square sound pressure level (SPL_{RMS}) at a reference distance of 50 meters, occasionally reaching as high as 128 dB re 1 µPa SPL_{RMS}, in the 10-Hz to 8-kilohertz range (Tougaard et al. 2020). It is important to note that the Tougaard et al. (2020) study assumed that the largest monopile-based WTG was 3.6 MW, which is smaller than those being considered for the Project, which are likely to range from 12.4 MW to 14.7 MW. Larger turbines are also taller, and the distance from the noise source in the nacelle to the water is greater in the larger turbines. Statistical models were developed by Tougaard et al. (2020) that showed the increase in SPL from WTGs with increased turbine size (approximately 5 SPL per MW) and the decline in SPL with distance from the WTG. The underwater noise from individual wind turbines is still low compared to the noise radiated from cargo ships despite turbines now being larger and more measurements (for models) being available (Tougaard et al. 2020). When compared[5] to injury thresholds for fish, no physiological effects on fish as a result of WTG operational noise is anticipated. In addition, WTG operational noise is not expected to exceed fish behavioral thresholds. More recently, Stöber and Thomsen (2021) attempted to estimate operational noise from larger current-generation, direct-drive WTGs. They found that these designs could generate higher operational noise levels than those reported in earlier research; however, these findings have not yet been validated. Tougaard et al. (2020) report that noise from operating WTGs is lower than noise from passing ships despite their larger size, but remains static, while ship noise does not. Moreover, if ambient noise in the area is high, such as with wind farms near shipping lanes, noise from operating WTGs would only be detectable above ambient noise very close to the WTGs (Tougaard et al. 2020). van der Molen et al. (2014) also predicted changes would be most concentrated within the wind turbine array and smaller changes can occur up to several tens of kilometers outside the array, based on acoustic model results. However, the combined contribution of multiple turbines and the scale at which they occur means that the cumulative effects must also be considered.

Collectively, noise from the WTG operations could have limited adverse effects on habitat suitability for finfish, invertebrates, and EFH within a certain distance of each monopile foundation. The extent of these effects is difficult to quantify, as they will vary depending on wind speed, water temperature, ambient noise conditions, and other factors. Applying the sensitivity thresholds detailed in Section 5.1.1.2 of the EFH Assessment, potential adverse effects on habitat suitability for squid and fish belonging to the hearing specialist group are estimated to extend up to 164 feet (50 meters) from each foundation. This equates to adverse effects on habitat suitability over 46 acres (18.6 hectares) for the 37-foot (11-meter) monopile.

Several reports have noted that offshore wind farms attract fish and invertebrate species as a result of providing an artificial reef effect (Russel et al. 2014; Degraer et al. 2020). As a result, adverse behavioral effects from operation of WTGs are not considered likely for some species. Ship noise, such as from transport or survey boats, is intermittent but can mask the communication signals of haddock (*Melanogrammus aeglefinus*), cod, and other taxa, which may also induce physiological stress and impair foraging and predator responses in both fish and invertebrates. However, acoustic masking is an

[5] To compare source levels in dB re 1 µPa SPL_{RMS} with thresholds in dB re 1 µPa SPL_{peak}, 10 dB must be subtracted from peak values in dB re 1 µPa (WSDOT 2020).

environmental stressor that ceases as soon as the noise source stops; unlike other stressors, there is no lingering effect.

In addition to operational noises described above, there is a potential for interactions with UXO as well as the corrosion of UXO in the Project area. Ocean Wind may encounter UXOs on the seabed in the Lease Area and along export cable routes. While non-explosive methods may be employed to lift and move these objects, some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could kill, injure, or disturb Atlantic sturgeon (the only ESA-listed fish anticipated, as described in Section 3.13.1). However, the APM seasonal restriction of UXO detonations from January through April would effectively eliminate the likelihood of any exposures for Atlantic sturgeon. Should a sturgeon be exposed to noises above behavioral thresholds, the effects would likely be brief (e.g., Atlantic sturgeon may be startled and divert away from the area), and any effects would be so small that they could not be measured, detected, or evaluated.

Geotechnical surveys (drilling, cone penetration testing, and vibracores) related to offshore activities are typically numerous but very brief sampling activities that introduce relatively low levels of sound into the environment. The geotechnical surveys would take place prior to construction and no geotechnical surveys are planned for the construction or post-construction phases. The HRG and geotechnical surveys would help identify sensitive habitats (e.g., shellfish, SAV beds) and allow these areas to be avoided to the extent practicable for siting of the WTGs, OSS, and cable routes. BOEM's regulations and guidance under 30 CFR 585.626 and 585.627 require the lessee to submit detailed G&G data and analysis, among other data requirements to establish engineering and other construction parameters, and the G&G activities are therefore mandatory.

Surveys would include equipment operating at less than 180 kilohertz and consist of multibeam depth sounding, seafloor imaging, and shallow- and medium-penetration sub-bottom profiling within the Project area. General vessel noise is produced from vessel engines and dynamic positioning to keep the vessel stationary while equipment is deployed and sampling is conducted for these surveys. The Atlantic sturgeon is the only ESA-listed fish species in the Project area that may be affected by these surveys (BOEM 2018). Impacts on the Atlantic sturgeon from these activities are summarized in Section 3.13.1.

Adverse effects on benthic habitat and communities are expected to be reversible; no impacts on hard-bottom communities would be anticipated from G&G surveys (for example, see BOEM 2014). In addition, a Programmatic BA was prepared to evaluate impacts from geotechnical and HRG surveys on the OCS (NMFS 2021d). The BA concluded that no adverse effects on ESA-listed species in the Project area are likely to occur. Impacts on species that are not ESA-listed would be similar.

No population-level impacts on finfish, invertebrate, and EFH resources from noise associated with the Proposed Action are anticipated. Overall impacts of noise on finfish are anticipated to be short term, temporary, and negligible to minor.

Presence of structures: Various impacts on finfish resulting from the presence of new structures associated with the Proposed Action are described in detail in Section 3.13.3.2 and include beneficial impacts as a result of the artificial reef effect associated with WTGs. The Proposed Action would include up to 98 WTGs. The primary impact would be from 98 WTG foundations, which would be constructed in mostly sandy seafloor. New structures could affect finfish migration through the area by providing unique complex features (relative to the primarily sandy seafloor) and altering water currents; this could lead to retention of those species and possibly affect spawning opportunities. Impacts on fish migration as a result of structures associated with offshore wind are unknown, as studies related to this potential impact are not available. New complex structures could result in additional impacts such as aggregation of fish, entanglement, gear loss, and habitat conversion. These impacts would largely be driven by changes to recreational and commercial fishing because foundations could provide areas of fish aggregation, leading to increased recreational and commercial fishing pressure. These impacts would be highly localized but could be long term for those structures that are not removed. Additionally, new structures could be beneficial to finfish and invertebrate species, providing potential feeding grounds and areas of protection from predators. The structures would create an "artificial reef effect," whereby more sessile and benthic organisms would likely colonize these structures over time (e.g., sponges, algae, mussels, shellfish, sea anemones). Higher densities of invertebrate colonizers would provide a food source and habitat to other invertebrates such as mobile crustaceans.

The presence of WTGs and corresponding scour protection would alter the ridge and trough habitat in the Project area. In the Mid-Atlantic Bight, infaunal assemblages and productivity differ between ridges and troughs (Byrnes et al. 2000; Slacum et al. 2010). For example, sand dollars and filter-feeding epibenthos are more prevalent on shoal crests than in troughs (VIMS 2000). In addition, the trough portions (or flat bottom) of the habitat generally have greater abundance, species richness, and species diversity, as well as greater abundance of benthic finfish, pelagic finfish, and pelagic invertebrates than ridges (or shoals); ridges with steeper elevation gradients had greater abundance than those with more gradual elevation changes (Slacum et al. 2010). The Wind Farm Area is dominated by sand and muddy sand interspersed with small to large patches of coarse sediment and small to large patches of coarse substrate such as pebbles or cobbles. Smaller areas of low-density boulders were also documented. Based on the 2022 benthic survey (Inspire 2022a), the vast majority of the impacts would be on soft-bottom habitat, with a small portion of impacts on complex (inclusive of coarse) habitats.

Structures may also reduce wind-forced mixing of surface waters, whereas water flowing around the foundations may increase vertical mixing. During summer, when water is more stratified, increased mixing could increase pelagic primary productivity near the structure, increasing the algal food source for zooplankton and filter feeders. Increased vertical mixing may also prevent or alter cold pool formation. Such alteration may cause finfish and invertebrates to avoid the area for the duration of the Project. Species that rely on soft-bottom habitat, such as surfclams and longfin squid, would experience a permanent reduction in habitat, which would no longer support these species, but not to the extent that population-level impacts would be expected. Therefore, potential impacts would be moderate.

The presence of WTGs is expected to result in wind-wake alterations in and around the Wind Farm Area due to downstream wind deficits that may result in changes to ocean stratification (mixing) and can reduce nutrient supplies to the ocean surface ocean and subsequently alter net primary productivity (Daewel et al. 2022; Christiansen et al. 2022). Turbulent processes near the sea surface boundary determine vertical fluxes between atmosphere and ocean and impacts can cascade downward into deeper layers. Resulting fluctuations of the mixed layer depth can alter nutrient availability, which, in turn, may affect local primary production and the nutrient balance (Christiansen et al. 2022; Daewel et al. 2022). Direct impacts of wind wake on fish include disturbance of fish larvae transport pathways (van Berkel et al. 2020).

Numerical modeling by Daewel et al. (2022) shows the offshore wind turbine–induced wind wakes in the North Sea result in large-scale changes in annual primary production with local changes of up to ±10 percent at offshore wind farm clusters and over a wider region; Christiansen et al. (2022) also report large-scale wake effects and subsequent changes to stratification in the southern North Sea. There are few empirical data showing the impact of WTGs on ocean stratification (Tagliabue et al. 2021), although recent models have demonstrated ocean mixing as a result of the wind-wake effect of WTGs in the North Sea (Carpenter et al. 2016; Floeter et al. 2017; Dorrell et al. 2022).

Importantly, net primary productivity is driven by photosynthesis in marine phytoplankton and accounts for half of global-scale photosynthesis and supporting major ocean ecosystem services (Field et al. 1998). However, interannual changes in net primary productivity in the North Atlantic are poorly correlated with parallel changes to stratification and emphasize the importance of other physical mechanisms, especially the Gulf Stream (Tagliabue et al. 2021). Wake-related changes are reportedly one order of magnitude smaller than the average perturbations due to climatic changes and account for a maximum of 10 percent of the annual and interannual variability of surface temperature in the southern North Sea (Christiansen et al. 2022). Potential impacts on net primary productivity in the north Atlantic from the Proposed Action are anticipated due to wind wake but, without additional data, impacts are considered negligible when compared with the effects of the Gulf Stream.

Large offshore wind farm clusters in the North Sea have been shown to result in large-scale changes in annual primary production with local changes (increase/decrease) of up to 10 percent, while region-wide averages in estimated annual primary production remain almost unchanged (Daewel et al. 2022). In the North Sea, the extent of wind wakes has been documented from 15 kilometers to 70 kilometers downstream of the wind farm and an average distance of 32 kilometers was reported by Christiansen et al. (2022), with highest deficits in the first kilometers behind the wind farm and a decrease over the downstream distance; wind wakes are highly dependent on ambient atmospheric conditions and subsequent changes in stratification are minor in shallow, mixed waters when compared with deeper waters.

Wake impacts would likely be permanent but variable, and because of the relatively low offshore wind blocking effect, impacts would be expected to be minor when compared to natural variability (Floeter et al. 2017). The greatest concern for Atlantic sturgeon with respect to placement of structures would be the changes in oceanographic and hydrologic conditions resulting from structures in the open ocean and the subsequent impacts on prey sources. However, Atlantic sturgeon consume prey not as closely affected by physical oceanographic features, such as the sand lance, mollusks, polychaete worms, amphipods, isopods, and shrimp, as other species discussed in the BA. Potential impacts on larval dispersion and survival of Atlantic sturgeon prey species from changes in hydrologic conditions are unlikely and impacts are expected to be negligible.

Concentration of recreational fishing around the foundations would potentially increase the risk of Atlantic sturgeon entanglement in vertical and horizontal fishing lines and subsequent injury and mortality due to infection and starvation. If there is an increase in recreational fishing in the Project area, it would likely represent a shift in fishing effort from areas outside the Wind Farm Area to within the Wind Farm Area or an increase in overall effort. Vessel safety concerns over proximity to foundations and other vessels limit the likelihood of recreational aggregations at the WTGs. Due to their benthic foraging strategy, Atlantic sturgeon have a reduced chance of being exposed to recreational fishing lines in the pelagic WTG area. Therefore, the potential impacts of fishing on the Atlantic sturgeon are expected to be short to long term and negligible to minor.

Gear utilization: Ocean Wind has committed to a Fisheries Monitoring Plan to assess fisheries status in the Project area and at a nearby control site throughout the pre-, during, and post-construction phases. Survey types include trawl surveys, environmental DNA surveys, structure-associated fishes surveys, clam surveys, pelagic fish surveys, and acoustic telemetry monitoring. Gear restrictions, closures, and other regulations set forth by take reduction plans would be adhered to as with typical scientific fishing operations to reduce the potential for interaction or injury to ESA-listed species.

The trawl surveys would be conducted using the Fishing Vessel Darana R, a 90-foot commercial dragger, and occur once per season, or four times per year. The trawls are designed to capture a representative sample of demersal fish species present in the impact and reference areas, emphasizing EFH and other species of commercial and recreational interest. This activity would directly affect EFH species and their prey through mortality of most or all of the trawled individuals. In addition to these direct impacts, bottom-disturbing trawls can alter the composition and complexity of soft-bottom benthic habitats. For example, when trawl gear contacts the seabed it can flatten sand ripples, remove epifaunal organisms and biogenic structures like worm tubes, and expose anaerobic sediments (BOEM 2022a). In this case, the survey tracks have been pre-selected by commercial fishermen based on their known suitability for bottom trawling. This indicates that the associated seabed is subjected to regular disturbance by commercial fishing activity, and that this type of disturbance has already and would continue to occur regardless of whether the Fisheries Research Monitoring Plan is implemented. Impacts on EFH species through capture during the trawl survey would not result in population-level impacts. Trawl surveys are not likely to significantly alter the rate and extent of disturbance of soft-bottom benthic habitat relative to the environmental baseline. BOEM therefore concludes that beam trawl surveys would not change the effects determination for EFH for any species in the EFH Assessment (BOEM 2022a). Mitigation measures for species protected under the ESA species that would be enacted during the trawl surveys include a short tow duration of 20 minutes; sampling during daylight only; marine mammal monitoring by the captain or other scientific crew member before, during, and after haul back; trawl operations commencing as soon as possible once the vessel arrives on station; and opening of codend[6] during haul back as quickly and carefully as possible to avoid damaging any protected species that may have been incidentally captured.

The environmental DNA sampling would occur synoptically with the trawl survey, enabling a more holistic understanding of the relative abundance and composition of the species assemblage at the Wind Farm Area. Environmental DNA sampling is non-invasive and can be conducted without causing damage to any individuals or the benthic habitat. BOEM therefore concludes that environmental DNA sampling would not change the effects determination for EFH for any species in the EFH Assessment (BOEM 2022a).

The multi-method survey for structure-associated fish would also be conducted concurrently with the trawl survey. Methods employed in the multi-method survey include chevron traps, rod-and-reel fishing, and baited remote underwater video. The equipment used for baited remote underwater video would include a weighted line attached to surface and subsurface buoys that would hold a stereo-camera system in the water column and a system at the seafloor. Fishing activity of the type described can damage benthic invertebrates on hard-bottom benthic habitat, resulting in long-term effects on community composition and complexity (Tamsett et al. 2010). However, hard-bottom benthic habitats within the Wind Farm Area, including the survey area, are regularly targeted by commercial trap and pot fisheries. This indicates that habitat disturbance from trap and pot placement is routine within the Wind Farm Area and would continue to occur regardless of whether the Fisheries Research Monitoring Plan is implemented. Moreover, the commercial fishing vessels contracted for the Fisheries Research Monitoring Plan would likely be engaged in trap and pot fishing if not engaged in research. As such, trap and pot survey activities under the Fisheries Research Monitoring Plan are not likely to measurably alter the extent or frequency of benthic habitat disturbance in the affected areas. Therefore, this activity is not likely to adversely alter the composition and complexity of EFH relative to the environmental baseline and any associated effects would be insignificant relative to those likely to result from the effects of Project construction and operation. BOEM therefore concludes that these surveys would not change the effects determination for EFH for any species in the EFH Assessment (BOEM 2022a). Mitigation measures for ESA-listed species that would be enacted during the structure-associated fishes surveys include a limited soak duration for chevron traps of less than 90 minutes, the vessel remaining on site during equipment deployment, lines used in the multi-method survey with a breaking strength of less than 1,700 pounds and weak links to reduce potential for moderate or significant NARW entanglement risk, labeled buoys with scientific permit numbers, immediate reports of any missing lines, and ensuring that deployment does not occur if any ESA-listed species are observed.

The clam survey would occur once yearly in the Project area and two control sites in August over at least 6 years. A towed, modified sampling dredge would be pulled by the Fishing Vessel Joey D at ten stations

[6] The terminal section of a trawl net in which captured fish may accumulate.

within the Project area and five stations at each of the two control sites. A robust commercial ocean quahog and surfclam fishery currently exists within the Wind Farm Area; therefore, similar dredging activities already regularly occur. The towed sampling dredge would cause localized and direct impacts on benthic EFH on both hard- and soft-bottom habitat, resulting in potentially long-term effects on community composition. Soft-bottom impacts would be short term and expected to recover quickly. BOEM therefore concludes that these surveys would not change the effects determination for EFH for any species in the EFH Assessment (BOEM 2022a).

The pelagic fish survey would employ two methods: towed, baited remote underwater video stations and autonomous gliders. The second survey method in the pelagic fish survey would occur while all survey vessels of opportunity (e.g., trawl survey vessel, clam survey vessel, glider deployment vessel, structure-associated habitat survey vessel) are underway. This survey would not result in additional vessel traffic. The survey techniques themselves would not cause any impacts on EFH or EFH-designated species. BOEM therefore concludes that these surveys would not change the effects determination for EFH for any species in the EFH Assessment (BOEM 2022a).

The acoustic telemetry survey would cover the Lease Area and adjacent inshore areas. Tagging efforts would not increase vessel transits, as they would occur aboard the trawl, trap, or hook-and-line sampling vessels. The sole increase to vessel traffic for this survey component would be the towing of the omni-directional hydrophone during the four trips per year by the 25-foot Research Vessel Resilience. BOEM has concluded that these surveys would not change the effects determination for EFH for any species in the EFH Assessment (BOEM 2022a).

Monitoring survey trawls are likely to adversely affect the Atlantic sturgeon. Capture of Atlantic sturgeon in trawl gear has the potential to result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations (Moser and Ross 1995; Collins et al. 2000; Moser et al. 2000). However, the use of trawl gear has been employed as a safe and reliable method to capture sturgeon, provided that the tow time is limited (NMFS 2014).

Negative impacts on sturgeon resulting from trawling capture are related to tow speed and duration (Moser et al. 2000). Northeast Fisheries Observer Program data from Miller and Shepherd (2011) indicate that mortality rates of Atlantic sturgeon caught in otter trawl gear is approximately 5 percent. Short tow durations and careful handling of individuals once on deck are likely to result in a very low risk of mortality of captured individuals (NMFS 2014, 2016). The equipment and methods used for the Project's trawl surveys are the same as are used for Northeast Area Monitoring and Assessment Program (NEAMAP) surveys. Northeast Fisheries Observer Program data calculate mortality rates of Atlantic sturgeon caught in otter trawl gear as approximately 5 percent (Miller and Shepherd 2011).

Atlantic sturgeon are captured incidentally in trawls used for scientific studies, including the standard NEFSC bottom-trawl surveys and both the spring and fall NEAMAP bottom-trawl surveys. However, the shorter tow durations and careful handling of any sturgeon once on deck during fisheries research surveys are likely to result in lower potential for mortality of captured individuals, as commercial fishing trawls tend to be significantly longer in duration. None of the hundreds of Atlantic and shortnose sturgeon captured in past state ocean, estuary, and inshore trawl surveys have had any evidence of serious injury and there have been no recorded mortalities. Both the NEFSC and NEAMAP surveys have recorded the capture of hundreds of Atlantic sturgeon since the inception of each. To date, there have been no recorded serious injuries or mortalities. In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s (NMFS 2016). To date, no serious injuries or mortalities of any sturgeon have been recorded in those surveys. A single capture of Atlantic sturgeon has occurred in trawl surveys currently being conducted for the South Fork Wind offshore wind project.

Given the dispersed nature of Atlantic sturgeon, the limited number of trawl tows that will be conducted, the short tow times of 20 minutes for the Project, and evidence that fisheries research surveys are associated with a low risk of mortality, BOEM does not anticipate serious injury or mortality of Atlantic sturgeon captured during Project trawl surveys. Therefore, the effects of trawl surveys from Project monitoring activities leading to potential capture or minor injury are anticipated to have minor to moderate impacts on small numbers of ESA-listed Atlantic sturgeon.

Vessel traffic: Project-related vessels used in pre-construction, construction, O&M, and decommissioning may pose a potential collision risk to finfish, including the Atlantic sturgeon. Construction activities (including offshore installation of WTGs, OSS, array cables, interconnection cable, and export cable) would require several vessel types transiting between the various ports and the Project area and result in an estimated total of 2,859 vessel trips over the 20-month construction period, or approximately 143 trips per month (COP Volume I, Section 6.1; Ocean Wind 2023). Vessels used and number of trips for decommissioning would be similar to those used in construction. Potential impacts on sturgeon from vessel traffic are detailed in the BA for the Project (BOEM 2022b).

While Atlantic sturgeon are known to be struck and killed by vessels in rivers and estuaries, there are no reports of vessel strikes in the marine environment, likely due to the space between bottom-oriented sturgeon and the propellers and hulls of vessels (BOEM 2021). Dunton et al. (2010) reported approximately 95 percent of all Atlantic sturgeon captured in sampling off New Jersey occurred in depths less than 66 feet (20 meters) with the highest catch per unit of effort at depths of 33 to 49 feet (10 to 15 meters). At these depths in open coastal and marine environments, Atlantic sturgeon are not likely to be struck by Project-related vessels. The dispersed nature of vessel traffic and individual sturgeons reduces the potential for co-occurrence of individual sturgeon and individual vessels throughout most of the Project area.

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). Atlantic sturgeon strikes are most likely to occur in areas with abundant boat traffic such as large ports or areas with relatively narrow waterways (ASSRT 2007). Vessel transits for the Project through the critical habitat of the Delaware River during spawning periods when sturgeon aggregate in the spring pose an increased risk of vessel strikes with Atlantic sturgeon. However, the infrequent nature of these transits and the existing vessel traffic in the Delaware River resulting from the Project are not expected to have a significant or measurable effect on Atlantic sturgeon in the Delaware River (NMFS 2021b). In offshore areas, the risk of a vessel strike is likely to be minimal due to overall lower densities of sturgeon and available space for sturgeon to avoid vessels in these areas. Therefore, the potential for vessel strikes to ESA-listed Atlantic sturgeon is considered extremely unlikely to occur and discountable.

3.13.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action reflect the impacts of the Proposed Action in combination with other ongoing and planned activities.

Accidental releases: The Proposed Action would contribute a noticeable increment to the cumulative impacts of accidental releases, which would likely be negligible and short term. Most of the risk of accidental releases of invasive species comes from ongoing activities, and the impacts (mortality, decreased fitness, disease) due to other types of accidental releases are expected to be negligible.

Anchoring: The Proposed Action would contribute an undetectable increment to the cumulative impacts of anchoring on finfish and invertebrates, which would likely be minor and short term, with localized impacts only occurring in the immediate vicinity of anchors. Anchoring would affect 19 acres under the Proposed Action and ongoing and planned activities, including the Proposed Action, could collectively affect up to 3.076 acres (12.4 km^2) (although some of this may occur after the resource has recovered from the earlier impacts). If anchoring occurs in sensitive SAV habitat, impacts would likely be moderate and long term within that specific habitat.

EMF: The Proposed Action would contribute an undetectable increment to the cumulative impacts because the Proposed Action would slightly increase the impacts of EMF in the geographic analysis area beyond those described under the No Action Alternative. The cumulative impact on finfish, invertebrates, and EFH would likely be negligible and localized but long term.

Lighting: The Proposed Action would contribute a undetectable to noticeable increment to the cumulative impacts. The Proposed Action would slightly increase the impacts of artificial lighting in the geographic analysis area beyond those described under the No Action Alternative. The cumulative impacts on finfish, invertebrates, and EFH would likely be minor and highly localized but long term.

Noise: The Proposed Action would contribute a noticeable increment to the cumulative noise impacts on finfish and invertebrates, which would likely be moderate, localized, and short term.

Presence of structures: The Proposed Action would contribute a noticeable increment to the cumulative impacts on finfish and invertebrates from the presence of structures , which would likely be minor to moderate, potentially beneficial, and long term, given that hard-structure surfaces could provide benefits to finfish and invertebrates while they are in place.

Cable emplacement and maintenance: Although cable routes and lengths for other offshore wind projects are not known at this time, using the assumptions in Appendix F, the total seafloor disturbance from new cable emplacement under the Proposed Action and other offshore wind projects is estimated to be 183,868 acres (744 km^2). In most locations, the affected areas are expected to recover naturally, and impacts would be short term because seabed scars associated with jet plow cable installation are expected to recover in a matter of weeks, allowing for recolonization (MMS 2009). Mechanical trenching, which could be used in coarser sediments, could result in more-intense disturbances and a greater width of the impact corridor, and is also expected to recover naturally. Other cable installation techniques would be expected to result in similar impacts. The Proposed Action would contribute a noticeable increment to the cumulative impacts on finfish from sediment resuspension during new cable emplacement, which would likely be negligible, as finfish would be expected to experience short-term and temporary behavioral impacts, resulting in displacement from the immediate vicinity of cable locations. The Proposed Action would contribute a noticeable increment to the cumulative impacts on invertebrates (disturbance, displacement, injury, and mortality) during new cable emplacement, which would likely be negligible to minor. However, the time period for recovery would depend on the mobility and life stage of the invertebrate species, with sessile organisms less able to avoid impacts and mobile organisms more able to avoid impacts. Similarly, the cumulative impacts on EFH would likely be long term but negligible to minor.

Gear utilization: The Proposed Action would contribute an undetectable increment to the cumulative impacts on finfish, which would likely be negligible, as impacts from fisheries surveys are expected to be localized and finfish are highly mobile and would be expected to experience short-term, temporary, and localized behavioral impacts where finfish may be displaced or captured by active survey gear. The Proposed Action would contribute an undetectable increment to the cumulative impacts (disturbance, displacement, injury, and mortality) on invertebrates and EFH, which would likely be negligible and short term, as impacts from surveys are expected to be localized and would often occur along transects already included in fisheries surveys. However, the time period for recovery would depend on the mobility and life stage of each species, with sessile organisms less able to avoid impacts and mobile organisms more able to avoid impacts.

Vessel traffic: The Proposed Action would contribute a noticeable incremental increase to the cumulative impacts of vessel traffic, which would likely be negligible and short term and minor with respect to the ESA-listed Atlantic sturgeon. Most of the risk of vessel traffic is due to ongoing and planned activities, and the impacts (mortality, decreased fitness, disease) due to additional vessel traffic are expected to be negligible to minor.

Discharges: The Proposed Action would contribute an undetectable increment to the cumulative impacts on finfish, which would be negligible because impacts on species or habitat would be so small as to be unmeasurable.

3.13.5.3. Conclusions

Impacts of the Proposed Action. Construction and installation, O&M, and decommissioning of the Proposed Action would have short- and long-term, permanent, and therefore **negligible** to **moderate** impacts on finfish, with the primary impacts on finfish occurring as a result of noise during construction and operation of the proposed Project. Short-term adverse effects include construction-related underwater noise impacts, crushing and burial effects, and disturbance of bottom substrates resulting in increased turbidity and sedimentation. O&M of the Wind Farm Area and offshore export cable route corridor (e.g., alteration of water column and benthic habitats, habitat conversion, operational noise, EMF and heat effects, hydrodynamic effects, food web effects) would result in long-term and permanent adverse effects on EFH for some life stages of EFH-designated species. Monopile foundations, scour protection, cable protection, and operational maintenance and improvements would alter or convert habitat, resulting in permanent habitat conversion. BOEM expects long-term impacts on EFH from construction and installation of the Proposed Action to be moderate, as habitat conversion is expected to occur over the life of the Project and would not recover naturally over time. Primary impacts on EFH would result from new cable emplacement, the presence of structures, and anchoring. Activities associated with construction and installation, O&M, and decommissioning of the Proposed Action alone would have **negligible** to **moderate** impacts on invertebrates through temporary disturbance and displacement, habitat conversion, and behavioral changes, injury, and mortality of sedentary fauna. For example, soft-bottom habitats that support Atlantic surfclam, ocean quahog, sea scallop, and others would be permanently converted to steel pile (foundation) and rock riprap and would not support these species, thereby reducing colonization and reproductive potential or recruitment.

The presence of structures may have a minor beneficial effect on invertebrates through an “artificial reef effect.” Despite invertebrate mortality and varying extents of habitat alteration, BOEM expects the long-term impact on invertebrates from construction and installation of the Proposed Action to be minor, as the resources would likely recover naturally over time. In general, the impacts are likely to be local on the scale of the benthic invertebrate geographic analysis area, and thus would not be expected to extend to the far larger geographic analysis area (New Jersey LME). The larger invertebrate geographic analysis area was selected to account for migratory movement of mobile species that are predicted to experience negligible impacts with respect to the Proposed Action’s contribution to the impacts of individual IPFs resulting from ongoing and planned activities. The primary impacts on invertebrates would be expected to occur as a result of new cable emplacement, the presence of structures, noise from pile driving, and anchoring.

Cumulative Impacts of the Proposed Action. The impacts resulting from individual IPFs would be negligible to moderate for finfish, invertebrates, and EFH. BOEM anticipates that the cumulative impacts on finfish, invertebrates, and EFH in the geographic analysis area associated with the Proposed Action would be **negligible** to **moderate**.

3.13.6 Impacts of Alternatives B, C, D, and E on Finfish, Invertebrates, and Essential Fish Habitat

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternatives B, C, D, and E. The impacts resulting from many of the individual IPFs associated with construction, O&M, and conceptual decommissioning of the Project under all action alternatives would be similar to those described under the Proposed Action. The number of WTGs would be reduced under Alternative B; the number of WTGs under Alternative C would be the same as under the Proposed Action, but structures would be compressed in a smaller area. Consequently, impacts associated with WTG construction, O&M, and decommissioning would be reduced under Alternative B but not under Alternative C in comparison to the Proposed Action, although the types of impacts and habitats affected would remain the same as for the Proposed Action. Under Alternatives D and E, specific areas of ridge and trough and SAV habitat, respectively, would be avoided and impacts on these habitats would be reduced when compared with the other action alternatives. Alternative D would remove up to 15 WTGs from the most sensitive area of ridge and sand habitat in the Project area. Under Alternative E, impacts on SAV would be reduced compared to the Proposed Action, as shown in Table 3.13-5.

The IPFs can be grouped under general evaluation of those with the potential to cause sedimentation and habitat alteration (e.g., cable emplacement, structures, anchoring), those that would generate noise (e.g., pile driving, construction noise, trenching, vessels), accidental releases (e.g., spills, debris, invasive species), EMF, the presence of structures (hydrodynamic disturbance, fish/invertebrate aggregation, migration disturbance), and climate change. The impacts expected to differ most among alternatives are from the presence of structures and cable installation and maintenance, while impacts of most IPFs (i.e., discharges, EMF, lighting, accidental releases, and anchoring) are expected to remain similar among the alternatives. These were considered in the following assessment of Alternatives B, C, D, and E on finfish, invertebrates, and EFH.

BOEM expects the decreased number of WTGs under Alternatives B-1 (up to nine WTGs), B-2 (up to 19 WTGs), and D (up to 15 WTGs) to have a slightly reduced impact on finfish, invertebrates, and EFH compared to the Proposed Action, given that there would be fewer foundations developed and therefore lower noise impact duration associated with pile driving and permanent loss of habitat. The most substantial difference would be relative to the presence of structures, which would be reduced by as many as 19 foundations for Alternative B-2 and up to 15 foundations for Alternative D (as described further in Section 3.6, *Benthic Resources* [Sections 3.6.6 and 3.6.7]).

The removal of WTGs in Alternative D would avoid impacts on the northeastern corner of the Lease Area, which has steeper and more biologically valuable sand ridge and trough features than other portions of the Project area. Ridges, and ridge and trough complexes, provide much of the large-scale physical relief and complexity on the OCS and represent macroscale habitats for finfish and invertebrates. These structures are also considered ecotones or habitat transition zones that enhance biological productivity and concentrate organisms at several trophic levels. Under Alternative D, impacts would be reduced compared to the Proposed Action by removal of up to 15 foundations and fewer miles of inter-array cable, resulting in an estimated 728 fewer acres of bottom impacts. Permanent impacts on complex habitat (NOAA habitat complexity category) would be reduced by 1.8 acres and soft-bottom habitat impacts would increase by 11.3 acres under Alternative D (refer to Table 3.6-4 in Section 3.6, *Benthic Resources*). Overall impacts (both adverse and beneficial) would be reduced associated with the presence of structures and conversion of habitat from existing bottom to scour protection.

Impacts from noise would be similar to those described in Section 3.13.5; however, the duration of impacts would be shorter due to the reduced number of foundations. A summary and comparison of changes to impact pile-driving requirements among these alternatives is provided in Table 3.15-2 in Section 3.15, *Marine Mammals*. Similarly, due to fewer WTG foundations, there would be a decrease in permanent benthic habitat loss and decreased impacts on hydrodynamics, which are discussed in Section 3.13.5.

Under Alternative E, the Oyster Creek export cable route would be limited to the option aimed at avoiding impacts on SAV in Barnegat Bay (as described in Section 3.6, *Benthic Resources*). Alternative E could result in significantly lower impacts on SAV; however, it would require additional trenching or HDD to avoid the SAV. It would be expected that impacts under Alternative E would result in greater benthic disturbance due to increased trenching and cable laying; therefore, impacts associated with increased turbidity, sedimentation, and burial would be greater under Alternative E. However, significantly less SAV would be affected under Alternative E relative to the southern route in the Proposed Action, which would be beneficial to numerous fish and invertebrate species that utilize this important inshore habitat. Impacts of HDD and dredging for cable landings in Barnegat Bay were listed previously in Table 3.13-2.

BOEM does not expect relocation of the eight WTGs and compression of the 98 WTGs under Alternatives C-1 and C-2, respectively, to significantly change the potential impacts compared to the Proposed Action, as the number of WTGs would remain the same and the overall footprint would remain the same or slightly less.

Given the assumed ubiquitous use of the water column throughout the OCS by finfish; smaller footprints under Alternatives B-1, B-2, C-1, and C-2; and the cable route under Alternative E, BOEM does not anticipate impacts to be significantly different than those described under the Proposed Action. Compared with the Proposed Action, Alternatives D and E would have reduced EFH impacts, specifically on ridge and trough habitat (Alternative D) and SAV habitat (Alternative E).

Table 3.13-5 SAV Impacts of Alternative E Compared to the Proposed Action

Data	Proposed Action Southern Route (Acres)	Proposed Action Northern Route/Alternative E (Acres)
1979 Data	15.25	0.89
1985–1987 Data	13.17	14.01
2003 Data	11.78	1.8
2009 Data	13.86	8.35
Ocean Wind Survey Data	15.25	0.89

Cumulative Impacts of Alternatives B, C, D, and E. The incremental impacts contributed by the action alternatives to the overall impacts from ongoing and planned activities would be similar to or slightly less than the impacts described under the Proposed Action.

3.13.6.1. Conclusions

Impacts of Alternatives B, C, D, and E. As discussed in the above sections, the anticipated impacts associated with the Proposed Action alone would not change substantially under all action alternatives considered. While the action alternatives could slightly change the impacts on finfish, invertebrates, and EFH, ultimately the same construction and installation, O&M, and decommissioning impacts would still occur, with the most pronounced being related to the addition of new structures and to noise. Alternatives

B-1, B-2, and D may result in slightly less, but not significantly different, **negligible** to **moderate** impacts on finfish, invertebrates, and EFH relative to those described under the Proposed Action. Alternative C-1 would have the same number of WTGs and overall footprint as the Proposed Action and would therefore have similar negligible to moderate impacts on fish and invertebrates. Alternative C-2 would have the same number of WTGs as the Proposed Action, but compressed into a smaller footprint, and would therefore have similar negligible to moderate impacts on finfish, invertebrates, and EFH.

Alternative E would have a slightly different cable route across Island Beach State Park to avoid SAV but would still require trenching activities. The anticipated impacts associated with Alternative E would be similar to those of the Proposed Action, although impacts on SAV within Barnegat Bay would be greatly reduced. The overall noticeable impacts would be similar across all action alternatives, although direct impacts on SAV would be reduced under Alternative E. Greater detail on impacts on, and avoidance of, SAV is provided in the EFH Assessment and Section 3.6, *Benthic Resources*.

Cumulative Impacts of Alternatives B, C, D, and E. The incremental impacts contributed by the action alternatives to the impacts from ongoing and planned activities would be undetectable to noticeable for finfish, invertebrates, and EFH. However, the differences in impacts among the action alternatives should still be considered alongside the impacts of other factors. Therefore, impacts on finfish, invertebrates, and EFH would be slightly less due to fewer WTGs, a smaller footprint, and avoidance of SAV and ridge and trough habitat but not significantly different for the geographic analysis area under all action alternatives. Considering all the IPFs together, BOEM anticipates that the overall impacts on finfish, invertebrates, and EFH associated with the action alternatives when each is combined with the impacts from ongoing and planned activities including offshore wind would be **negligible** to **moderate**.

3.13.7 Proposed Mitigation Measures

Several measures are proposed to minimize impacts on finfish (including ESA-listed fish), invertebrates, and EFH (Appendix H, Table H-2 and H-3). In the Draft EIS, BOEM analyzed a proposed winter flounder time-of-year restriction to minimize impacts on finfish. After publication of the Draft EIS, BOEM conducted consultation with NMFS pursuant to Section 305(b) of the MSA (i.e., EFH consultation), which resulted in NMFS issuing EFH Conservation Recommendations that replace the winter flounder time-of-year restriction measure analyzed in the Draft EIS. EFH Conservation Recommendations are analyzed collectively in Table 3.13-6. If one or more of the measures analyzed below are adopted by BOEM or cooperating agencies, some adverse impacts could be further reduced.

Table 3.13-6 Measures Resulting from Consultations (Also Identified in Appendix H, Table H-2): Finfish, Invertebrates, and Essential Fish Habitat

Measure	Description	Effect
PAM Plan	BOEM, BSEE, and USACE would ensure that Ocean Wind prepares a PAM Plan that describes all proposed equipment, deployment locations, detection review methodology and other procedures, and protocols related to the required use of PAM for monitoring. This plan would be submitted to NMFS, BOEM and BSEE (at OSWsubmittals@bsee.gov) for review and concurrence at least 120 days prior to the planned start of pile driving.	Ocean Wind has committed to implementing passive acoustic monitoring as part of the Proposed Action. Requiring that Ocean Wind submit a Passive Acoustic Monitoring Plan for agency approval further defines how the APM would be enforced. Because analysis of the Proposed Action already accounts for implementation of a Passive Acoustic Monitoring Plan, this measure would not further reduce the impact on finfish from underwater noise.

Measure	Description	Effect
Sound field verification	BOEM, BSEE, and USACE would ensure that if the clearance and/or shutdown zones are expanded, PSO coverage is sufficient to reliably monitor the expanded clearance and/or shutdown zones. Additional observers would be deployed on additional platforms for every 1,500 m that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification.	Sound field verification would increase the accountability of underwater noise mitigation during pile driving but would not alter the impact determination of negligible for gear utilization. While these measures would reduce risk and improve accountability under the Proposed Action, they would not alter the impact determination of negligible to minor for noise from WTG pile driving.
UXO detonations – Atlantic sturgeon	Ocean Wind would extend the APM seasonal restriction of UXO detonations (January to April) to include months of increased Atlantic sturgeon presence in the offshore wind area. No UXOs can be detonated from November to April in the offshore areas greater than 3 nautical miles (state waters). UXO surveys are expected in Fall of 2022 which defines the exact location and size of UXO.	The APM seasonal restriction of UXO detonations from January through April would effectively eliminate the likelihood of any exposures for Atlantic sturgeon. Should a sturgeon be exposed to noises above behavioral thresholds, the effects would likely be brief (e.g., Atlantic sturgeon may be startled and divert away from the area), and any effects would be so small that they could not be measured, detected, or evaluated
Procedures for regular gear haul out, gear identification, and recovery of lost survey gear	All sampling gear would be hauled at least once every 30 days, and all gear would be removed from the water and stored on land between survey seasons to minimize risk of entanglement. To facilitate identification of gear on any entangled animals, all trap/pot gear used in the surveys would be uniquely marked to distinguish it from other commercial or recreational gear. All reasonable efforts would be undertaken to recover lost gear and lost gear would be reported to NMFS and BSEE within 24 hours.	The regular hauling of sampling gear and recovery of lost survey gear would reduce risk of entanglement in fisheries survey gear. Gear identification would improve accountability in the case of gear loss. While adoption of these measures would reduce risk and improve accountability under the Proposed Action, it would not alter the impact determination of negligible for gear utilization. Monthly haul-out of gear will assist in decreasing the likelihood of gear being lost. Lost gear can result in fish and invertebrate mortality and affect sensitive habitats. Adherence to this mitigation measure is a proactive approach to minimize potential long-term impacts of lost gear on finfish, invertebrates, and sensitive habitats, including EFH.
Marine debris awareness training	The Lessee would ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually.	Training would improve management of trash and debris and reduce the potential for interactions and impacts on finfish, invertebrates, and EFH. This measure is not expected to change the overall impact determination for marine debris impacts.

Measure	Description	Effect
Training	At least one of the survey staff onboard the trawl surveys and ventless trap surveys would have completed NEFOP observer training (within the last 5 years) or other training in protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon). Reference materials for identification, disentanglement, safe handling, and genetic sampling procedures would be available on board each survey vessel. BOEM and BSEE would ensure that Ocean Wind prepares a training plan that addresses how this requirement would be met and that the plan is submitted to NMFS in advance of any trawl or trap surveys. This requirement is in place for any trips where gear is set or hauled.	Training would improve the potential for identification, safe handling, and disentanglement of finfish from any activities that include trawls, traps, or gear setting or hauling, and reduce the potential for harm to the ESA-listed Atlantic sturgeon. This measure is not expected to change the overall impact determination for gear impacts on finfish, invertebrates, and EFH.
Atlantic sturgeon identification and data collection	Any Atlantic sturgeon caught and/or retrieved in any fisheries survey gear will be identified to species or species group. Each ESA-listed species caught and/or retrieved would then be properly documented using appropriate equipment and data collection forms. Biological data, samples, and tagging would occur as outlined below. Live, uninjured animals should be returned to the water as quickly as possible after completing the required handling and documentation.	Identification and documentation of Atlantic sturgeon and subsequent return to the water of any tagged or captured fish would reduce the potential for harm to the fish and inform population trends for the species. While adoption of these measures would reduce risk and improve accountability under the Proposed Action, it would not alter the impact determination of negligible for gear utilization.
Atlantic sturgeon handling and resuscitation guidelines	Any Atlantic sturgeon caught and retrieved in gear used in fisheries surveys would be handled and resuscitated (if unresponsive) according to established protocols and whenever at-sea conditions are safe for those handling and resuscitating the animal(s) to do so.	Training would improve the potential for identification, safe handling, and disentanglement of finfish from any activities that include trawls, traps, or gear setting or hauling, and reduce the potential for harm to the ESA-listed Atlantic sturgeon. However, these measures would not alter the impact determination of negligible for gear utilization
Take notification	GARFO PRD would be notified as soon as possible of all observed takes of Atlantic sturgeon occurring as a result of any fisheries survey. At the end of each survey season, a report would be sent to NMFS that compiles all information on any observations and interactions with ESA-listed species.	Take notification would improve accountability for documenting Atlantic sturgeon take associated with the Proposed Action to inform the impacts of proposed and similar activities on population trends in the Atlantic sturgeon and other ESA-listed species. However, this would not alter the overall impact determination for the Proposed Action.

Measure	Description	Effect
Monthly/annual reporting requirements	BOEM and BSEE would ensure that Ocean Wind submits regular reports (in consultation with NMFS and USFWS) necessary to document the amount or extent of take that occurs during all phases of the proposed action.	Reporting requirements to document take would improve accountability for documenting take associated with the Proposed Action. While adoption of these measures would improve accountability, it would not alter the overall impact determination for the Proposed Action.
Data Collection BA BMPs	BOEM would ensure that all Project Design Criteria and BMPs incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (June 2021) shall be applied to activities associated with the construction, maintenance, and operations of the Project as applicable. Project Design Criteria and BMPs aim to minimize potential impacts on natural resources.	Adherence to these practices will assist in minimizing impacts on finfish, invertebrates, and EFH. However, this measure would not change the overall impact determination for impacts from the proposed activities.
Periodic Underwater Surveys, Reporting of Monofilament and other fishing gear around WTG foundations	The Lessee must monitor indirect impacts associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least 10 of the WTGs located closest to shore in the Ocean Wind 1 Lease Area (OCS-A 0498) annually. The Lessee must report the results of the surveys to BOEM and BSEE in an annual report.	Periodic underwater surveys and reporting of monofilament and other fishing gear around WTG foundations would reduce the risk of entanglement associated with the presence of structures. Implementation of this measure would reduce risk to finfish and their prey under the Proposed Action but would not alter the impact determination associated with the presence of structures and fishing gear.
Project design criteria (PDC) minimize vessel interactions with listed species	All vessels associated with survey activities (transiting [i.e., travelling between a port and the survey site] or actively surveying) must comply with the vessel strike avoidance measures specified below. The only exception is when the safety of the vessel or crew necessitates deviation from these requirements.	Compliance with project design criteria to minimize vessel interactions with listed species and vessel speed restrictions would reduce risk of vessel strikes to Atlantic sturgeon. While adoption of these measures would reduce risk to the Atlantic sturgeon under the Proposed Action, it would not alter the potential for vessel strikes to Atlantic sturgeon, which is considered extremely unlikely to occur and discountable.
Operational sound field verification	BOEM would require the Lessee to develop an operational sound field verification plan to determine the operational noises emitted from the Offshore Wind Area.	Operational sound field verification would allow BOEM to confirm that impacts of operating WTG noise does not exceed predicted impacts based on existing monitoring data and modeling efforts. While adoption of this measure would improve accountability of WTG operational noise under the Proposed Action, it would not alter the impact determination for WTG noise.

Measure	Description	Effect
EFH Conservation Recommendations	EFH Conservation Recommendations from NMFS were transmitted by letter dated February 24, 2023, which is included in its entirety in Attachment H-1 of Appendix H. EFH Conservation Recommendations for activities under BOEM's jurisdiction were provided for WTG and cable removal and relocation (micrositing), habitat alteration minimization, noise mitigation, contents of the Benthic Habitat and Fisheries Monitoring Plans. EFH Conservation Recommendations for activities under USACE's jurisdiction were provided for offshore impact minimization, inshore/ estuarine habitat impact minimization, and compensatory mitigation.	Implementation of Conservation Recommendations, including micro-siting WTGs, scour protection avoidance, anchoring avoidance, reduced distance in boulder/cobble relocation, and cable re-routing, would minimize known or reasonably foreseeable adverse impacts on EFH, including high-relief/high-heterogeneity and ridge/trough areas, NOAA Complex Category habitats, and fishing grounds such as "The Ham" and "Atlantic City Bluefish Lump," thereby minimizing the potential for the elimination/conversion of existing habitats and EFH. Conservation Recommendations for noise during construction, such as soft starts, use of noise-dampening equipment, and noise mitigation protocols in consultation with resource agencies prior to construction activities, would avoid and minimize potential noise impacts on EFH species and habitat. Implementation of Conservation Recommendations to revise the Benthic Habitat and Fisheries Monitoring Plans would benefit EFH and species by ensuring robust experimental design, methods, and data collection/analysis to assess changes in the benthic and fisheries communities in the Project area(s). Although implementation of the Conservation Recommendations would provide incremental reductions in impacts on the most unique and spatially limited components of the ridge and trough features and complex habitats and associated EFH, reductions in the overall impact rating are not anticipated for any of the Proposed Action's IPFs.

Measure	Description	Effect
Biological Opinion Reasonable and Prudent Measures (RPMs) and Terms and Conditions	RPMs and Terms and Conditions to minimize the impact of incidental take of ESA-listed species were documented in the NMFS Biological Opinion dated April 3, 2023. These measures include adherence to mitigation measures specified in the final MMPA ITA to minimize impacts during pile driving and UXO detonation; compliance with requirements for vessel operations within the Delaware River and Delaware Bay included in the Incidental Take Statements provided with the Paulsboro Marine Terminal Biological Opinion (dated July 19, 2022) and the New Jersey Wind Port Biological Opinion (dated February 25, 2022); reporting requirements related to effects to, or interactions with, ESA-listed species; submittal of required plans (e.g., PSO Training Plan for Trawl Surveys, Passive Acoustic Monitoring Plan, Marine Mammal and Sea Turtle Monitoring Plan, Cofferdam Installation and Removal Monitoring Plan, Alternative Monitoring Plan/Night Time Pile Driving Monitoring Plan, Sound Field Verification Plan, North Atlantic Right Whale Vessel Strike Avoidance Plan) to NMFS GARFO with sufficient time for review, comment and approval; and conducting on-site observation and inspection to gather information on the effectiveness and implementation of measures to minimize and monitor incidental take.	These RPMs and Terms and Conditions would minimize the exposure of ESA-listed species to pile-driving noise and the effects of UXO detonation. These RPMs and Terms and Conditions would also ensure that all incidental take that occurs is documented and reported to NMFS in a timely manner and that any incidentally taken individual specimens are properly handled, resuscitated if necessary, transported for additional care or reporting, or returned to the sea. Reporting requirements to document take would improve accountability for documenting take associated with the Proposed Action. In some cases, these PRMs and Terms and Conditions provide additional detail or clarification of measures that are included as part of the Proposed Action. Implementation of these RPMs and Terms and Conditions would provide incremental reductions in impacts on finfish, invertebrates, and sensitive habitats, including EFH, and would improve accountability, but would not alter the overall impact determination of the Proposed Action.

ft/sec = foot per second; GARFO = Greater Atlantic Regional Fisheries office; ITA = incidental take authorization; m = meter; NEFOP = Northeast Fisheries Observer Program; OSW = offshore wind; PAM = passive acoustic monitoring; PRD = Protected Resources Division; PSO = protected species observer; RPM = Reasonable and Prudent Measure

Table 3.13-7 Additional Proposed Measures (Also Identified in Appendix H, Table H-3): Finfish, Invertebrates, and Essential Fish Habitat

Measure	Description	Effect
Anadromous fish time of year restriction	Avoid construction activities during anadromous fish migration and spawning activity from March 1 through June 30 of each year within Barnegat Bay.	Avoidance of construction activities in Barnegat Bay during this sensitive time period will avoid potential disruption and mortality of anadromous species, including American shad, river herring (alewife and blueback herring), and striped bass. Avoiding impacts on migration during this time period is important to avoid affecting local populations.
Live and Hard Bottom Habitat Mapping and Avoidance	Vessel operators would be provided with maps of sensitive hard-bottom habitat in OSW Project area, as well as a proposed anchoring plan that would avoid or minimize impacts on the hard-bottom habitat to the greatest extent practicable. These plans would be provided for all anchoring activity, including construction, maintenance, and decommissioning.	The live and hard-bottom mapping would document presence of sensitive habitats in the Project area and inform avoidance and minimization of these habitats; this would reduce the extent of potential impacts on live and hard-bottom habitats from the proposed activities.
Live and Hard Bottom Impact Monitoring	The Lessee would develop and implement a monitoring plan for live and hard-bottom features that may be affected by proposed activities. The monitoring plan would also include assessing the recovery time for these sensitive habitats. BOEM recommends that all monitoring reports classify substrate conditions following the Coastal and Marine Ecological Classification Standards (CMECS), including live bottoms (e.g., submerged aquatic vegetation and corals and topographic features. The plan would also include a means of recording observations of any increased coverage of invasive species in the affected hard-bottom areas.	The live and hard-bottom monitoring plan would document conditions of live and hard-bottom habitats during construction and operational activities and assess potential impacts on these habitats, including extent of invasive species, to inform potential mitigation strategies and reduce potential impacts on these habitats.
Intake Screens on Pump Intakes for In-shore Hydraulic Dredges	All hydraulic dredge intakes should be covered with a mesh screen or screening device that is properly installed and maintained to minimize potential for impingement or entrainment of fish species. The screening device on the dredge intake should prevent the passage of any material greater than 1.25” in diameter, with a maximum opening of 1.25” x 6”. Water intakes should be positioned at an appropriate depth to avoid or minimize the entrainment of eggs and larvae. Intake velocity should be limited to less than 0.5 ft/sec.	Intake screens would reduce the potential entrainment of fish during hydraulic dredging; appropriate positioning of screens would reduce the entrainment of early life stages such as eggs and larvae. However, this would not alter the determination of negligible impact for Atlantic sturgeon from entrainment under the Proposed Action.

Measure	Description	Effect
Scour and Cable Protection	To the extent technically and economically feasible, the Lessee must ensure that all materials used for scour and cable protection consist of natural or engineered stone that does not inhibit epibenthic growth. The materials selected for protective purposes should mirror the natural environment and provide similar habitat functions.	The use of natural or engineered stone would not inhibit epibenthic growth and would provide three-dimensional complexity. This type of scour protection would most nearly replicate natural habitat features. This measure would reduce impacts on benthic habitat composition and structural complexity and, in the case of cable protection, reduce the time required for colonization by habitat-forming organisms. While long-term impacts from these structures would remain, the time required to achieve beneficial effects would decrease.

ft/sec = foot per second; OSW = offshore wind

3.13.7.1. Measures Incorporated in the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.13-6 and Table H-2 in Appendix H, *Mitigation and Monitoring*, are incorporated in the Preferred Alternative. BOEM has identified the following additional measures in Table 3.13-7 as incorporated in the Preferred Alternative: EFH Conservation Recommendations for WTG and cable removal and relocation (micrositing), habitat alteration minimization, noise mitigation, contents of the Benthic Habitat and Fisheries Monitoring Plans, and anadromous fish time-of-year restriction. These measures, if adopted, would further ensure the effectiveness and compliance of APMs by requiring the submittal of plans for approval by the enforcing agency(ies) and by defining reporting requirements. Time-of-year restrictions would have the overall effect of avoiding interactions with sensitive species and their habitat during spawning and migration periods in nearshore waters. While the impact determination for finfish or EFH, described in Section 3.13.2, would not change, these measures ensure the effectiveness and compliance with APMs already analyzed as part of the Proposed Action.

3.14. Land Use and Coastal Infrastructure (see Appendix G)

The reader is referred to Appendix G for a discussion of current conditions and potential impacts on land use and coastal infrastructure from implementation of the No Action Alternative, the Proposed Action, and other action alternatives.

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3.15. Marine Mammals

This section discusses potential impacts on marine mammal resources from the proposed Project, alternatives, and ongoing and planned activities in the marine mammal geographic analysis area. The marine mammal geographic analysis area, as shown on Figure 3.15-1, includes the Canadian Scotian Shelf, Northeast U.S. Continental Shelf, and Southeast Continental Shelf LMEs. This area is intended to capture the movement range for marine mammal species that could be affected by the Project. Due to the size of the geographic analysis area, the analysis for this EIS focuses on marine mammals that would likely occur in the Project area (see Figure 1-1, Section 1.2) and have the potential to be affected by Project-related activities, while providing context within the larger geographic analysis area.

3.15.1 Description of the Affected Environment for Marine Mammals

The Project area is used by a variety of species for a range of life-sustaining activities, migration, foraging, mating, and giving birth, which directly affect species distribution (Madsen et al. 2006; Weilgart 2007). Some species occur in all seasons (e.g., NARW, Risso's dolphins; Appendix I, Section I.4, Table I-8) while others are seasonally present in the area (e.g., harbor seal, harbor porpoise, blue whale, sperm whale). There are several species that have been considered seasonally occurring in the offshore area in the past; however, year-round occurrence near the Project area may also be possible (e.g., fin whale). Prey distribution can influence the distribution of marine mammals and is highly dependent on oceanographic properties and processes. Therefore, impacts on prey items must also be considered when assessing impacts on marine mammals. Impacts on availability of prey are addressed in Section 3.15.2 under the IPFs of climate change, noise, presence of structures, accidental releases, and lighting.

Marine mammal composition in the marine mammal geographic analysis area (see Figure 3.15-1) includes 38 species, comprising six mysticetes (baleen whales), 28 odontocetes (toothed whales), and four pinnipeds (BOEM 2014). Seventeen of those species (18 stocks[1]) have the potential to be affected by the Project, as they are likely to have regular or common occurrences in the Project area.

[1] The MMPA defines a marine mammal stock as a group of individuals "of the same species or smaller taxa in a common spatial arrangement that interbreed when mature."

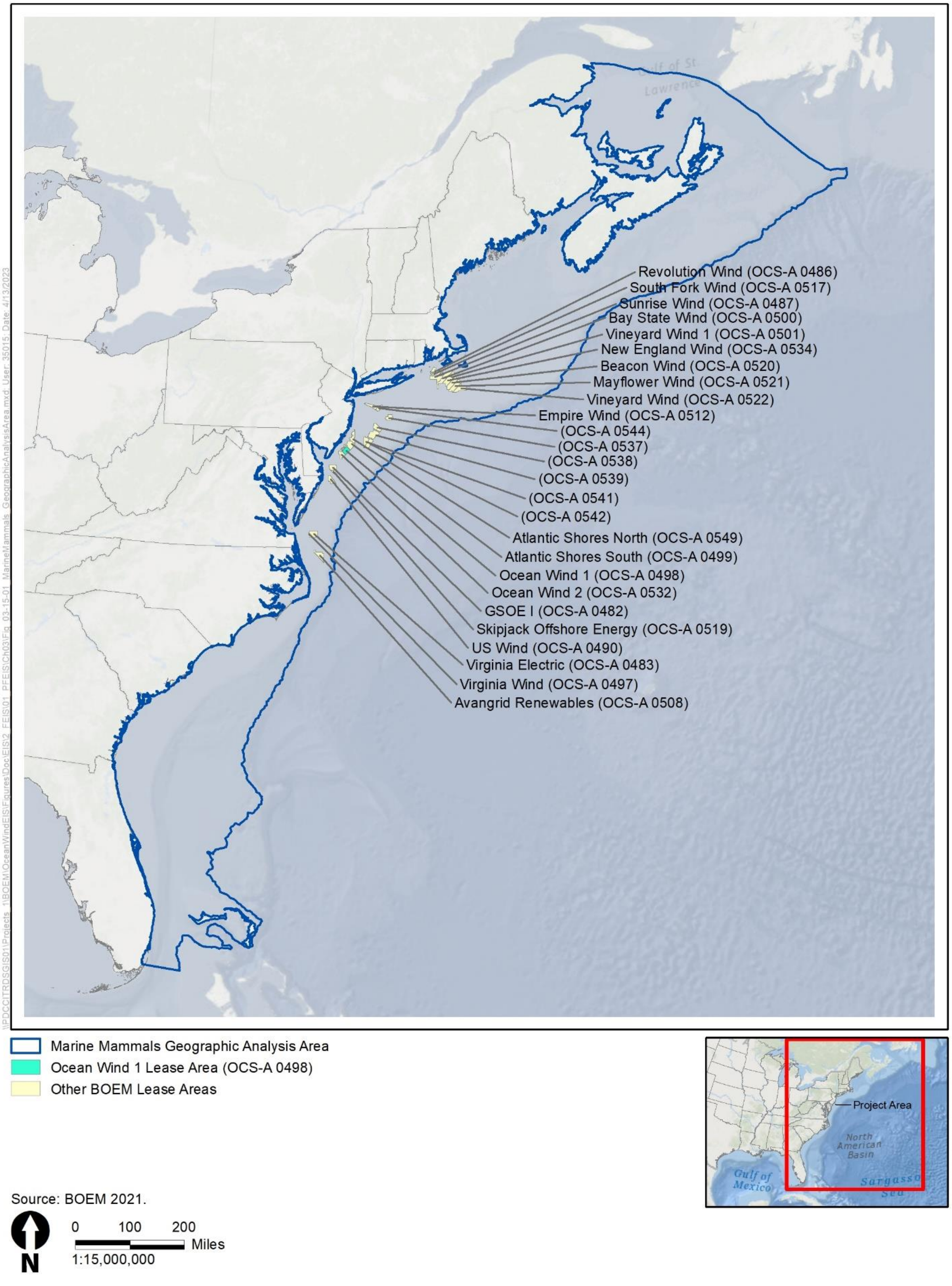

Figure 3.15-1 Marine Mammals Geographic Analysis Area

The analysis of the Proposed Action includes 17 species (18 stocks) of marine mammals that have been documented or are considered likely to occur in the Project area and have the potential to be affected by Project-related activities, as described in Section I.4 in Appendix I. Species occurrence, seasonality, habitat use, and density were determined based on the most current available aerial and vessel survey data, which are routinely collected near the Project area, as well as other available data including passive acoustic monitoring data and habitat-based modeling efforts conducted using multiple years of visual survey data. Several studies of marine mammal occurrence and distribution have been conducted in or near the Project area. NJDEP funded the New Jersey Ecological Baseline Studies (EBS) from January 2008 through December 2009 and used visual line-transect (aerial and shipboard) methods and passive acoustic monitoring to estimate the abundance and density of marine mammals from the shoreline to around 20 nm (37 kilometers) off the coast of New Jersey between Stone Harbor and Seaside Park (NJDEP 2010). Ship surveys were conducted once per month between January 2008 and December 2009. Aerial surveys were conducted once per month between February and May 2008, and twice monthly (when possible) between January and June 2009 (NJDEP 2010).

In addition, the Atlantic Marine Assessment Program for Protected Species (AMAPPS) coordinates data collection and analysis to assess the abundance, distribution, ecology, and behavior of marine mammals in the U.S. Atlantic. These include both ship and aerial surveys conducted between 2011 and 2019. Although the majority of AMAPPS survey effort has been focused on offshore areas outside the Project area, a portion were relevant to the assessment of the Proposed Action (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2018, 2020, 2022).

Habitat-based marine mammal density models for the U.S. Exclusive Economic Zone of the East Coast (eastern U.S.) and Gulf of Mexico were also developed by the Duke University Marine Geospatial Ecology Lab in 2016 (Roberts et al. 2016a). These models were recently updated in June 2022 (Roberts and Halpin 2022) and serve as a complete replacement for the Roberts et al. (2016a) models and subsequent updates and are based primarily on a collection of Roberts et al. (2016b, 2017, 2018, 2020, 2021a, 2021b) density estimates and data collected through September 2020. Collectively, these estimates are considered the best information currently available for marine mammal densities in the U.S. Atlantic; marine mammal densities used in this analysis are summarized in Attachment J-1 of Appendix J, *Underwater Sound and Acoustic Modeling Results*.

Threatened and Endangered Marine Mammals

The ESA (16 USC 1531 et seq.) classifies certain species as threatened or endangered based on their overall population status and health. Five marine mammals that are known to occur in the Project area (Figure 1-1, Section 1.2) are classified as endangered: the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), NARW (*Eubalaena glacialis*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*) (35 *Federal Register* 18319, December 2, 1970). Of the marine mammal species listed under the ESA, critical habitat has only been designated for the NARW (81 CFR 4838, January 27, 2016). Critical habitat for the NARW within the marine mammal geographic analysis area comprises the feeding areas in Cape Cod Bay, Stellwagen Bank, and the Great South Channel, as well as the calving grounds that stretch from off Cape Canaveral, Florida to Cape Fear, North Carolina (Hayes et al. 2021). The closest designated NARW critical habitat area is approximately 260 miles north of the Project area. These critical habitat areas do not overlap with the Project area; however, the general region is an important migratory corridor for a number of ESA-listed large whales including the NARW (Hayes et al. 2020, 2021). The nearest biologically important areas (BIA)[2] for NARW feeding have been

[2] BIAs identify areas and times within which cetacean species or populations are known to concentrate for specific behaviors, or be range-limited, and consist of reproductive areas, feeding areas, migratory corridors, and small and resident populations. NOAA's Biologically Important Areas Map is available at https://cetsound.noaa.gov/biologically-important-area-map.

identified well north of the Project area near Georges Bank, Cape Cod Bay, and the Gulf of Maine between the months of April and July (Van Parjis et al. 2015). BIAs for NARW migration overlap with the Project area and surrounding waters for the months of March–April and November–December (Van Parjis et al. 2015). No other BIAs have been identified near the Project area.

In 2017, an Unusual Mortality Event (UME) began for NARW and in that year a total of 31 mortalities, serious injuries, and morbidities were documented. Between 2017 and April 2023, a total of 98 mortalities, serious injuries, and morbidities (sublethal injury and illness) of NARW were documented (NOAA Fisheries 2023a). Entanglement in fishing gear and vessel strikes are the preliminary causes of mortality, serious injury, and morbidity during the ongoing UME. The whales affected by the UME represent more than 20 percent of the population. The draft 2022 NMFS stock assessment report estimates the median population abundance (Nbest) is 338 NARWs (Hayes et al. 2022b).

Other endangered species that have the potential to occur near the Project area are the fin whale, blue whale, sei whale, and sperm whale. Fin whales are common/regular year-round residents of the areas near the Project area with peak abundances noted in the spring, summer, and fall (Hayes et al. 2021). BIAs for fin whale feeding have been identified to the north of the Project area, off Rhode Island Sound between March and October, and year-round for Georges Bank, Cape Cod Bay, and the Gulf of Maine (Van Parjis et al. 2015). Blue whales have been observed near the Project area in spring and summer but are considered rare visitors (Waring et al. 2011). BIAs have not been identified for blue whales on the East Coast (Van Parjis et al. 2015). Sei whales are also considered rare in the Project area but regular visitors to the offshore areas near the continental slope where they have been observed year-round. BIAs for sei whale feeding have been identified north of the Project area, stretching from the Gulf of Maine to the continental shelf off Georges Bank between the months of March and November (Van Parjis et al. 2015). Sperm whales generally prefer deeper waters off the continental slope and are found primarily in water 200 to 1,500 meters deep. They are considered uncommon year-round visitors near the Project area with peak abundances likely to occur in the spring, summer, and fall. Based upon the most recent NOAA Fisheries stock assessments (Hayes et al. 2020, 2021), the population estimates for these species are as follows: 6,802 fin whales in the western North Atlantic stock, 402 blue whales in the western North Atlantic stock, 6,292 sei whales in the Nova Scotia stock, and 4,349 sperm whales in the North Atlantic stock (as outlined in Appendix I).

Non-Endangered Marine Mammals

Pursuant to the MMPA (16 USC 1361 et seq.), all marine mammals are protected, and their populations are monitored by NOAA and USFWS. Mysticetes that are not endangered or threatened and regularly occur in the Project area include the humpback whale and minke whale. BIAs for humpback whale feeding have been identified near Georges Bank, Cape Cod Bay, and the Gulf of Maine between the months of March and December (Van Parjis et al. 2015), all of which are more than 450 kilometers north of the Project area. Humpback whales have a regular occurrence near the Project area in the spring, summer, and fall and may occur year-round (Hayes et al. 2021). A UME was declared for this species in January 2016, and since then, 28 humpback whales have stranded off New Jersey, with 191 coastwide (NOAA Fisheries 2022a). A potential leading cause of the ongoing UME is vessel strikes; however, more research is necessary to be definitive. Minke whales are also considered common in the waters near the Project area. BIAs for minke whale feeding have been identified on Georges Bank, in Cape Cod Bay, and the Gulf of Maine between the months of March and November (Van Parjis et al. 2015), all of which are more than 450 kilometers north of the Project area. A UME was also declared for the minke whale in January 2017 (NOAA Fisheries 2022b). A total of 142 individuals stranded from Maine to South Carolina, and preliminary results of necropsy examinations indicate evidence of human interactions or infectious disease; however, these results are not conclusive (NOAA Fisheries 2022b).

Odontocetes known to occur near the Project area include pilot whales (*Globicephala* spp.), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), common dolphins (*Delphinus delphis*), bottlenose dolphins (*Tursiops truncatus*), Risso's dolphins (*Grampus griseus*), and harbor porpoise (Hayes et al. 2020, 2021). Two species of pilot whale (*Globicephalus* spp.) occur along the edge of the U.S. continental shelf in the winter and early spring: the long-finned pilot whale (*Globicephalus melas*) and the short-finned pilot whale (*Globicephalus macrorhynchus*). They move onto the Georges Bank and into the Gulf of Maine and more northern waters in late spring and remain there until late autumn (Hayes et al. 2020). Atlantic white-sided dolphins could potentially be observed in the Project area; their seasonal abundance estimates off New Jersey were highest in the spring, followed by fall with very low numbers in the fall to no estimate during the winter (Palka et al. 2017). Two distinct stocks of Western North Atlantic bottlenose dolphins can occur within the Project area: the migratory coastal stock and the offshore stock (Hayes et al. 2021). Although they can be difficult to identify from surveys, the two stocks exhibit slightly different ecotypes, with both morphological and genetic differences. During warmer months, the migratory coastal stock is found from the coastline out to the 20-meter isobath from Assateague, Virginia, north to Long Island, New York, and in the colder months this stock has been found to occupy coastal waters from Cape Lookout, North Carolina, north to the North Carolina/Virginia border (Hayes et al. 2021). Because the current assessment relies heavily on survey data, the two stocks are referred to collectively. Density models predicted that Risso's dolphins (which typically prefer deeper waters) occur at very low densities near the Project area even in offshore areas close to the shelf break (Roberts and Halpin 2022), but no sightings of Risso's dolphins in the Project area or coastal strandings were recorded. Harbor porpoises prefer coastal waters shallower than 150 meters but can also be found farther offshore and are considered regular visitors to the Project area particularly during the winter and possibly during spring and summer months (Hayes et al. 2020). Current population estimates for these species are included in Appendix I, Table I-8.

The most common pinniped species documented in the Project area are harbor and gray seals, with the former being the most dominant (Hayes et al. 2022a). Data on habitat use and foraging of harbor and gray seals in the mid-Atlantic are limited; however, there are three major harbor seal haul-out sites in New Jersey: (1) Great Bay, which is adjacent to the Project area (and the largest haul-out south of Long Island, New York), (2) Barnegat Inlet/Barnegat Lighthouse, and (3) Sandy Hook (Slocum et al. 2005; NJDEP 2010; CWF 2023). The population of harbor seals has increased in the mid-Atlantic states in recent years, with regular occurrences in North Carolina and consistent haul-outs of 40–60 individuals in Virginia and the Chesapeake Bay (Rees et al. 2016). In March 2019, 45 seals were detected via aerial surveys of the known haul-outs: six in the Sandy Hook area, five in the Barnegat Lighthouse area, and 34 in the Great Bay area (Ocean Wind 2019). Another ground-based survey recorded 145 seals at the Great Bay site. Since July 2018, increased numbers of gray seal and harbor seal mortalities have been recorded across Maine, New Hampshire, and Massachusetts (Hayes et al. 2021). This event has been declared a UME by NMFS and encompasses 3,152 seal strandings from Maine to Virginia (Hayes et al. 2021). Off New Jersey, 172 seals stranded between July 2018 and March 2020 (NOAA Fisheries 2020). The pathogen phocine distemper virus was found in the majority of deceased seals and, based on this finding, has been identified as the cause of the UME. This 2018–2022 UME is non-active with closure pending. Since June 2022, another UME for harbor and gray seals has been declared by NMFS off the southern and central coast of Maine, with 322 seal strandings between June and December 18, 2022 (NOAA Fisheries 2023b). Preliminary testing has found some of the harbor and gray seals affected by the June 2022 UME to be positive for highly pathogenic avian influenza H5N1. Current population estimates for these species are included in Appendix I, Table I-8.

Overview of Sound and Marine Mammal Hearing

Underwater noise can be described through a source-path-receiver model. An acoustic source emits sound energy that radiates outward and travels through the water and the seafloor as pressure waves, which is the most relevant component of sound to marine mammals. The sound level decreases with increasing distance from the acoustic source as the sound pressure waves spread out under the influence of the surrounding environment. The amount by which the sound levels decrease between a source and receiver is called transmission loss (Richardson et al. 1995). The amount of transmission loss that occurs depends on the source-receiver separation, frequency of the sound, properties of the water column, and properties of the seafloor layers. Underwater sound levels are expressed in dB, which is a logarithmic ratio relative to a fixed reference pressure of 1 μPa (equal to 10^{-6} Pa or 10^{-11} bar).

Underwater sound can be produced by biological and physical oceanographic sources, as well as anthropogenic sources. A brief overview of acoustic units and the propagation of underwater sound can be found in Appendix J, *Underwater Sound and Acoustic Modeling Results*. Biological sounds include vocalizations made by marine mammals and physical oceanographic sounds, including wind and wave activity, rain, sea ice, and undersea earthquakes. Anthropogenic (human-introduced) sounds include shipping and other vessel traffic, military activities, marine construction, oil and gas exploration, and more. Some of these natural and anthropogenic sounds are present everywhere in the ocean all of the time; therefore, background sound in the ocean is commonly referred to as “ambient noise” (DOSITS 2019). The efficiency of underwater sound propagation allows marine mammals to use underwater sound as a primary method of communication, navigation, prey detection (i.e., foraging), and predator avoidance (Richardson et al. 1995; Southall et al. 2007; OSPAR Commission 2009). Anthropogenic noise has gained recognition as an important stressor for marine mammals because of their reliance on underwater hearing for maintenance of these critical biological functions (Richardson et al. 1995; Ketten 1998). Underwater noise generated by human activities can often be detected by marine mammals many kilometers from the source. With decreasing distance from a noise source, potential acoustic impacts can result in mortality, non-auditory injury, permanent or temporary hearing loss, behavioral changes, and acoustic masking. All of these effects have the potential to induce impacts on marine mammals (OSPAR Commission 2009; Erbe 2013).

Auditory masking occurs when sound signals used or produced 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 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, 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). The potential for masking can be assessed qualitatively by comparing the frequencies of anthropogenic sources with the frequencies at which marine mammal vocalizations are made and the hearing ranges of marine mammal species.

Marine mammals are acoustically diverse, with wide variations in ear anatomy, hearing frequency range, and amplitude sensitivity (Ketten 1991). An animal’s sensitivity to sound likely depends on the presence and level of sound in certain frequency bands and the range of frequencies to which the animal is most sensitive (Richardson et al. 1995). In general, larger species, such as baleen whales, are believed to hear better at lower frequency ranges than smaller species, such as porpoises and dolphins. Hearing abilities are generally only well understood for smaller species for which audiograms (plots of hearing threshold at different sound frequencies) have been developed based on captive behavioral studies (reactions to sound or behavioral audiograms), and electrophysiological experiments (measuring auditory evoked potentials) on captive or stranded animals (Erbe et al. 2012). Audiograms have been obtained in some toothed whale (odontocetes) and pinniped species (Southall et al. 2007; Finneran 2015), while direct measurements of baleen whale (mysticetes) hearing are lacking (Ridgway and Carder 2001). Baleen whale hearing sensitivities have therefore been estimated based on anatomy, modeling, vocalizations, taxonomy, and behavioral response studies (Houser et al. 2001; Ketten and Mountain 2011, 2014 in Southall et al. 2019; Cranford and Krysl 2015; Richardson et al. 1995; Wartzok and Ketten 1999; Au and Hastings 2008; Dahlheim and Ljungblad 1990; Reichmuth 2007).

Auditory Criteria for Injury and Disturbance

Assessment of the potential effects of underwater noise on marine mammals requires acoustic thresholds against which received sound levels can be compared. Acoustic thresholds from underwater noise are expressed using two common metrics: SPL, measured in dB relative to 1 μPa (dB re 1 μPa), and sound exposure level (SEL), a measure of energy in decibels relative to 1 μPa squared second (dB re 1 $\mu Pa^2 s$). SPL is an instantaneous value represented as either root mean squared (RMS) SPL (also, SPL_{RMS}) or peak SPL (also, SPL_{peak}), whereas SEL is the total noise energy to which an organism is exposed over a given time period, typically 1 second for pulse sources. As such, the cumulative SEL (SEL_{cum}) metric is appropriate when assessing effects to marine mammals from cumulative exposure to multiple pulses.

For marine mammals, NMFS has developed Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (NMFS 2018a). The technical guidance established acoustic criteria identifying the potential for onset of permanent threshold shift (PTS) and TTS (NMFS 2018a). NMFS developed dual metric thresholds that consider the peak SPL and cumulative SEL and marine mammal weighting functions. The thresholds are divided by hearing group to acknowledge that not all marine mammal species have identical hearing or susceptibility to noise-induced hearing loss (Table 3.15-1). NMFS has also established behavioral disturbance thresholds for marine mammals that utilize an RMS SPL of 160 dB re 1 μPa for impulsive/intermittent sounds and 120 dB re 1 μPa for continuous sounds for all marine mammal species (NOAA 2013). Unlike PTS and TTS thresholds, behavioral disturbance thresholds are not frequency weighted to account for different hearing abilities by the five marine mammal hearing groups.

Table 3.15-1 Marine Mammal Hearing Groups

Hearing Groups	Functional Hearing Groups	Taxonomic Group	Generalized Hearing Range*
Low-frequency cetaceans (LFC)	Low-frequency cetaceans	Baleen whales (e.g., humpback whale, blue whale)	7 Hz to 35 kHz
Mid-frequency cetaceans (MFC)	Mid-frequency cetaceans	Most dolphin species, beaked whales, sperm whale	150 Hz to 160 kHz
High-frequency cetaceans (HFC)	High-frequency cetaceans	True porpoise, river dolphins, *Cephalorhynchus* dolphins)	275 Hz to 160 kHz
Phocid pinnipeds in-water (PW)	Phocid pinnipeds in-water	Phocid or true seals (e.g., harbor seal)	50 Hz to 86 kHz
Otariid pinnipeds in-water (OW)	Otariid pinnipeds in-water	Otariid (e.g., sea lions and fur seals)	60 Hz to 39 kHz

Source: NMFS 2018a
kHz = kilohertz

Table 3.15-2 outlines the acoustic thresholds for onset of hearing impairment (PTS and TTS) for marine mammals for both impulsive and non-impulsive noise sources. For further detail about classification of underwater sounds, please see Appendix J, *Underwater Sound and Acoustic Modeling Results*. Impulsive noise sources considered in this assessment include impact pile driving, some HRG equipment, and UXO detonation. Non-impulsive noise sources include vibratory pile driving, vessel traffic, some HRG equipment, turbine operations, and dredging.

Table 3.15-2 NMFS PTS and TTS Thresholds (NMFS 2018a)

Marine Mammal Hearing Group	Effect	Impulsive Source		Non-Impulsive Source
		PK (dB re 1 μPa)	Weighted SEL_{24h} (dB re 1 μPa²s)	Weighted SEL_{24h} (dB re 1 μPa²s)
Low-frequency cetaceans (LFC)	PTS	219	183	199
	TTS	213	168	179
Mid-frequency cetaceans (MFC)	PTS	230	185	198
	TTS	224	170	178
High-frequency cetaceans (HFC)	PTS	202	155	173
	TTS	196	140	153
Phocid pinnipeds underwater (PW)	PTS	218	185	201
	TTS	212	170	181
Otariid pinnipeds underwater (OW)	PTS	232	203	219
	TTS	226	188	199

Note: Peak sound pressure (PK) values are flat weighted or unweighted within the generalized hearing range of marine mammals (i.e., 7 Hz to 160 kilohertz): Values presented for SEL_{cum} use a 24-hour cumulative analysis unless stated otherwise.
dB re 1 μPa = decibels relative to 1 micropascal; dB re 1 μPa^{2}s = decibels relative to 1 micropascal squared second

Mortality and Non-auditory Injury Criteria for Explosives (Unexploded Ordnance)

Shock waves associated with underwater detonations can induce non-auditory physiological effects, including direct tissue damage involving mortality (i.e., severe lung injury), slight lung injury, and gastrointestinal injury known as *primary blast injury*. The gas-containing organs (lungs and gastrointestinal tract) are most vulnerable to primary blast injury. The U.S. Navy established thresholds to identify to assess the potential for mortality, slight lung, and gastrointestinal injury from explosive sources; this assessment adopts and applies these thresholds. The magnitude of the acoustic impulse (which is the integral of the instantaneous sound pressure) of the underwater blast causes the most common injuries, and therefore its value is used to determine if there is potential for mortality and slight lung injuries. Gastrointestinal injury potential is identified using the peak SPL (Navy 2017). Mortality and slight lung injury threshold for each depends upon an animal's mass and depth. Table 3.15-3 provides an estimate of mass of the different marine mammal species considered in this assessment. Table 3.15-4 lists equations used to calculate thresholds based on effects observed in 1 percent of exposed animals.

Table 3.15-3 Representative Calf/Pup and Adult Mass Estimates Used for Assessing Impulse-based Onset of Lung Injury and Mortality Threshold Exceedance Distances

Impulse Animal Group	Representative Species	Calf/Pup Mass (kilograms)	Adult Mass (kilograms)
Baleen whales and sperm whale	Sei whale (*Balaenoptera borealis*) Sperm whale (*Physeter macrocephalus*)	650	16,000
Pilot and minke whales	Minke whale (*Balaenoptera acutorostrata*)	200	4,000
Beaked whales	Gervais' beaked whale (*Mesoplodon europaeus*)	49	366

Impulse Animal Group	Representative Species	Calf/Pup Mass (kilograms)	Adult Mass (kilograms)
Dolphins, kogia, pinnipeds, and sea turtles	Harbor seal (*Phoca vitulina*)	8	60
Porpoises	Harbor porpoise (*Phocoena phocoena*)	5	40

Table 3.15-4 Thresholds for Onset of Non-auditory Injury Based on Observed Effects on 1 Percent of Exposed Animals (Navy 2017)

Hearing Group	Mortality (Severe lung injury)*	Slight Lung Injury[1]	Gastrointestinal Tract Injury
All marine mammals	$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa·s	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa·s	$L_{pk,flat}$: 237 dB

[1] Lung injury (severe and slight) thresholds are dependent on animal mass.
M animal (adult and/or calf/pup) mass (kilograms) (see Table C.9 in Navy 2017)
D animal depth (meters)

Auditory Explosive Thresholds

The supersonic shock wave from an explosion transitions to a normal pressure wave at a range determined by the weight and type of the explosive used. The ranges to the impulsive TTS and PTS thresholds (Table 3.15-2) are applicable for determining auditory injury impacts.

Behavioral Explosive Thresholds

Single blast events within a 24-hour period are not presently considered by NMFS to produce behavioral effects below the onset of TTS thresholds for frequency-weighted SEL and peak pressure level (Table 3.15-2). Therefore, the effective disturbance threshold for single events in each 24-hour period is the TTS onset.

3.15.2 Environmental Consequences

3.15.2.1. Impact Level Definitions for Marine Mammals

Definitions of potential impact levels for adverse effects from each alternative are provided in Table 3.15-5. Definitions for duration and significance criteria are provided in Section 3.3. Beneficial impacts are also described, as applicable, for each IPF. Beneficial impacts are those that result in a positive effect on marine mammals. Impact levels are intended to serve NEPA purposes only and they are not intended to incorporate similar terms of art used in other statutory or regulatory reviews. For example, the term “negligible” is used for NEPA purposes as defined here and is not necessarily intended to indicate a negligible impact or effect under the MMPA. Similarly, the use of “detectable” or “measurable” in the NEPA significance criteria is not necessarily intended to indicate whether an effect is “insignificant” or “adverse” for purposes of ESA Section 7 consultation.

Table 3.15-5 Impact Level Definitions for Marine Mammals

Impact Level	Impact Type	Definition
Negligible	Adverse	The impacts on individual marine mammals or their habitat, if any, would be at the lowest levels of detection and barely measurable, with no perceptible consequences to individuals or the population.
	Beneficial	Impacts on species or habitat would be beneficial but so small as to be unmeasurable.
Minor	Adverse	Impacts on individual marine mammals or their habitat would be detectable and measurable; however, they would be of low intensity, short term, and localized. Impacts on individuals or their habitat would not lead to population-level effects.
	Beneficial	If beneficial impacts occur, they may result in a benefit to some individuals and would be temporary to short term in nature.
Moderate	Adverse	Impacts on individual marine mammals or their habitat would be detectable and measurable; they would be of medium intensity, can be short term or long term, and can be localized or extensive. Impacts on individuals or their habitat could have population-level effects, but the population can sufficiently recover from the impacts or enough habitat remains functional to maintain the viability of the species both locally and throughout their range.
	Beneficial	Beneficial impacts on species would not result in population-level effects. Beneficial impacts on habitat may be short term, long term, or permanent but would not result in population-level benefits to species that rely on them.
Major	Adverse	Impacts on individual marine mammals or their habitat would be detectable and measurable; they would be of severe intensity, can be long lasting or permanent, and would be extensive. Impacts on individuals and their habitat would have severe population-level effects and compromise the viability of the species.
	Beneficial	Beneficial impacts would promote the viability of the affected population or increase population resiliency. Beneficial impacts on habitats would result in population-level benefits to species that rely on them.

3.15.3 Impacts of the No Action Alternative on Marine Mammals

Section 3.1 of the Final EIS explains the approach to predicting impacts related to the No Action Alternative. When analyzing the impacts of the No Action Alternative on marine mammals, BOEM considered the impacts of past and ongoing trends and activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for marine mammals and how the No Action Alternative affects those baseline conditions. BOEM separately analyzes how resources will be affected over time as reasonably foreseeable activities are implemented. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*. Separate impact conclusions are presented for both scenarios.

3.15.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, BOEM would not approve the COP. Various stressors associated with the construction, operations, and maintenance of the Project would not occur. However, baseline conditions for marine mammals described in Section 3.15.1, *Description of the Affected Environment for Marine Mammals*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. As such, this section primarily discusses the impacts from baseline conditions and separately makes conclusions on the incremental impact of not approving the COP.

Marine mammals in the geographic analysis area are currently subject to a variety of ongoing human-caused IPFs. The main known contributors to mortality events include collisions with vessels (ship strikes), entanglement with fishing gear, and fisheries bycatch. Other important IPFs considered include underwater noise from anthropogenic sources, pollution (accidental spills and waste discharge), and climate change. For example, impacts associated with climate change have the potential to reduce reproductive success and increase individual mortality and disease occurrence, which could have population-level effects. Many marine mammal migrations cover long distances, and these factors can have impacts on individuals over broad geographic and temporal scales.

Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on marine mammals include:

- Continued O&M of the Block Island project (five WTGs) installed in state waters;
- Continued O&M of the Coastal Virginia Offshore Wind pilot project (two WTGs) installed in OCS-A 0497; and
- Construction and O&M of two offshore wind projects, the Vineyard Wind 1 project (62 WTGs and 1 OSS) in OCS-A 0501 and the South Fork project (12 WTGs and 1 OSS) in OCS-A 0517.

The effects of approved projects have been evaluated through previous NEPA review and are incorporated by reference. Ongoing O&M of the Block Island and pilot Coastal Virginia Offshore Wind projects and construction and O&M of the Vineyard Wind 1 and South Fork projects would affect marine mammals through the primary IPFs of noise and presence of structures. Ongoing offshore wind activities would have the same type of impacts from noise, presence of structures, cable emplacement and maintenance, port utilization, and lighting that are described in detail in Section 3.15.3.2 for planned offshore wind activities.

Ongoing non-offshore wind activities that may affect marine mammals include, but are not limited to, submarine cables and pipelines, tidal energy projects, oil and gas activities, dredging and port improvement, marine minerals extraction, military use (i.e., sonar, munitions training), marine transportation, research initiatives, and installation of new structures (such as artificial reefs) on the U.S. Continental Shelf (see Section F.2 in Appendix F for a description of ongoing activities). These activities could result in temporary or permanent displacement and injury or, to a lesser extent, mortality of individual marine mammals. See Table F1-13 for a summary of potential impacts associated with ongoing non-offshore wind activities by IPF for marine mammals.

It is difficult to consider all potential impacts on marine mammals within the geographic analysis area while considering the interconnectedness of those impacts. The paragraphs below provide an overview of what is known regarding the IPFs affecting marine mammals.

Traffic (vessel strikes): Vessel collisions are a major source of mortality and injury for many marine mammal species (Hayes et al. 2021; Laist et al. 2001). Almost all sizes and classes of vessels have been involved in collisions with marine mammals around the world, including large container ships, ferries, cruise ships, military vessels, recreational vessels, commercial fishing boats, whale-watch vessels, research vessels, and even jet-skis (Dolman et al. 2006). Research into vessel strikes and marine mammals has focused largely on baleen whales given their higher susceptibility to a strike because of their larger size, slower maneuverability, larger proportion of time spent at the surface foraging, and inability to actively detect vessels using sound (i.e., echolocation). Focused research on vessels strikes on toothed whales is lacking. Factors that affect the probability of a marine mammal vessel strike and its severity include number, species, age, size, speed, health, and behavior of animal(s) (Martin et al. 2016; Vanderlaan and Taggart 2007); number, speed, and size of vessel(s) (Martin et al. 2016; Vanderlaan and Taggart 2007); habitat type characteristics (Gerstein et al. 2006; Vanderlaan and Taggart 2007); operator's ability to avoid collisions (Martin et al. 2016); vessel path (Martin et al. 2016; Vanderlaan and Taggart 2007); and the ability of a marine mammal to detect and locate the sound of an approaching vessel. Vessel strikes have been preliminarily determined as a leading cause of death for humpback whales during the current UME (NOAA Fisheries 2022a) and a primary contributor to the NARW UME (NOAA 2022).

North Atlantic cetaceans and pinnipeds including, but not limited to, the fin whale, humpback whale, NARW, sei whale, minke whale, sperm whale, long-finned pilot whale, Risso's dolphin, Atlantic white-sided dolphin, common bottlenose dolphin, harbor porpoise, harbor seal, and gray seal, are all common or regular visitors within the geographic analysis area and could be susceptible to vessel collisions. Most odontocetes (e.g., harbor porpoise) and pinnipeds (e.g., harbor seals) are considered to be at low risk for vessel strikes due to their swimming speed and agility in the water. Although data are limited, events of vessel collisions were recorded by Hayes et al. 2021 for the following species:

- Since 2017, there have been there have been 16 confirmed vessel strikes on NARWs; 14 of those resulted in mortality or serious injury. From 2016–2020, 29 percent of the observed mortality and serious cases were attributed to vessel strike (Hayes et al. 2022b). Applying this to the estimated mortality/serious injury cases (n= 156), it is estimated that 46 cases of mortality have occurred between the same time period (Hayes et al. 2022b). In 2020, 1.3 collisions occurred with U.S. vessels. Two cases of morbidity (a lesser impact than mortality/serious injury) are documented in the NARW UME. Although vessel strikes with NARW may not seriously injure or kill the animal, sustained injuries can be internal and affect reproductive success (van der Hoop et al. 2012; Corkeron et al. 2018).
- For data collected in 2020, the fin whale had an annual average rate of 0.8 U.S. vessel collision. Between 2014 and 2018, there were confirmed fin whale mortalities linked with vessel collisions: two in 2016 and one each in 2017 and 2018.
- Similar to the fin whale, the annual average rate of vessel collisions was 0.8 per year for the sei whale.
- The minke whale had between one and two confirmed cases of whale mortalities linked with vessel traffic in North Atlantic waters between 2014 and 2018, with the exception of the year 2016, which had no confirmed deaths. The average rate of vessel collisions is 1.2 in U.S. waters.
- Humpback whales: Of the 184 whales involved in the 2016–2023 humpback whale UME, 40 percent showed evidence of human interaction (either entanglement or vessel strike). The exact percentage attributable to vessel strike alone is not available; however, recent strandings in the New York/New Jersey area demonstrate that vessel strikes of humpback whales remain a serious threat.
- From 2014 to 2018, 692 common bottlenose dolphins of the Northern Migratory Coastal Stock stranded between North Carolina and New York; 11 percent (n = 80) had evidence of human interaction and of those 5 percent (n = 4) exhibited evidence of vessel strikes. Nineteen percent (n = 134) showed no evidence of human interaction and 69 percent (n = 478) could not be determined.
- Hayes et al. 2021 did not report any harbor porpoise strandings exhibiting evidence of vessel strikes for the Gulf of Maine/Bay of Fundy stock.

Vessel speed and size are important factors for determining the probability and severity of vessel strikes. The size and bulk of the large vessels inhibit the ability for crew to detect and react to marine mammals along the vessel's transit route. Two vessel types that carry AIS transponders were thought to be of the highest threat to humpback whales in the New York Bight apex: tug/tow vessels due to their ability to traverse shallower waters outside shipping channels where humpbacks are frequently found, and passenger vessels due to their high rate of speed (Brown et al. 2019).

Smaller vessels have also been involved in marine mammal collisions. Minke whales, humpback whales, fin whales, and NARWs have been killed or fatally wounded by whale-watching vessels around the world (Jensen et al. 2003; Pfleger et al. 2021). Strikes have occurred when whale-watching boats were actively watching whales as well as when they were transiting through an area (Laist et al. 2001; Jensen et al. 2003). Small vessels, other than whale watching vessels, are also potential sources of large whale vessel strikes; however, many go unreported and are a source of cryptic mortality (Pace et al. 2021). Vessel traffic in the vicinity of the Project area from March 2019 to February 2020 was composed of cargo/carriers (22.4 percent), fishing vessels (19.6 percent), pleasure craft (19.1 percent), tugs (11.4 percent), other/undefined (11.1 percent), cruise ships/large ships (10.5 percent), and tanker/oil tanker (5.8 percent) (COP Volume III, Appendix M; Ocean Wind 2023). Vessels more than 80 meters in length or longer, and therefore those more likely to cause lethal or severe injury to large whales (Laist et al. 2001), in this area account for up to 38.7 percent of vessel traffic.

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 that most lethal or severe injuries are caused by ships 80 meters or longer traveling at speeds greater than 13 knots. A more recent analysis conducted by Conn and Silber (2013) built upon collision data collected by Vanderlaan and Taggart (2007) and Pace and Silber (2005) 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). The relationship between lethality and strike speed was still evident; however, the speeds at which 50 percent probability of lethality occurred was approximately 9 knots. Vanderlaan and Taggart (2007) reported that the probability of whale mortality increased with vessel speed, with greatest increases occurring between 8.6 and 15 knots, and that the probability of death declined by 50 percent at speeds less than 11.8 knots.

As a result of these findings, NMFS implemented a seasonal, mandatory vessel speed rule in certain areas along the U.S. East Coast in 2008 to reduce the risk of vessel collisions with NARW. These Seasonal Management Areas require vessel operators to maintain speeds of 10 knots or less and to avoid Seasonal Management Areas when possible. Effectiveness of the Seasonal Management Area program was reviewed by NMFS in 2020. Results indicated that while it was not possible to determine a direct causal link, the mortality and serious injury incidents on a per-capita basis suggest a downward trend in recent years (NOAA 2020a). NARW vessel strike mortalities decreased from 10 prior to the implementation of Seasonal Management Areas to 3, while serious injuries (defined as a 50-percent probability of leading to mortality) increased from 2 to 4 and injuries increased from 8 to 14 (potentially due to increased monitoring levels). Laist et al. 2014 and NMFS (2020) assessed the effectiveness of Seasonal Management Areas 5 years after their initiation by comparing the number of NARW and humpback whale carcasses attributed to ship strikes since 1990 to proximity to the Seasonal Management Areas. Prior to implementation of Seasonal Management Areas, they found that 87 percent of NARW and 46 percent of humpback whale ship-strike deaths were found either inside Seasonal Management Areas or within 52 miles (83 kilometers, 43 nm), and that no ship-struck carcasses were found within the same proximity during the first 5 years of Seasonal Management Areas.

NMFS also recognized that NARW may be present outside of established Seasonal Management Areas; therefore, temporal voluntary Dynamic Management Areas are established when a group of three or more NARWs are sighted; similarly, a NARW acoustic Slow Zone is triggered if an acoustic detection is made. Right Whale Slow Zones and Dynamic Management Areas are voluntary programs NOAA Fisheries uses to notify vessel operators to slow down to avoid right whales. Mariners are encouraged to avoid the Dynamic Management Area/Slow Zone or reduce speed to less than 10 knots when transiting through the area. NMFS establishes a Dynamic Management Area/Slow Zone boundary around the whales for 15 days and alerts mariners through radio and local notices.

In 2022, NMFS proposed changes to the 2008 NARW vessel speed rule to further reduce the likelihood of mortalities and serious injuries to NARW from vessel collisions. The proposed rule, if issued, would: (1) modify the spatial and temporal boundaries of current Seasonal Management Areas, (2) include most vessels greater than or equal to 35 feet (10.7 meters) and less than 65 feet (19.8 meters) in length in the size class subject to speed restriction, (3) create a Dynamic Speed Zone framework to implement mandatory speed restrictions when whales are known to be present outside active Seasonal Management Areas, and (4) update the speed rule's safety deviation provision (NOAA Fisheries 2022c).

In general, large baleen whales are more susceptible to a vessel strike than smaller cetaceans and pinnipeds. While there are rare reports of toothed whales/delphinds being struck by ships (Van Waerebeek et al. 2007; Wells and Scott 1997), these animals are at relatively low risk due to their speed and agility (Richardson et al. 1995). However, the behavioral choice by small delphinds to bowride does expose them to the potential for vessel strike and has occurred seasonally in Florida (Wells and Scott 1997) as vessel traffic increases with recreational vessels. Pinnipeds are also fast and maneuverable in the water and have sensitive underwater hearing, potentially enabling them to avoid being struck by approaching vessels (Olson et al. 2021). Of the 3,633 stranded harbor seals in the Salish Sea (Canada/U.S.) from 2002–2019, 28 exhibited injuries consistent with propeller strike (Olson et al. 2021). There are very few documented cases of seal mortalities as a result of vessel strikes in the literature (Richardson et al. 1995). Large whales are more susceptible to vessel strikes than other marine mammals due to their large size, slower travel and maneuvering speeds, lower avoidance capability, and increased proportion of time they spend near the surface (Laist et al. 2001; Vanderlaan and Taggart 2007). In the marine mammal geographic analysis area, whales at risk of collision include NARW, humpback whales, blue whales, fin whales, sei whales, sperm whales, and, to a lesser extent, minke whales due to their smaller size (Hayes et al. 2020, 2021). The impacts of traffic (vessel strikes) on marine mammals, with the exception of NARW, from ongoing activities (from any vessel) would be moderate because it is likely to result in long-term consequences to individuals or populations that are detectable and measurable. Impacts of traffic (vessel strikes) on individual mysticetes could have population-level effects, but the population should sufficiently recover. BOEM notes that not all populations (e.g., minke whales, fin whales) are experiencing population-level consequences from vessel strikes; however, vessel strikes are a threat for all whales. The impacts of traffic (vessel strikes) on NARW from ongoing activities would be major and long term because vessel strikes have had and continue to have population level effects that compromise the viability of the species. The impacts of traffic (vessel strikes) on odontocetes and pinnipeds from ongoing activities would be minor to moderate because population-level effects are unlikely although consequences to individuals would be detectable and measurable.

The likelihood of an offshore wind vessel striking a marine mammal is negligible. BOEM concluded that vessel strikes were unlikely to occur from ongoing offshore wind projects because of the relatively low number of vessel trips and monitoring and mitigation activities to avoid vessel strikes (BOEM 2021a, 2021b). Therefore, ongoing offshore wind activities are anticipated to have no effect on marine mammals via the vessel traffic IPF, as vessel strikes from this industry are not likely to occur.

Gear utilization: Global demand for fish as a food source will likely increase; however, output of seafood from wild fish capture has plateaued (Costello et al. 2020). Although traditional fisheries' gear utilization may not increase, there is potential for more aquaculture gear utilization to meet the growing demand (Costello et al. 2020). Fisheries interactions can have adverse effects on marine mammal species, with estimated global mortality exceeding hundreds of thousands of individuals each year (Read et al. 2006). Marine mammals can ingest or become entangled in marine debris (e.g., ropes, plastic) that is lost from fishing vessels and other offshore activities. The majority of recorded marine megafauna entanglements are directly or indirectly attributable to ropes and lines associated with fishing gear (Benjamins et al. 2014; Harnois et al. 2015; McIntosh et al. 2015). Depending on the severity of entanglement, this could lead to reduced foraging and swimming capacity and eventual mortality due to drowning.

Entanglement is listed as a threat to humpback whales, NARWs, blue whales, fin whales, sei whales, common bottlenose dolphins, and gray seals (Hayes et al. 2020, 2021). There is limited information regarding entanglements of blue, fin, sei, and minke whales; however, evidence of fishery interactions causing injury or mortality has been noted for each of these species in the Greater Atlantic Regional Fisheries Office/NMFS entanglement/stranding database (Hayes et al. 2021). Of the available information, there are considerable data on the potential for entanglement of humpback whales. A study of 134 individual humpback whales in the Gulf of Maine suggested that between 48 and 65 percent of the whales experienced entanglements (Robbins and Mattila 2001) and that 12 to 16 percent encounter gear annually (Robbins 2012). Along with vessel collisions (discussed above), entanglement of humpback whales could be limiting the recovery of the population (Hayes et al. 2020). Entanglement in fishing gear has also 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).

Limited information is available for sperm whale entanglement mortalities; however, from 1993 to 1998 there were documented three sperm whale entanglements, two of which were in the North Atlantic Ocean. Three additional sperm whale mortalities from entanglement were also documented in 2009–2010 in a similar region (Waring et al. 2015). There are no documented reports of fishery-related mortality or serious injury to this stock in the U.S. exclusive economic zone during 2013–2017 (Hayes et al. 2020).

Pinnipeds, including harbor seals and gray seals, are also at risk for entanglements (Hayes et al. 2020, 2021). Drowning or asphyxiation in gear, chronic secondary complications of injuries, and feeding impairment are all associated with entanglement mortalities in seals (Moore et al. 2013). A 2014 unoccupied aerial system survey of large populations of gray and harbor seals was used to assess the prevalence of entanglement within haul-out locations in the North Atlantic. The mean prevalence of entanglement within the haul-outs varied between 0.83 percent and 3.70 percent (Waring et al. 2015). However, observed serious injury rates are lower than would be expected from the anecdotally observed numbers of gray seals living with ongoing entanglements, as gray seals entangled in netting are common at haul-out sites in the Gulf of Maine and southeastern Massachusetts. This may be because the majority of observed animals are dead when they come aboard the vessel at bycatch (Josephson et al. 2021); therefore, rates do not reflect the number of live animals that may have broken free of the gear and are living with entanglements. Martins et al. 2019 estimated the mean prevalence of live entangled gray seals at haul-out sites in Massachusetts and Isle of Shoals to be between 1 and 4 percent.

Bycatch occurs in various commercial, recreational, and subsistence fisheries with hotspots driven by marine mammal density and fishing intensity (Lewiston et al. 2014). Small cetaceans and seals are at most risk of being caught as bycatch due to their small body size that allows them to be taken up in fishing gear. Of the species considered in this assessment, Risso's dolphins, short-finned pilot whales, harbor porpoises, white-sided dolphins, harbor seals, and gray seals have been documented in several fisheries' bycatch data. Several commercial fisheries have documented bycatch. The ones that most commonly report bycatch are pelagic longlining, bottom trawling, and sink gillnetting (Hayes et al. 2020, 2021). Purse seine fisheries, Atlantic blue crab trap/pot, North Carolina roe mullet stop net, and hook and line (rod and reel) have also noted instances of marine mammal bycatch.

Stranding data indicate that other marine mammal species may be affected by entanglements or bycatch; however, the contribution of fishery-related mortalities and serious injuries to these strandings is often difficult to determine. This is because not all of the marine mammals that die or are seriously injured wash ashore, and not all will show signs of entanglement or other fishery interaction (Hayes et al. 2020, 2021). As a result, the contribution of fisheries interactions to the annual mortality and injury of marine mammal species in the geographic analysis area and beyond is likely underestimated (Hayes et al. 2020, 2021). Although the duration of increased gear utilization is long term, the frequency of individual gear in any one location throughout the geographic analysis area is short term and localized. The impacts of gear utilization on mysticetes, odontocetes, and pinnipeds from ongoing non-offshore wind activities would be moderate because it is likely to result in long-term consequences to individuals or populations that are detectable and measurable, with the exception of NARW. Impacts on individual mysticetes, odontocetes, and pinnipeds could have population-level effects, but the population should sufficiently recover. Gear utilization from ongoing non-offshore wind activities would likely result in long-term major impacts for NARW because impacts on individual NARWs could have severe population-level effects and compromise the viability of the species.

BOEM does not anticipate that mysticete, odontocete, and pinniped entanglement with gear used for biological monitoring in ongoing offshore wind projects would occur. There are no documented cases associated with biological monitoring for the Block Island, Coastal Virginia Offshore Wind pilot project, and Vineyard Wind 1 wind farms. There are 13 documented seal deaths from South Fork Wind Farm biological monitoring; however, these occurred during gillnet surveys and South Fork Wind Farm has since ceased gillnet surveys. While impacts from gear utilization associated with biological resource monitoring on individual marine mammals could occur, monitoring plans will have sufficient mitigation procedures in place to reduce potential impacts so as to not result in population-level effects. Accordingly, impacts are expected to be minor to moderate (BOEM 2021a, 2021b).

Noise: Underwater sound is a pervasive issue throughout the world's oceans and can adversely affect marine mammals. Vessel traffic, seismic surveys, and active naval sonars are the main anthropogenic contributors to low- and mid-frequency noises in oceanic waters (NMFS 2018a), with vessel traffic the dominant contributor to ambient sound levels in frequencies below 200 Hz (Arveson and Vendittis 2000; Veirs et al. 2016). In the marine mammal geographic analysis area, underwater noise from anthropogenic sources includes offshore marine construction activities (including pile driving), vessel traffic, seismic surveys, sonar and other military training activities. The long-term effects of multiple anthropogenic underwater noise stressors on marine mammals across their large geographical range are difficult to determine and relatively unknown. The potential for these stressors to have population-level consequences likely varies by species, among individuals, across situational contexts, and by geographic and temporal scales (Southall et al. 2021).

Noise generated from ongoing non-offshore wind activities includes impulsive (e.g., seismic surveys,[3] sonar, military training [sonar and munitions training]) and non-impulsive (e.g., vessels, aircraft, dredging) sources. Impact pile driving, seismic exploration, and sonar surveys can lead to PTS/injury-level effects in marine mammals. In addition, high-intensity tactical sonar activities have been linked to stranding events (Fernandez et al. 2005; Cox et al. 2006; Balcolmb and Claridge 2001; Jepson et al. 2003; Wang and Yang 2006; Parsons et al. 2008; D'Amico et al. 2009; Dolman et al. 2010). All noise sources that are audible by a given species have the potential to cause behavioral effects and some may also cause PTS and TTS when in closer proximity to the sound source. The frequency and number of noise-generating anthropogenic activities in the marine mammal geographic analysis area are relatively unknown. If marine mammal populations are subjected to multiple anthropogenic noise stressors throughout their lifetimes that disrupt critical life stages (e.g., feeding, breeding, calving) and throughout

[3] Seismic surveys used in oil and gas exploration create high-intensity impulsive noise to penetrate deep into the seabed, whereas site characterization surveys associated with offshore wind typically use sub-bottom profiler technologies, such as shallow penetrating high-resolution seismic systems, that generate less-intense sound waves more similar to common deep-water echosounders. Exploratory oil and gas surveys are anticipated to occur infrequently over the next 35 years.

their ranges, then impacts from noise from ongoing non-offshore wind activities could be major, particularly for listed species such as NARW, and have the potential to result in population-level effects through detectable and measurable impacts on the individual that could compromise the viability of the species.

BOEM previously determined that noise impacts on marine mammals from pile driving for Vineyard Wind 1 would be negligible for mid-frequency cetaceans (MFC) and high-frequency cetaceans (HFC) and pinnipeds. Minor impacts on NARW were determined due to avoidance of peak seasons of occurrence and the incorporation of extensive mitigation specific to the species. Impacts from pile driving were determined to be moderate for all other marine mammals in the low-frequency hearing group. Impacts of vessel noise during construction were determined to be moderate for all mysticetes because the lower frequency of sound emitted from vessels overlaps in the most sensitive hearing range of mysticetes. Potential temporary behavioral impacts on all other marine mammals from vessel traffic and temporary impacts on marine mammals from cable-laying noise were determined to be minor. Operation of WTGs was determined to result in negligible impacts on marine mammals (BOEM 2021a). No mortality or non-auditory injury of any marine mammal would occur.

For South Fork, BOEM’s analysis determined construction noise exposures associated with impact pile driving would have moderate effects on fin, minke, and humpback whales and harbor porpoises; minor effects on NARW and Atlantic spotted, Atlantic white-sided, common bottlenose, and common dolphins; and negligible effects on Risso’s dolphin and sei, sperm, and pilot whales. Construction vessel noise impacts on marine mammals was assessed to be minor. Dredging noise effects on marine mammals from O&M facility construction were expected to be negligible, while vibratory and impact pile-driving noise to install moorage improvements at the O&M facility would likely result in minor effects on seals and porpoises (BOEM 2021b).

BOEM reviewed underwater noise levels produced by the available types of HRG survey equipment as part of a programmatic BA for this and other activities associated with regional offshore wind energy development. NMFS concurred with BOEM’s determination that planned HRG survey activities using even the loudest available equipment types would be unlikely to injure or measurably affect the behavior of ESA-listed marine mammals. The rationale supporting this conclusion also applies to non-listed marine mammal species. Specifically, the noise levels produced by HRG survey equipment are relatively low, meaning that an individual marine mammal would have to remain close to the sound source for extended periods of time to experience injury. This type of exposure is unlikely, as the sound sources are continuously mobile and directional (i.e., pointed at the bottom) (BOEM 2021a).

Accidental releases and discharges: Marine mammals are particularly susceptible to the effects of contaminants from pollution and discharges as they accumulate through the food chain or are ingested with garbage. Polychlorinated biphenyls (PCBs) and chlorinated pesticides (e.g., DDT, DDE, dieldrin) are of most concern and can cause long-term chronic impacts. These contaminants can lead to issues in reproduction and survivorship, and other health concerns (e.g., Pierce et al. 2008; Jepson et al. 2016; Hall et al. 2018; Murphy et al. 2018); however, the population-level effects of these and other contaminants are unknown. Research on contaminant levels for many marine mammal species is lacking. Some information has been gathered from necropsies conducted from bycatch and therefore focus on smaller whale species and seals. Moderate levels of these contaminants have been found in pilot whale blubber (Taruski et al. 1975; Muir et al. 1988; Weisbrod et al. 2000). Weisbrod et al. (2000) examined PCBs and chlorinated pesticide concentrations in bycaught and stranded pilot whales in the western North Atlantic. Contaminant levels were similar to or lower than levels found in other toothed whales in the western North Atlantic, perhaps because they are feeding farther offshore than other species (Weisbrod et al. 2000). Dam and Bloch (2000) found very high PCB levels in long-finned pilot whales in the Faroe Islands. Also, high levels of toxic metals (e.g., mercury, lead, cadmium) and selenium were measured in pilot whales harvested in the Faroe Islands drive fishery (Nielsen et al. 2000).

Impacts from accidental releases and discharges associated with the ongoing construction and operation of offshore wind projects have been previously analyzed and were anticipated to result in negligible impacts (BOEM 2021a, 2021b). Offshore wind projects will comply with their Oil Spill Response Plan and USCG requirements for the prevention and control of oil and fuel spills. However, impacts from accidental releases and discharges from ongoing non-offshore wind activities would likely be minor for mysticetes, odontocetes, and pinnipeds and are unlikely to result in population-level effects, although consequences to individuals would be detectable and measurable, except for the NARW. Impacts from accidental releases and discharges from ongoing non-offshore wind activities would likely be moderate to major and long term for NARW and have the potential to result in population-level effects through detectable and measurable impacts on the individual that could compromise the viability of the species.

EMF: There are four in-service and six out-of-service submarine telecommunication cables present in the offshore export cable corridor and in the vicinity of the Project area. The four in-service cables would presumably continue to operate and generate EMF effects under the No Action Alternative. While the type and capacity of those cables is not specified, the associated baseline EMF effects can be inferred from available literature. Fiber-optic communications cables with optical repeaters would not produce EMF effects. Impacts from EMF from ongoing non-offshore wind activities would likely be negligible for mysticetes, odontocetes, and pinnipeds, of the lowest level of detection, and barely measurable, with no perceptible consequences to individuals or the population.

Exponent Engineering, P.C. (2018) modeled EMF levels that could be generated by the South Fork Wind Farm export cable and inter-array cable. The model estimated induced magnetic field levels ranging from 13.7 to 76.6 milligauss on the bed surface above the buried and exposed South Fork Wind Farm export cable and 9.1 to 65.3 milligauss above the inter-array cable, respectively. Induced field strength would decrease effectively to 0 milligauss within 25 feet (7.6 meters) of each cable. By comparison, Earth’s natural magnetic field produces more than five times the maximum potential EMF effect from projects similar to the Project (BOEM 2021b, Appendix F, Figure F-8). Background magnetic field conditions would fluctuate by 1 to 10 milligauss from the natural field effects produced by waves and currents. The maximum induced electrical field experienced by any organism close to the exposed cable would be no greater than 0.48 millivolt per meter (Exponent Engineering, P.C. 2018). EMF effects on marine mammals from offshore wind activities would vary in extent and magnitude depending on overall cable length, the proportion of buried versus exposed cable segments, and project-specific transmission design (e.g., HVAC or HVDC, transmission voltage). However, measurable EMF effects are generally limited to within tens of feet of cable corridors. BOEM would require these future submarine cables to have appropriate shielding and burial depth to minimize potential EMF effects from cable operation. Impacts from EMF from the ongoing construction and operation of offshore wind projects have been previously analyzed and were anticipated to be negligible due to estimate low EMF levels, the localized nature of EMF along the cables near the seafloor, and appropriate shielding and burial depth (BOEM 2021a, 2021b).

Presence of structures: There are more than 130 artificial reefs in the Mid-Atlantic region, 15 of which are offshore New Jersey. Artificial reefs in the vicinity of the Project area are depicted in Section 3.6, *Benthic Resources*, Figure 3.6-2. Artificial reefs are made of a variety of materials including cars, trucks, subway cars, bridge rubble, barges, boats, and large cables (MAFMC 2023). Artificial reefs may have higher levels of recreational fishing, which increases the chances of marine mammals encountering lost fishing gear, resulting in possible ingestions, entanglement, injury, or death of individuals, if present where artificial reefs are located. Ongoing offshore wind projects will add a total of 81 WTGs and 2 OSS to the offshore environment. Hard bottom from scour and cable protection and vertical structures such as WTG foundations in a soft-bottom habitat can create artificial reefs, thus inducing the “reef” effect. The reef effect is usually considered a beneficial impact, associated with higher densities and biomass of fish and decapod crustaceans, providing a potential increase in available forage items and shelter for seals and small odontocetes compared to the surrounding soft bottoms (Appendix F, Table F1-13). Increased prey abundance would be localized at foundation and cable protection locations, and a substantial increase in use offshore wind project areas by foraging whales is not anticipated (NMFS 2021b). Impacts from presence of structures from the ongoing construction and operation of offshore wind projects have been previously analyzed and were anticipated to be negligible to minor as a result of the potential for increased interaction with active or ghost fishing gear. Minor beneficial impacts on pinniped and odontocete foraging and sheltering occur as a result of the monopiles and scour protection creating an artificial reef effect (BOEM 2021a, 2012b; Russell et al. 2016). These beneficial effects have the potential to be offset by risk of entanglement for derelict fishing gear or reduced feeding potential (prey concentrations) for some marine mammal species.

Cable emplacement and maintenance: Emplacement and maintenance of submarine cables and pipelines associated with non-offshore wind activities, and cable emplacement and maintenance for ongoing offshore wind activities, would disturb bottom sediments and cause temporary increases in suspended sediment; these disturbances would be local and generally limited to the emplacement corridor. Data are not available regarding marine mammal avoidance of localized turbidity plumes; however, Todd et al. (Todd et al. 2015) suggest that because some marine mammals often live in turbid waters and some species of mysticetes and sirenians employ feeding methods that create sediment plumes, some species of marine mammals have a tolerance for increased turbidity. If elevated turbidity caused any behavioral responses such as avoiding the turbidity zone or changes in foraging behavior, such behaviors would be temporary, and any impacts would be temporary and short term. Turbidity associated with increased sedimentation may result in temporary, short-term impacts on marine mammal prey species (Appendix F, Table F1-13). Impacts from emplacement and maintenance of submarine cables and pipelines are anticipated to be negligible. Sediment resuspension during cable and pipeline emplacement and maintenance would be short term and localized and individual marine mammals, if present, would be expected to successfully forage in nearby areas not affected by increased turbidity.

Port utilization: Vineyard Wind 1 will use port facilities in Connecticut, Massachusetts, Rhode Island, and Canada during construction and O&M, and BOEM found that no changes to port utilization would occur (BOEM 2021a). South Fork will use existing port facilities in New York, Rhode Island, Massachusetts, Connecticut, New Jersey, Maryland, Virginia, or Nova Scotia for offshore construction, staging, fabrication, crew transfer, and logistics support, and BOEM found that although dredging or in-water work could be required for the Port of Montauk, these actions would occur within heavily modified habitats (BOEM 2021b). Impacts from port utilization from ongoing construction and operation of offshore wind projects are anticipated to be negligible. Port expansion activities are localized to nearshore habitats and are expected to result in temporary, short-term impacts, if any, on marine mammals. Vessel noise may affect marine mammals, but response would be expected to be temporary and short term. The impacts on water quality from sediment suspension during port expansion activities is temporary and short term, and would be similar to those described under the cable emplacement and maintenance IPF above.

Lighting: The addition of 81 WTGs and 2 OSS to the geographic analysis area with aviation and marine navigation lighting, as well as lighting associated with construction vessels, would increase artificial lighting in the offshore environment. Orr et al. (2013) concluded that the operational lighting effects from wind farm facilities on marine mammal distribution, behavior, and habitat use were uncertain but likely negligible if recommended design and operating practices are implemented. BOEM requires wind farm developers to comply with the current design guidance for avoiding and minimizing artificial lighting effects; however, artificial light could aggregate prey species at night. Impacts from lighting from ongoing offshore wind activities would likely be negligible for mysticetes, odontocetes, and pinnipeds and are likely to be of the lowest level of detection and barely measurable, with no perceptible consequences to individuals or the population (BOEM 2021a, 2021b).

Climate change: NMFS lists the long-term changes in climate as a threat for almost all marine mammal species (Hayes et al. 2020, 2021). Climate change is known to increase temperatures, alter ocean acidity, raise sea levels, and increase numbers and intensity of storms. Increased temperatures can alter habitat, modify species' use of existing habitats, change precipitation patterns, and increase storm intensity (USEPA 2016; NASA 2019; Love et al. 2013). Increase of the ocean's acidity has numerous effects on ecosystems including reducing available carbon that organisms use to build shells and causing a shift in food webs offshore (USEPA 2016; NASA 2019; Love et al. 2013). This has the potential to affect the distribution and abundance of marine mammal prey. For example, between 1982 and 2018 the average center of biomass for 140 marine fish and invertebrate species along U.S. coasts shifted approximately 20 miles north. These species also migrated an average of 21 feet deeper (USEPA 2016). Shifts in abundance of their zooplankton prey will affect baleen whales who travel over large distances to feed (Hayes et al. 2020). The extent of these impacts is unknown; however, it is likely that marine mammal populations already stressed by other factors (e.g., NARWs) will likely be the most affected by the repercussions of climate change.

Impacts from climate change would likely be moderate for mysticetes, odontocetes, and pinnipeds and are likely to result in long-term consequences to individuals or populations that are detectable and measurable, except for NARW. Impacts from climate change would likely be major for NARW and have the potential to result in population-level effects through detectable and measurable impacts on the individual that could compromise the viability of the species.

3.15.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative (i.e., not approving the COP) in combination with other planned non-offshore wind activities and planned offshore wind activities (without the Proposed Action).

Planned non-offshore wind activities that may affect marine mammals include new submarine cables and pipelines, tidal energy projects, oil and gas activities, dredging and port improvement, marine minerals extraction, military use (i.e., sonar, munitions training), marine transportation, research initiatives, and installation of new structures (such as artificial reefs) on the U.S. Continental Shelf (see Section F.2 in Appendix F for a description of planned activities). These activities could result in displacement and injury to or mortality of individual marine mammals. Planned non-offshore wind activities would have the same types of impacts from traffic (vessel strikes), gear utilization, noise, accidental releases and discharges, EMF that are described in detail in Section 3.15.3.1 for ongoing non-offshore wind activities. Additional detail regarding the analysis of impacts from planned non-offshore wind activities is provided in Appendix F, Table F1-12.

This EIS anticipates that planned offshore wind projects, exclusive of the Proposed Action, could affect marine mammals through the following primary IPFs: underwater noise, presence of structures, vessel traffic (vessel strikes), accidental releases, EMF, cable emplacement and maintenance, gear utilization, port utilization, lighting, and climate change. Details regarding planned offshore wind projects are provided in Appendix F.

The IPFs deemed to have impacts on marine mammals are summarized below for planned offshore wind activities on marine mammals during construction, O&M, and decommissioning of projects without the Proposed Action. This section provides a general description of these mechanisms, recognizing that the extent and significance of potential effects of planned offshore wind projects on conditions cannot be fully quantified for projects that are in the conceptual or proposal stage and have not been fully designed. Where appropriate, potential effects resulting from planned activities are generally characterized by comparison to effects resulting from approved projects that have been evaluated and are likely to be similar in nature. Planned activities with federal funding or approval would be subject to independent

NEPA analyses and regulatory approvals. The environmental effects of other offshore wind energy development activities would be fully considered before BOEM makes a decision on the respective COP.

Noise: In the geographic analysis area, offshore wind activities that could cause underwater noise are impact and vibratory pile driving (installation of WTGs and OSS, and installation and removal of piles to support cable landfall construction activities), G&G surveys (HRG surveys and geotechnical drilling activities), detonations of UXO, vessel traffic, aircraft, cable laying or trenching, and site preparation (boulder clearance, sandwave clearance, pre-lay grapnel run, and dredging) during construction, vessel traffic during O&M, and turbine operation. Each of these sub-IPFs are discussed under their own heading below. Decommissioning activities related to noise are likely similar to those outlined for construction activities.

Impact and vibratory pile-driving noise: Impact and vibratory pile driving are used for both the installation of WTG and OSS foundations and also at export cable landfalls for the installation and removal of sheet pile cofferdams and casing pipes. The installation of WTG foundations into the seabed involves impact or vibratory pile driving, which can produce high SPLs in the underwater environment and may affect marine mammals. In the planned activities scenario (see Appendix F), the construction of up to 3,101 new WTG and OSS foundations in the geographic analysis area would create underwater noise and may affect marine mammal species in the area (see Section I.5.1 of Appendix I). Construction of offshore wind facilities is expected to occur intermittently over an 8-year period in lease areas that are anticipated to be developed in the marine mammal geographic analysis area. Noise from pile driving would occur during installation of foundations for offshore structures. The sound generated during pile driving will vary depending on the piling method (impact or vibratory), pile material, size, hammer energy, water depth, and substrate type. A description of the physical qualities of pile-driving noise can be found in Appendix J, *Underwater Sound and Acoustic Modeling Results*. These impacts would vary in extent and intensity based on the scale and design of each project (which may include underwater noise attenuation), as well as the schedule of project activities. There are three potential exposure scenarios that marine mammals could experience:

- Concurrent exposure to noise from two or more impact or vibratory hammers operating simultaneously
- Non-concurrent exposure to noise from multiple pile-driving events within the same year
- Exposure to two or more concurrent or non-concurrent pile-driving events over multiple years

Concurrent pile-driving scenarios would increase the geographical extent and sound intensity to which a marine mammal is exposed at a given time when the piles are being driven but would decrease the total number of days of exposure (assuming the project is completed faster if they drive piles consecutively and thus they can install more piles per day than if pile driving is non-concurrent). Concurrent pile driving may be considered appropriate or desirable if scheduled to avoid critical periods when sensitive or particularly vulnerable populations (e.g., NARW) are present in highest densities and to complete project construction faster. However, this could result in greater potential for TTS and PTS to occur in marine mammals that are more likely to be present during concurrent pile driving. Because driving non-concurrently would likely extend the time over which construction would occur, this scenario could increase the total number of exposure days. Given that multiple planned activities are proposed for construction, it is likely that some individual marine mammals would experience two or more impact and vibratory pile-driving noise exposure days within the same year.

Pile-driving activities from planned offshore wind development projects have the potential to affect all marine mammal hearing groups within a certain radius around each project site. Depending on the hearing sensitivity of the species, exceedance of PTS thresholds may occur on the scale of several kilometers, whereas exceedance of TTS thresholds and behavioral effects may occur on the order of tens of kilometers from the center of pile-driving activity. However, based on the mobility of most marine mammals and the likelihood that they will avoid the area to a certain extent (e.g., Schakner and Blumstein 2013), certain marine mammal species (MFC, HFC, and pinnipeds) may not be exposed to underwater sound for sufficient duration to cause PTS or TTS. In addition, when mitigation measures are applied (e.g., bubble curtains, exclusion zones) all of these effects and exposure ranges can be reduced.

The most commonly reported behavioral effect of pile-driving activity 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. Given that species like harbor porpoise produce echolocation clicks nearly constantly (Osiecka et al. 2020), strategically placed passive acoustic instruments can allow researchers to derive insights about the animals' presence and behavior around wind farms by listening for their clicks. A 2011 study of harbor porpoise acoustic activity in the North Sea at the Horns Rev II wind farm revealed that porpoise vocal activity was reduced as distant as 17.8 kilometers from the construction site during pile driving. At the closest measured distance of 2.5 kilometers, vocal activity completely ceased at the start of pile driving and did not recommence for up to 1 hour after pile driving ended, and remained below average levels for 24–72 hours (Brandt et al. 2011). Dahne et al. (2017) visually and acoustically monitored harbor porpoises during construction of the Alpha Ventus wind farm in German waters and found a decline in porpoise detections at distances up to 10.8 kilometers from pile driving, while an increase in porpoise detections occurred at points 25 and 50 kilometers away, suggesting displacement away from the pile-driving activity. During several construction phases of two Scottish windfarms, an 8–17 percent decline in porpoise acoustic presence was seen in the 25-kilometer by 25-kilometer block containing pile-driving activity in comparison to a control block. Displacement within the pile-driving monitored area was seen up to 12 kilometers away (Benhemma-Le Gall et al. 2021).

A more recent analysis in the North Sea looked at harbor porpoise density and acoustic occurrence relative to the timing and location of pile-driving activity, as well as the sound levels generated during the development of eight wind farms (Brandt et al. 2016). Using data from passive acoustic monitoring pooled across all projects, changes in porpoise detections across space and time were modeled. Compared to the 25–48-hour pre-piling baseline period, porpoise detections during construction declined by about 25 percent at SELs between 145–150 dB re 1 μPa^2s and 90 percent at SELs above 170 dB re 1 μPa^2s. Across the eight projects, a graded decline in porpoise detections was observed at different distances from pile-driving activities. The results revealed a 68-percent decline in detections within 5 kilometers of the noise source during construction, 33-percent decline 5–10 kilometers away, 26-percent decline 10–15 kilometers away, and a decline of less than 20 percent at greater distances, up to the 60-kilometer range modeled (note: the authors used a 20-percent decline to indicate an adverse effect had occurred). However, within 20–31 hours after pile driving porpoise detections increased in the 0- to 5-kilometer range, suggesting no long-term displacement of the animals. Little to no habituation was found, i.e., over the course of installation, porpoises stayed away from pile-driving activities. It is worth noting that there was substantial inter-project variability in the reactions of porpoises that were not all explained by differences in noise level. The authors hypothesized that the varying qualities of prey available across the sites may have led to a difference in motivation for the animals to remain in an area. Temporal patterns were observed as well: porpoise abundance was significantly reduced in advance of construction up to 10 kilometers around the wind farm area, likely due to the increase in vessel traffic activity. This study showed that although harbor porpoises actively avoid pile-driving activities during the construction phase, these short-term effects did not lead to population-level declines over the 5-year study period (Brandt et al. 2016).

A study conducted during wind farm construction in Cromarty Firth, Scotland compared the effect of impact and vibratory pile-driving on the vocal presence of both bottlenose dolphins and harbor porpoises in and outside the Cromarty Firth area (Graham et al. 2017). The researchers found a similar level of response, of both species to both impact and vibratory piling, likely due to the similarly low, received sound exposure levels from the two approaches (129 dB re 1 μPa^{2}s [vibratory] and 133 dB re 1 μPa^{2}s [impact], both at 812 meters from the pile). There were no statistically significant responses attributable to either type of pile-driving activity in the three metrics considered: daily presence/absence of a species, number of hours in which a species was detected, or duration of daytime (between 06:00–18:00) encounters of a species. The only exception was seen in 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. The authors hypothesized that 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. This study underscores the important influence of environmental conditions on the propagation of sound and its subsequent impacts on marine mammals.

In addition to avoidance behavior, several studies have observed other behavioral responses in marine mammals. A playback study on two harbor porpoises revealed that high-amplitude sounds, like pile driving, may adversely affect foraging behavior in this species by decreasing catch success rate (Kastelein et al. 2019). In another playback study, trained dolphins were asked to perform a target detection exercise during increasing levels of vibratory pile driver playback sounds (up to 140 dB re 1 μPa) (Branstetter et al. 2018). Three of the five dolphins exhibited either a decrease in their ability to detect targets in the water or a near-complete cessation of echolocation activity, suggesting the animals became distracted from the task by the vibratory pile-driving sound.

In addition to bottlenose dolphins and harbor porpoises, the effects of pile driving have been studied on a limited set of additional species. Würsig et al. (2000) studied the response of Indo-Pacific hump-backed dolphins to impact pile driving in the seabed in water depths of 6–8 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. A study using historical telemetry data collected before and during the construction and operation of a British wind farm showed that harbor seals may temporarily leave an area affected by pile-driving sound beginning at estimated received peak-to-peak pressure levels between 166 and 178 dB re 1 μPa (Russell et al. 2016). Seal abundance was reduced by 19 to 83 percent during individual piling events (i.e., the installation of a single pile) within 25 kilometers of the center of the pile. Displacement lasted no longer than 2 hours after the cessation of pile-driving activities, and the study found no substantial displacement during construction as a whole. The study also showed that seal usage in the wind farm area increased during the operational phase of the wind farm, although this may have been due to another factor, as seal density increased outside the wind farm area as well.

Because there are no studies that have directly examined the behavioral responses of baleen whales to pile driving, studies using other impulsive sound sources such as 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). In a 1986 study, researchers observed the responses of feeding gray whales to a 100-cubic-inch airgun, and found that there was a 50-percent probability that the whales would stop feeding and move away from the area when the received levels reached 173 dB re 1 μPa SPL (Malme et al. 1986). Other studies have documented baleen whales initiating avoidance behaviors to full-scale seismic surveys at distances of less than 10 kilometers (Johnson et al. 2007; Ljungblad et al. 1988; McCauley 1998; Richardson et al. 1986) and as far away as 20 kilometers (Richardson et al. 1999). Bowhead whales have exhibited other behavioral changes, including increased calling rates when airgun pulses are detectable, which level off at a received cumulative SEL around 94 dB re 1 μPa^{2}s and decrease once the 10-minute cumulative SEL exceeds 127 dB re 1 μPa^{2}s (Blackwell et al. 2015). 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. 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 4 kilometers of the ship at SELs over 135 dB re 1 μPa^{2}s (Dunlop et al. 2017).

Acoustic masking can occur if the frequencies of the sound source overlap with the frequencies of sound used by marine species. Given that most of the acoustic energy from pile driving is below 1 kilohertz, low-frequency cetaceans (LFC) and pinnipeds are more likely to experience acoustic masking from pile driving than MFC or HFC. In addition, 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 avoid acoustic masking by changing their vocalization rates (e.g., bowhead whale [Blackwell et al. 2013], blue whale [Di Iorio and Clark 2010], humpback whale [Cerchio et al. 2014]), increasing call amplitude (e.g., beluga whale [Scheifele et al. 2004], killer whales [Holt et al. 2009]), or shifting dominant frequencies (Lesage et al. 1999; Parks et al. 2007). When masking cannot be avoided, increasing noise could affect the ability to locate and communicate with other individuals. However, given that pile driving occurs intermittently, with some quiet periods between pile strikes, it is unlikely that complete masking would occur. For vibratory pile driving, the overall levels are reduced compared to impact pile driving but the source is transmitting for a longer and continuous period. If animals are vocalizing in the same band, it would be expected that the masking effect would be more disruptive, but that due to the lower source levels, the range from the source of this disruption would be reduced. The range for masking would be similar to that for Level B because below that 120-dB threshold, this signal would be approaching ambient noise levels.

Overall, it is reasonable to assume that there would be greater impacts on LFC (i.e., baleen whales) than other species groups, even though direct research on pile-driving noise on baleen whales is limited. As discussed above, there is evidence suggesting that baleen whales may avoid or change their behavior when exposed to impulsive sounds. Secondly, their primary frequency range for listening to their environment and communicating with others overlaps with the dominant frequency of impact and vibratory pile-driving noise. Finally, because baleen whales have specific feeding and breeding grounds (unlike toothed whales who can perform these life functions over broader spatial scales), disturbance by anthropogenic noise occurring in one of these key geographic areas may come at an increased cost to these species. Considering the number and extent of projects planned in the geographic analysis area, moderate impacts, such as some individual-level fitness effects, are expected on marine mammals from pile-driving activities. These impacts could be reduced with implementation of project-specific avoidance, mitigation, and monitoring measures. For example, noise abatement devices, such as double-bubble curtains, can be used to reduce the overall acoustic energy that is introduced and decrease the geographic extent of noise-related impacts. The implementation of shutdown zones and seasonal restrictions based on species presence in an area can reduce the intensity and likelihood of effects to minor, by only allowing activity when animals are not present. Many of these are requirements as conditions of compliance with the ESA, MMPA, and other federal regulations. These measures would reduce the potential for PTS and TTS effects from pile driving on all marine mammals. The likelihood of behavioral avoidance and masking effects are still high, especially for baleen whales.

Drilling may be required at the site of WTG foundations in the unlikely event that pile refusal occurs prior to meeting the target embedment depth for the piles (e.g., if the pile cannot be driven deep enough into the seabed). While measurements of operations specifically for offshore wind installation have not been conducted, the closest proxy is from oil and gas-related operations, where a 6-meter-diameter drill bit was used for the excavation of mudline cellars (Austin et al. 2018). They measured received levels at 1,000 meters from the operations and back-calculated SPLs between 191–193 dB re 1 micropascal meter (µPa-m). Based on these levels, New England Wind estimated that received levels would reach 120 dB re 1 µPa at 21.5 kilometers from operations (JASCO 2022b).

Research suggests that the sensitivity of marine mammals to drilling noise varies between and within species and is likely context dependent (Richardson et al. 1990). For example, ringed seals and harbor porpoises may be relatively tolerant to drilling activities (Moulton et al. 2003; Todd et al. 2009). In fact, Todd et al. (2020) measured drilling noise from jack-up platforms and concluded that harbor porpoises can only detect drilling noise out to a distance of approximately 70 meters from the source at the study site and concluded that the noise is unlikely to interfere with or mask echolocation clicks. Given the low-frequency nature of drilling sounds, baleen whales may be more vulnerable to disturbance. The majority of studies on baleen whale behavioral responses to drilling noise have been conducted on arctic species in the context of oil and gas extraction, and these studies currently serve as the best available proxies. Bowhead whales have been reported to avoid a radius of about 10 kilometers around an operating drillship, with some individuals avoiding the site up to 20 kilometers away (Richardson et al. 1995). Richardson et al. (1990) performed playback experiments of drilling and dredging noises and observed bowhead whale responses. Behavioral reactions were observed for most of the animals, such as orienting away from the sound, cessation of feeding, and altered surfacing, respiration, and diving cycles (Richardson et al. 1990). Roughly half of the bowhead whales responded to the drilling noise playback at a received level of 115 dB re 1 µPa (20–1000 Hz band) (Richardson et al. 1990). Blackwell et al. 2017 reported that bowhead whale calling rates were correlated with increasing levels of drilling noise, where calling rates initially increased, peaked, and then decreased. While such behavioral responses may result from offshore drilling, they are expected to be short term and intermittent. Therefore, impacts on odontocetes are expected to be negligible and impacts on mysticetes are expected to be minor.

At export cable landfalls in nearshore areas, the installation and removal of sheet pile cofferdams, goal posts, and casing pipes may require the use of an impact or vibratory hammer. Pile driving in the nearshore environment is even more spatially dependent (i.e., affected by the shape of the surrounding seabed) than in the offshore environment. Noise from cable landfall construction pile-driving activities that could result in harassment of marine mammals for all offshore wind farms could range from kilometers to tens of kilometers. However, the duration of these activities is short (days to weeks). The physical distance separating planned offshore wind project landfall locations and the separation in planned construction timeframes make it unlikely that impacts associated with nearshore pile driving would overlap.

Cumulative impacts on marine mammals from noise resulting from impact and vibratory pile driving for planned offshore wind activities (without the Proposed Action) is expected to be similar to that described for the Proposed Action in Section 3.15.5.

G&G survey noise (HRG surveys and geotechnical drilling activities): Recently, BOEM and the U.S. Geological Survey 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, even without mitigation, are unlikely to result in substantial behavioral disturbances of marine mammals (Ruppel et al. 2022). Of the few empirical studies assessing the effect of HRG sources on marine mammals, 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 scientific echosounder; Quick et al. (2017) found that short-finned pilot whales did not change foraging behavior but did increase their heading variance during use of an EK-60; and Cholewiak et al. (2017) found a decrease in beaked whale echolocation click detections during use of an EK-60. 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, click rate) during two deep-water 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 that 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;). For some of the higher-amplitude sources such as bubble guns, some boomers, and the highest-power sparkers, behavioral disturbance is possible but unlikely if mitigation measures such as clearance zones and shutdowns are applied. Geotechnical surveys may introduce low-level, intermittent, broadband noise into the marine environment. These sounds could result in acoustic masking in LFC or MFC but are unlikely to result in behavioral disturbance given their low source levels and intermittent use. BOEM also requires applicants to develop mitigation plans to protect marine mammals during HRG surveys such as those outlined in Appendix H (e.g., protected species observers, clearance zones, shutdowns), which would further minimize exposure risk. There are project design criteria and BMPs that are laid out in a recent Programmatic Letter of Concurrence (BOEM 2021c) that, if followed, would result in limited effects on marine mammals. The physical and temporal separation of planned offshore wind survey activities make it unlikely for impacts associated with G&G surveys to overlap. Therefore, the cumulative effects of offshore wind geophysical survey noises (without the Proposed Action) are likely similar to those described for the Proposed Action in Section 3.15.5.

UXO detonation and deflagration noise: Planned offshore wind activities may encounter UXO on the seabed in their offshore wind lease areas or along export cable routes. While non-explosive methods may be employed to lift and move these objects (i.e., lift-and-shift), some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could cause disturbance and injury to marine mammals. A physical description of UXO detonation and deflagration can be found in Appendix J, *Underwater Sound and Acoustic Modeling Results*. The number and location of detonations that may be required for other offshore wind projects can be extrapolated based on information contained within COPs submitted to date: Revolution Wind (OCS-A 0486) (Revolution Wind 2022a:10), Sunrise Wind (OCS-A 0487) (Sunrise Wind 2022a:13), and New England Wind (OCS-A 0534) (New England Wind 2022:167–168) off the coast of Massachusetts and Rhode Island have proposed up to 13 UXO, 3 UXO, and 10 UXO detonations, respectively; while Atlantic Shores South Offshore Wind (OCS-A 0499) (Atlantic Shores 2022:10), off the coast of New Jersey, and CVOW-C (OCS-A 0483) (Dominion Energy 2022a:15) off the coast of Virginia are not proposing UXO detonation. Alternative strategies, such as avoidance, lifting and moving the UXO, low-order detonation, and deflagration, are typically considered prior to in-situ disposal and only one detonation per day, during daylight only, is being proposed. Therefore, the potential for overlapping UXO detonations from nearby projects is unlikely. If overlapping detonations were to occur, they would be instantaneous and limited in the zone of impact. Therefore, impacts associated with UXO detonations for other projects would be similar to those described and modeled for the Proposed Action in Section 3.15.5.

Vessel noise: In general, vessel noise increases with ship size, power/speed, propeller blade size, number of blades, and rotations per minute, with the majority of underwater noise generated by propeller cavitation and singing (Gray and Greeley 1980; JASCO 2011; Mitson 1995). A physical description of vessel noise can be found in Appendix J, *Underwater Sound and Acoustic Modeling Results*.

A comprehensive review of the literature (Erbe et al. 2019; Richardson et al. 1995) revealed that most of the reported adverse effects of vessel noise and presence are changes in behavior, although the specific behavioral changes vary widely across species. Physical behavioral responses include changes to dive patterns (e.g., longer dives in beluga whales [Finley 1990]), disruption to resting behavior (harbor seals [Mikkelsen et al. 2019]), increases in swim velocities (belugas [Finley 1990], humpback whales [Sprogis et al. 2020], narwhals [Williams et al. 2022]), and changes in respiration patterns (longer inter-breath intervals in bottlenose dolphins [Nowacek et al. 2001], increased breathing synchrony in bottlenose dolphin pods [Hastie et al. 2003], 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 that the mother's respiration rates doubled and swim speeds increased by 37 percent in the high-noise conditions (low-frequency-weighted received SPL at 100 meters was 133 dB re 1 µPa) compared to control and low-noise conditions (104 dB re 1 µPa and 112 dB re 1 µPa, 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 that fecal cortisol levels in NARWs decreased following the 9/11 terrorist attacks, when vessel activity was significantly reduced. NARWs do not seem to avoid vessel noise or 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 versus if it is a completely novel interaction (Finley 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. For a more detailed and comprehensive review of the effects of vessel noise on specific marine mammal groups, the reader is referred to Erbe et al. (2019).

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 belugas (Lesage et al. 1999) have altered the frequency characteristics of their calls in the presence of vessel noise. When vessels are present, bottlenose dolphins have increased the number of whistles (Buckstaff 2004; Guerra et al. 2014), while sperm whales decrease the number of clicks (Azzara et al. 2013), and humpbacks and belugas have been seen to completely stop vocal activity (Finley 1990; Tsujii et al. 2018). Some species may change the duration of vocalizations (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 10 kilometers) of a large commercial vessel, the potential communication space of Bryde's whale was reduced by 99 percent compared to ambient conditions.

Aircraft noise: Planned offshore wind activities will also employ helicopters and fixed-wing aircraft. Noise generated from aircraft associated with projects in the geographic analysis area could affect marine mammals. In general, marine mammal behavioral responses to aircraft most commonly occur at distances of less than 1,000 feet (less than 305 meters) (Patenaude et al. 2002). Patenaude et al. (2002) showed that aircraft operations (helicopter and fixed wing) could result in temporary behavioral responses from beluga (*Delphinapterus leucas*) and bowhead whales (*Balaena mysticetus*). Responses included short surface durations, abrupt dives, and percussive behaviors (i.e., breaching and tail slapping) (Patenaude et al. 2002). Most observed reactions by bowheads (63 percent) and belugas (86 percent) occurred when the helicopter was at altitudes of 150 meters or less and lateral distances of 250 meters or less. BOEM would require all aircraft operations to comply with current approach regulations for NARWs or unidentified large whales (50 CFR 222.32). These include the prohibition of aircraft from approaching within 1,500 feet (457 meters).

Most aircraft operations would likely occur above this altitude except under specific circumstances (e.g., helicopter landings on the service operations vessel or visual inspections of WTGs). Aircraft operations could result in temporary behavioral responses including short surface durations, abrupt dives, and percussive behaviors (i.e., breaching and tail slapping) (Patenaude et al. 2002).

Cable-laying or trenching noise: Noise associated with cable emplacement and maintenance activities for planned offshore wind activities or for other submarine cables associated with non-offshore wind activities (i.e., for undersea transmission lines or submarine telecommunication cables) could periodically occur in the geographic analysis area. Cable laying and trenching can involve a variety of methods including jetting, vertical injection, controlled-flow excavation, trenching, and plowing. HDD may also be used at landfalls. Cable laying and installation would likely involve several vessels including dynamic positioning vessels and associated support craft. For a detailed description of the physical attributes of these noise sources, see Appendix J, *Underwater Sound and Acoustic Modeling Results*. Impacts of noise generated by planned cable-laying and trenching activities on marine mammals would likely be similar to that described for the Proposed Action in Section 3.15.5.

Site preparation (e.g., boulder clearance, sandwave clearance, pre-lay grapnel run, dredging) noise: Prior to offshore wind project foundation and export cable installation, boulder clearance and pre-lay grapnel runs may be conducted to clear the area of obstructions. This may involve the use of a displacement plow, a subsea grab or, in shallower waters, a backhoe dredger. Sandwave clearance may also be conducted in advance of export cable installation to remove mobile sediments using suction hopper dredger, controlled-flow excavation, or plow. At landfall locations, export cables may be installed using HDD, which may require mechanical dredging of the HDD exit pit. Mechanical dredging uses crane-operated buckets, grabs (clamshell), or backhoes, whereas hydraulic dredging uses suction or controlled-flow excavation. Underwater noise generated by dredging depends on the type of dredge equipment used; for a physical description of this noise source, see Appendix J, *Underwater Sound and Acoustic Modeling Results*.

Given the low source levels and transitory nature of these sources, exceedance of PTS and TTS levels are not likely for harbor porpoise and seals, according to measurements and subsequent modeling by Heinis et al. (2013). For other marine mammals, PTS is not likely, but if dredging occurs in one area for relatively long periods, TTS and behavioral thresholds could be exceeded (Todd et al. 2015; NMFS 2018a).

Behavioral reactions and masking of low-frequency calls in baleen whales and seals are considered more likely to occur due to the low-frequency spectrum over which the sounds occur. Of the few studies that have examined behavioral responses from dredging noise, most have involved other industrial activities, making it difficult to attribute responses specifically to dredging noise (e.g., Bryant et al. 1984). Some found no observable response (beluga whales [Hoffman 2012]), while others showed avoidance behavior (bowhead whales in a playback study of drillship and dredge noise [Richardson et al. 1990]). Diederichs et al. (2010) found short-term avoidance of dredging activities by harbor porpoises near breeding and calving areas in the North Sea. Pirotta et al. (2013) found that, despite a documented tolerance of high vessel presence, as well as high availability of food, bottlenose dolphins spent less time in the area during periods of dredging. The study also showed that with increasing intensity in the activity, bottlenose dolphins avoided the area for longer durations (with one instance being as long as 5 weeks) (Pirotta et al. 2013). Brief behavioral effects or acoustic masking over small spatial scales may occur for baleen whales due to the low-frequency nature of these sound sources.

Turbine operation noise: Sound is generated by operating WTGs due to pressure differentials across the airfoils of moving turbine blades and from mechanical noise of bearings and the generator converting kinetic energy to electricity. Both airfoil sound and mechanical vibration may result in long-term, continuous noise in the offshore environment. A physical description of turbine operation noise can be found in Appendix J, *Underwater Sound and Acoustic Modeling Results*.

Once wind farms are operational, low-level sounds are generated by each WTG, but sound levels are much lower than during construction. This type of sound is considered to be continuous, omnidirectional radially from the pile, and non-impulsive. Most of the energy associated with operations is below 120 Hz. Sound levels from wind turbine operations are likely to increase somewhat with increasing generator size and power ratings, as well as with wind speeds. Recordings from Block Island Wind Farm indicated that there was a correlation between underwater sound levels and increasing wind speed, but this was not clearly influenced by turbine machinery; rather it may have been explained by the natural effects that wind and sea states have on underwater sound levels (Elliott et al. 2019; Urick 1983).

A recent compilation (Tougaard et al. 2020) of operational noise from several wind farms, with turbines up to 6.15 MW in size, showed that operational noise generally attenuates rapidly with distance from the turbines (falling to near-ambient sound levels within approximately 1 kilometer from the source), and the combined noise levels from multiple turbines are lower or comparable to that generated by a small cargo ship. Tougaard et al. (2020) developed a formula predicting a 13.6-dB increase for every tenfold increase in 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-MW turbine to a 5-MW one, or from 1 MW to 10 MW. The least squares fit of that dataset would predict that the SPL measured 100 meters from a hypothetical 15-MW turbine in operation in 10-meter-per-second (19-knot or 22-mile-per-hour) wind would be 125 dB re 1 μPa. However, all of the 46 data points in that dataset—with the exception of the two from Block Island Wind Farm—were from WTGs operated with gear boxes of various designs rather than the newer use of direct-drive technology, which is expected to lower underwater noise levels substantially. Only one study of direct-drive turbines presented in Elliott et al. (2019) was available in the literature. The study measured SPLs of 114 to 121 dB re 1 μPa SPL_{RMS} at 50 meters for a 6-MW direct-drive turbine. Stöber and Thomsen (2021) make predictions for source levels of 10-MW turbines based on a linear extrapolation of maximum received levels from WTGs with ratings up to 6.15 MW. The linear fit is likely inappropriate, and the resulting predictions may be exaggerated. Tougaard et al. (2020) point out that received level differences among different pile types could be confounded by differences in water depth and turbine size. In any case, additional data are needed to fully understand the effects of WTG size and foundation type on operational noise. Jansen and de Jong (2016) and Tougaard et al. (2009a) concluded that marine mammals would be able to detect operational noise within a few thousand feet of 2-MW WTGs, but the effects would have no significant impacts on individual survival, population viability, distribution, or behavior. Lucke et al. (2007) exposed harbor porpoise to simulated noise from operational wind turbines and found masking effects at 128 dB re 1 μPa within the frequencies of 0.7, 1,000, and 2,000 Hz. This suggests the potential for a reduction in effective communication space within the wind farm environment for marine mammals that communicate primarily in frequency bands below 2,000 Hz. Any such effects would likely be dependent on hearing sensitivity and the ability to adapt to low-intensity changes in the noise environment.

Based on the currently available data, underwater noise from turbine operations from offshore wind activities (without the Proposed Action) is likely to reach ambient noise levels within relatively short distances of the foundations. It is unlikely operational noise would cause PTS or TTS in marine mammals but could cause behavioral and masking effects at relatively short distances from the foundations (Miller and Potty 2017; Tougaard et al. 2009b, 2020). However, more acoustic research is warranted to characterize SPLs originating from large direct-drive turbines.

Summary of noise impacts: Underwater noise impacts on marine mammals from planned offshore wind activities are anticipated to occur. Noise generated from planned offshore wind activities include impulsive (e.g., impact pile driving, UXO detonations, some HRG surveys) and non-impulsive sources (e.g., vibratory pile diving, some HRG surveys, vessels, aircraft, cable laying or trenching, site preparation activities, turbine operations). Of those activities, only pile driving and UXO detonations are anticipated to cause PTS/injury-level effects in marine mammals. Vibratory pile driving of WTG and

OSS foundations could result in PTS if conducted continuously for long time periods. UXO detonation may also cause mortality, slight lung injury, and gastrointestinal tract injury at close range. All noise sources that are audible by a given species have the potential to cause behavioral responses ranging from very low to more severe. All projects are expected to include applicant-proposed measures (e.g., exclusion zones, protected species observers), similar to the measures included in Vineyard Wind 1 and South Fork, that would minimize underwater noise impacts on marine mammals. The effects of implementing underwater noise impact minimization measures would likely be similar to that described for the Proposed Action in Section 3.15.5.

The intensity of this IPF is considered severe for UXO detonations, as mortality thresholds will be exceeded; medium for impact pile driving, as PTS thresholds will be exceeded; and low for all other activities, as TTS and behavioral thresholds will be exceeded. The predicted effect would be permanent in the case of some PTS effects and mortality and slight lung injury resulting from UXO detonations and short term with respect to TTS, behavioral effects, and masking. The geographic extent is considered localized for PTS effects and extensive for behavioral disturbance effects, as noise could exceed behavioral thresholds several tens of kilometers away depending on the activity. The frequency of the activity causing the effect is considered infrequent for impact pile driving, vibratory pile driving, UXO detonations, aircraft, cable laying and trenching, and dredging noise; frequent for HRG survey noise; and continuous for WTG operation noise. With the application of mitigation measures similar to those outlined in Appendix H for UXO detonations, the likelihood of mortality and non-auditory injury of a marine mammal from UXO detonations is considered low. Based on the source levels available in the literature and using the underwater noise modeling completed for the Proposed Action as a proxy for planned offshore wind activities, some PTS, TTS, behavioral disturbance, and masking effects on LFC, MFC, HFC, and phocid pinnipeds in water are considered likely, with respect to this IPF, but would vary by species and population. Based on the available information regarding offshore wind activities in the marine mammal geographic analysis area (Figure 3.15-1) the impact of noise is considered moderate and short term for LFC, MFC, HFC, and phocid pinnipeds in water.

Noise impacts from planned offshore wind activities would likely result in moderate short-term impacts for LFC, MFC, HFC, and pinnipeds. Impacts on individual marine mammals would be detectable and measurable; however, populations are expected to recover from the impacts. Impacts from noise from planned non-offshore wind activities could be moderate for listed species such as NARW because impacts on an individual could result in population-level effects; however, applicant-proposed measures and agency-required mitigation would be implemented to minimize impacts.

Presence of structures: Ongoing non-offshore wind activities (i.e., the installation of hard-bottom and vertical structures in soft-bottom habitat) have resulted in the creation of 130 artificial reefs in the Mid-Atlantic region. Ongoing offshore wind projects will add a total of 81 WTGs and 2 OSS to the offshore environment. The addition of up to 3,000 new WTG and OSS foundations in the geographic analysis area associated with planned activities would result in hydrodynamic and artificial reef effects that influence primary and secondary productivity and the distribution and abundance of fish and invertebrate community structure within and in proximity to project footprints. Depending on proximity and extent, hydrodynamic and reef effects from planned activities could influence the availability of prey and forage resources for marine mammals. Project-specific effects would vary, recognizing that larger and contiguous projects could have more significant hydrodynamic effects and broader scales. An increase in offshore wind farms may weaken the regional thermocline and affect heat storage, atmospheric CO_2 uptake, and benthic resupply of oxygen gas (Dorrell et al. 2022). This could in turn lead to more significant effects on prey and forage resources, but the extent and significance of these effects cannot be predicted based on currently available information.

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:

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

Shelf sea dynamics have natural mixing driven by internal waves and flow over seafloor sand banks. In the Mid-Atlantic Bight, biological production from phytoplankton relies on seasonal stratification that occurs during the summer (Dorrell et al. 2022). As seen in van Berkel et al. (2020), the potential hydrodynamic effects identified above from the presence of vertical structures in the water column therefore affect nutrient cycling and could influence the distribution and abundance of fish and planktonic prey resources. Turbulence resulting from vertical structures in the water column could lead to localized changes in circulation and stratification patterns, with potential implications for primary and secondary productivity and fish distribution. Structures may reduce wind-forced mixing of surface waters, whereas water flowing around the foundations may increase vertical mixing (Carpenter et al. 2016). Increased mixing may also result in warmer bottom temperatures, increasing stress on some shellfish and fish at the southern or inshore extent of the range of suitable temperatures. Changes in cold pool dynamics resulting from future activities, should they occur, could conceivably result in changes in habitat suitability and fish community structure, but the extent and significance of these potential effects are unknown. These effects and their implications for fish, invertebrates, and primary and secondary productivity are discussed in detail in Appendix I.

However, the scale of vertical mixing is infrastructure specific. Strong thermoclines act as a barrier to vertical mixing and transport. In extreme scenarios, as seen near islands, enhanced mixing could prevent stratification; however, at regional scales, water columns typically re-stratify by natural buoyancy forcing (Dorrell et al. 2022). The waters surrounding offshore wind farms are characterized by strong seasonal stratification (NOAA Fisheries 2022d). The strong seasonal stratification of the Mid-Atlantic Bight is the dominant oceanographic feature limiting phytoplankton productivity, which then affects zooplankton prey productivity (Schofield et al. 2008).

Scour protection at WTG and OSS foundations may induce a reef effect. The reef effect and impacts from artificial reefs are described for the No Action Alternative in Section 3.15.3.1. Planned offshore wind activities would result in increased hard-bottom habitat and a potential for increased prey abundance;

however, it is anticipated that the beneficial impacts on foraging marine mammals would be localized and difficult to detect.

In contrast, broadscale hydrodynamic impacts could alter zooplankton distribution and abundance (van Berkel et al. 2020). This possible effect is primarily relevant to NARWs and other baleen whales, as their planktonic prey (calanoid copepods and krill) are driven primarily by hydrodynamic processes that can redistribute nutrients and create patchiness of prey both spatial and temporally. As aggregations of plankton, which provide a dense food source for NARWs to efficiently feed upon, are concentrated by physical and oceanographic features, increased mixing may disperse aggregations and may decrease efficient foraging opportunities. Potential effects of hydrodynamic changes in prey aggregations are specific to listed species that feed on plankton, whose movement is largely controlled by water flow, as opposed to other listed species that eat fish, cephalopods, crustaceans, and marine vegetation, which are either more stationary on the seafloor or are more able to move independent of typical ocean currents (NMFS 2021a). There is considerable uncertainty as to how these broader ecological changes will affect marine mammals in the future, and how those changes will interact with other human-caused impacts. The effect of the increased presence of structures on marine mammals and their habitats is likely to be negative, varying by species, and their significance is unknown.

The presence of structures could also concentrate recreational fishing around foundations, potentially increasing the risk of marine mammal entanglement in both lines and nets and increasing the risk of injury and mortality due to infection, starvation, or drowning (Moore and van der Hoop 2012). These structures could also result in fishing vessel displacement or gear shift. The potential impact on marine mammals from these changes is uncertain. However, if a shift from mobile gear to fixed gear occurs due to inability of the fishermen to maneuver mobile gear, there would be a potential increase in the number of vertical lines, resulting in an increased risk of marine mammal interactions with fishing gear. Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARW and may be a limiting factor in the species' recovery (Knowlton et al. 2012). Johnson et al. (2005) reports that 72 percent of NARWs show evidence of past entanglements. Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pace 2021). Entanglement may also be responsible for high mortality rates in other large whale species (Read et al. 2006). Abandoned or lost fishing gear may become tangled with foundations, reducing the chance that abandoned gear would cause additional harm to marine mammals and other wildlife, although debris tangled with WTG foundations may still pose a hazard to marine mammals. These potential long-term, intermittent impacts would persist until decommissioning is complete and structures are removed.

The long-term presence of WTG structures could also displace marine mammals from preferred habitats or alter movement patterns, potentially resulting in exposure to commercial and recreational fishing activity. The evidence for long-term displacement is unclear and varies by species. Long (2017) compiled a statistical study of seal and cetacean (including porpoises and baleen whales) behavior in and around Scottish marine energy facilities. The study found evidence of displacement during construction, but habitat use appeared to return to previous levels once construction was complete and the projects were in operation. The study cautioned that observational evidence was limited for certain species and further research would be required in order to draw a definitive conclusion about operational effects. Some research has suggested long-term displacement of species like harbor porpoise, but the evidence is mixed, and observed changes in abundance may be more indicative of general population trends than an actual wind farm effect (Nabe-Nielsen et al. 2011; Teilmann and Carstensen 2012; Vallejo et al. 2017). Other studies have documented apparent increases in marine mammal density around wind energy facilities. Russel et al. (2014) found clear evidence that seals were attracted to a European wind farm, apparently attracted by the abundant concentrations of prey created by the artificial reef effect. Gray seals are susceptible to entrapment in gillnet fisheries, as well as trawl fisheries to a lesser degree (Orphanides

2020; Lyssikatos 2015). If commercial trawling were to occur near wind farms, increased interactions and resulting mortality of gray seals could potentially occur.

The widespread development of offshore renewable energy facilities may facilitate a slowing of climate change. Hayes et al. (2021) note that 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 artificial reef effect created by these structures forms biological hotspots that could support species range shifts and expansions and changes in biological community structure resulting from a changing climate (Degraer et al. 2020; Methratta and Dardick 2019; Raoux et al. 2017).

Impacts from the presence of structures from planned offshore wind activities would likely be minor for mysticetes, odontocetes, and pinnipeds; although impacts on individuals would be detectable and measurable, they would not lead to population-level effects. Impacts on odontocetes and pinnipeds may result in minor beneficial effects due to increases in aggregations of prey species.

Traffic (vessel strikes): Increased vessel traffic presents a potential increase in collision-related risks to marine mammals. Based on information available in COPs for planned offshore wind projects (e.g., Atlantic Shores 2021; Empire 2022), is assumed that construction of each individual offshore wind project would generate approximately 20 to 65 simultaneous construction vessels operating in the geographic analysis area for marine mammals at any given time. Planned offshore wind projects on the OCS would be constructed between 2023 and 2030, contributing to increases in vessel traffic within the marine mammal geographic analysis area. Vessels used during construction range in size from larger heavy-lift vessels and heavy transport vessels to smaller crew transfer vessels. BOEM anticipates that non-offshore wind vessel traffic would gradually increase over time. Additional information regarding the expected increase in vessel traffic is provided in Appendix F, *Planned Activities Scenario*. Once projects are operational, they would be serviced by crew transfer vessels and service operations vessels making routine trips between the wind farms and port-based O&M facilities. Crew transfer vessels generally make one round-trip per week while service operations vessels would make trips on an as-needed basis. Based on information available in COPs for planned offshore wind projects (e.g., Revolution Wind 2022b; Sunrise Wind 2022b; Dominion Energy 2022b; Empire 2022), it is assumed that annual O&M vessel trips could range from 76 crew transfer vessel and service operations vessel trips to up to 518 vessel trips. Unplanned maintenance activities would require the periodic use of larger vessels of the same class used for project construction. The number and size of crew transfer vessels and number of trips per week required for unplanned maintenance would vary by project based on the number of WTGs. Vessel requirements for unplanned maintenance would also likely vary based on overall project size. Additionally, vessels required to complete monitoring programs at various stages of project development will add to the number of vessel trips undertaken by other projects. These planned activities would pose the same type of vessel-related collision risks to marine mammals as for planned trips, but the potential extent and number of animals potentially exposed cannot be determined without project-specific information.

Marine mammal vessel strikes are possible; however, the risk is negligible. Developers would be required to abide by several vessel strike avoidance measures during construction, operation, and maintenance. If a vessel strike from ongoing and planned offshore wind activities (without the Proposed Action) did occur, the outcome could range from no apparent injury to mortality. As discussed in Section 3.15.3.1, *Impacts of the No Action Alternative*, the speed and size of a vessel influences the outcome. Impacts from traffic (vessel strikes) from planned offshore wind activities would likely be long term and major for NARW and have the potential to result in population-level effects through detectable and measurable impacts on the individual that could compromise the viability of the species. The impacts of traffic (vessel strikes) on odontocetes and pinnipeds from planned non-offshore wind activities would be minor because population-level effects are unlikely although consequences to individuals would be detectable and measurable. However, as described above, offshore wind vessels would be required to abide by mitigation measures designed to avoid vessel strike. If those measures are successful in avoiding vessel strikes, there would be no impact on marine mammal species from this IPF.

Accidental releases and discharges: Gradually increasing non-offshore wind vessel traffic over time would increase the risk of accidental releases. Accidental releases of fuel, fluids, hazardous materials, trash, and debris may also increase as a result of offshore wind activities. The risk of any type of accidental release would be increased primarily during construction when additional vessels are present, but also during operations and decommissioning of offshore wind facilities. Refueling of primary construction vessels at sea is anticipated for planned offshore wind projects.

In the planned activities scenario (see Table F2-3 in Appendix F), there would be a low risk of a leak of fuel, fluids, or hazardous materials from any one of approximately 2,946 WTGs, each with approximately 5,000 gallons (18,927 liters) stored. Total fuel, fluids, or hazardous materials within the geographic analysis area would be approximately 15.7 million gallons (71.3 million liters; see Table F2-3 in Appendix F). According to BOEM’s modeling (Bejarano et al. 2013), a release of 128,000 gallons (484,532.7 liters), which represents all available oils and fluids from 130 WTGs and an OSS, is likely to occur no more often than once per 1,000 years, and a release of 2,000 gallons (7,571 liters) or less is likely to occur every 5 to 20 years. The likelihood of a spill occurring from multiple WTGs and OSS at the same time is very low and, therefore, the potential impacts from a spill larger than 2,000 gallons (7,571 liters) are largely discountable.

Marine mammal exposure to aquatic contaminants and inhalation of fumes from oil spills can result in mortality or sublethal effects on individual fitness, including adrenal effects, hematological effects, liver effects, lung disease, poor body condition, skin lesions, and several other health effects attributed to oil exposure (Kellar et al. 2017; Mazet et al. 2001; Mohr et al. 2008; Smith et al. 2017; Sullivan et al. 2019; Takeshita et al. 2017). Based on the volumes potentially involved, the likely amount of additional releases associated with offshore wind development would fall within the range of accidental releases that already occur on an ongoing basis from non-offshore wind activities.

Trash and debris may be released by vessels during construction, operations, and decommissioning of offshore wind facilities. Operators would be required to comply with federal and international requirements to minimize releases. In the unlikely event of a trash or debris release, it would be accidental and localized in the vicinity of offshore wind lease areas. Worldwide, 62 of 123 (about 50 percent) marine mammal species have been documented ingesting marine litter (Werner et al. 2016). The global stranding data indicate potential debris-induced mortality rates of 0 to 22 percent. Mortality has been documented in cases of debris interactions, as well as blockage of the digestive tract, disease, injury, and malnutrition (Baulch and Perry 2014). However, it is difficult to link physiological effects on individuals to population-level impacts (Browne et al. 2015). While precautions to prevent accidental releases will be employed by vessels and port operations associated with offshore wind development, it is likely that some debris could be lost overboard during construction, maintenance, and routine vessel activities. However, the amount would likely be miniscule compared to other inputs already occurring and considered negligible. If a release were to occur, it would be an accidental, low-probability event in the vicinity of offshore wind lease areas or the ports to the offshore wind lease areas used by vessels.

Intakes and discharges related to cooling offshore wind conversion stations are possible for planned offshore wind projects. Potential effects resulting from intake and discharge use include altered micro-climates of warm water surrounding outfalls, altered hydrodynamics around intakes/discharges, prey entrainment, and association with intakes if prey are aggregated on intake screens from which marine mammals scavenge. The number of OSS per project is likely small; therefore, these impacts, though long term, would be low in intensity and localized.

Impacts from accidental release and discharges from planned offshore wind activities would likely be negligible and long term for mysticetes, odontocetes, and pinnipeds, except for NARW. Offshore wind projects would be expected to comply with Oil Spill Response Plan and USCG requirements for the prevention and control of oil and fuel spills. If these releases or discharges were to occur, they would be likely to result in long-term consequences to a few individuals that are detectable and measurable but do not lead to population-level effects. Impacts from accidental release and discharges from planned offshore wind activities would likely be moderate and long term for NARW and have the potential to result in population-level effects through detectable and measurable impacts on the individual, but the population should sufficiently recover.

EMF: In the planned activities scenario, up to 10,297 miles (16,571 kilometers) of inter-array and export cable would be added in the marine mammal geographic analysis area, producing EMF in the immediate vicinity of each cable during operations (Table F2-2 in Appendix F). Studies documented electric or magnetic sensitivity up to 0.05 microTesla or Earth’s magnetic field for fin whale, humpback whale, sperm whale, bottlenose dolphin, common dolphin, long-fin pilot whale, Atlantic white-sided dolphin, Risso’s dolphin, and harbor porpoise (Tricas and Gill 2011). However, evidence used to make the determinations was only observed behaviorally/physiologically for bottlenose dolphins and the remaining species were concluded based on theory or anatomical details. Recent reviews by Bilinski (2021) of the effects of EMF on marine organisms concluded that measurable, though minimal, effects can occur for some species, but not at the relatively low EMF intensities representative of marine renewable energy projects. Electrical telecommunications cables are likely to induce a weak EMF on the order of 1 to 6.3 microvolts per meter within 3.3 feet (1 meter) of the cable path (Gill et al. 2005). Fiber-optic communications cables with optical repeaters would not produce EMF effects. Under the No Action Alternative, export cables would be added in 26 BOEM offshore wind lease areas. As of October 1, 2021, 12 of these projects have a COP under review and are presumed to include at least one identified cable route, which will produce EMF in the immediate vicinity of each cable during operations. Transmission cables using HVAC emit ten times less magnetic field than HVDC (Taormina et al. 2018); therefore, HVAC cables are likely to have less EMF impacts on marine mammals. Additionally, marine mammal species that are more likely to forage near the benthic organisms, such as certain delphinids, have more potential to experience EMF above baseline levels (Tricas and Gill 2011). This EIS anticipates that the proposed offshore energy projects would use HVAC transmission, but HVDC designs are possible and could occur.

EMF effects on marine mammals from these other projects would vary in extent and magnitude depending on overall cable length, the proportion of buried versus exposed cable segments, and project-specific transmission design (e.g., HVAC or HVDC, transmission voltage). However, measurable EMF effects are generally limited to within tens of feet of cable corridors. BOEM would require these submarine power cables to have appropriate shielding and burial depth to minimize potential EMF effects from cable operation.

Impacts from EMF from planned offshore wind activities would likely be negligible for mysticetes, odontocetes, and pinnipeds and are likely to be of the lowest level of detection and barely measurable, with no perceptible consequences to individuals or the population.

Impacts from EMF from planned non-offshore wind activities would likely be negligible for mysticetes, odontocetes, and pinnipeds, of the lowest level of detection, and barely measurable, with no perceptible consequences to individuals or the population.

Cable emplacement and maintenance: Cable emplacement and maintenance activities for ongoing and planned non-offshore wind activities (i.e., for undersea transmission lines or submarine telecommunication cables) could periodically occur in the geographic analysis area. Cable emplacement and maintenance activities disturb bottom sediments and cause temporary local increases in suspended sediment that are generally limited to the emplacement corridor. Planned offshore wind projects could disturb up to 34,299 acres (139 km^2) of seabed while installing associated undersea inter-array cables, and up to 150,280 acres (608 km^2) while installing undersea export cables, causing an increase in suspended sediment (see Table F2-2 in Appendix F for calculation details). Those effects would be similar in nature to those observed during construction of the Block Island Wind Farm (Elliot et al. 2017). While suspended sediment impacts would vary in extent and intensity depending on project- and site-specific conditions, measurable impacts are likely to be on the order of 500 mg/L or lower, short term lasting for minutes to hours, and limited in extent to within a few feet vertically and a few hundred feet horizontally from the point of disturbance.

Impacts from cable emplacement and maintenance from planned offshore wind activities would likely be minor for mysticetes, odontocetes, and pinnipeds and are likely to result in short-term, localized consequences to individuals that are detectable and measurable but do not lead to population-level effects.

Gear utilization (biological/fisheries monitoring surveys): Planned offshore wind projects are likely to include plans that monitor biological resources in and nearby associated project areas throughout various stages of development. These could include trawl, and trap surveys, as well as other methods of sampling the biota in the area. The presence of monitoring gear could affect marine mammals by entrapment or entanglement; however, developers have included marine mammal mitigation and monitoring procedures in COPs submitted to date designed to avoid entanglement or entrapment in any biological survey plans. Therefore, it is expected that monitoring plans will have sufficient mitigation procedures in place to avoid entanglement and entrapment and impacts would not occur. Should future developers not develop plans that avoid entanglement and entrapment, such an outcome could lead to injury, serious injury, or mortality of a marine mammal.

If entanglement or entrapment occurs, the impacts of gear utilization on mysticetes (with the exception of NARWs), odontocetes, and pinnipeds from planned non-offshore wind activities would be moderate because they are likely to result in long-term consequences to individuals or populations that are detectable and measurable. Population-level effects on these species are unlikely to occur because the rate of entanglement for any given species would likely not be high enough to result in population-level effects. Gear utilization from planned non-offshore wind activities could result in major long-term impacts for NARW if a NARW is entangled because impacts on individual NARWs could have severe population-level effects and compromise the viability of the species. However, the likelihood of NARW entanglement in biological monitoring gear is negligible given the amount of survey effort, many types of gear proposed (e.g., trawls) have not been implicated in NARW entanglement, and the implementation of mitigation and monitoring measures designed to avoid entanglement.

Port utilization: The development of an offshore wind industry in the marine mammal geographic analysis area may incentivize the expansion or improvement of regional ports to support planned projects. Three main activities surrounding port utilization have the potential to affect marine mammals: port expansion/construction, increased vessel traffic, and increased dredging. The State of New Jersey is planning to build an offshore wind port on the eastern shore of the Delaware River in Lower Alloways Creek (Appendix F). The Atlantic Shores South Offshore Wind project would construct an O&M facility in Atlantic City, New Jersey on a shoreside parcel that was formerly used for vessel docking and other port activities. As described for the Proposed Action in Section 3.15.5, at larger ports such as Charleston and Norfolk, offshore wind-related activities would make up a small portion of the total activities at the port; therefore, offshore wind activities are likely to have a negligible impact on marine mammals through increased port utilization at these ports. However, for smaller ports within the geographic analysis area, such as Paulsboro and Hope Creek, port expansion may be necessary to accommodate the increased activity, resulting in more significant increases to vessel traffic, dredging, and shoreline construction. USACE has proposed maintenance dredging of portions of the Newark Bay, New Jersey federal navigation channel, including the removal of material from the Port Elizabeth Channel, to occur between

July 2021 and February 2022 (USACE 2021). Additionally, in 2017 USACE Charleston District awarded contracts as part of the Charleston Harbor Deepening Project, which will create a 52-foot depth at the entrance channel to Charleston Harbor in South Carolina. Port improvements could lead to an increase in vessel traffic and underwater noise from pile driving and dredging during construction, O&M, and conceptual decommissioning of planned offshore wind projects. The realized impacts on marine mammals in the geographic analysis area from the activities described above include potential increased vessel interaction, exposure to noise, and localized turbidity plumes from dredging. See the *noise, vessel traffic (vessel strike)*, and *cable emplacement and maintenance* IPFs above for discussion of impacts on marine mammals from underwater noise, vessel strike, and elevated turbidity that would also be associated with port utilization and expansion.

Impacts from port utilization from planned offshore wind activities on mysticetes, odontocetes, and pinnipeds would likely be moderate and long term and result in population-level effects through detectable and measurable impacts on the individual, but the population should sufficiently recover, except the NARW. Impacts from port utilization from planned offshore wind activities would likely be long term and major for NARW and have the potential to result in population-level effects through detectable and measurable impacts on the individual that could compromise the viability of the species. However, any future port expansion and associated increase in vessel traffic would be subject to independent NEPA analysis and regulatory approvals requiring full consideration of potential effects on marine mammals regionwide.

Lighting: The addition of up to 2,937 new WTGs in the geographic analysis area with long-term hazard and aviation lighting, as well as lighting associated with construction vessels, would increase artificial lighting. Increased lighting associated with nighttime pile driving (if allowed) could increase prey concentrations and attract marine mammals. Orr et al. (2013) concluded that the operational lighting effects from wind farm facilities on marine mammal distribution, behavior, and habitat use were uncertain but likely negligible if recommended design and operating practices are implemented. BOEM would require wind farm developers to comply with the current design guidance for avoiding and minimizing artificial lighting effects; however, artificial light could aggregate prey species at night. Impacts from lighting from planned offshore wind activities would likely be negligible for mysticetes, odontocetes, and pinnipeds and are likely to be of the lowest level of detection and barely measurable, with no perceptible consequences to individuals or the population.

Climate change: Global climate change is also an ongoing risk for marine mammal species in the geographic analysis area. Warming and sea level rise could affect marine mammals through increased storm frequency and severity, altered habitat/ecology, altered migration patterns, increased disease incidence, and increased erosion and sediment deposition (Evans and Bjørge 2013; Evans and Waggitt 2020; Learmonth et al. 2006). Increased storm severity or frequency may result in increased energetic costs, particularly for young life stages, reducing individual fitness. Altered habitat/ecology associated with warming has resulting in northward distribution shifts for some prey species (Hayes et al. 2021) and marine mammals are altering their behavior and distribution in response to these alterations (Davis et al. 2017, 2020; Hayes et al. 2020, 2021). Warming is expected to influence the frequency of marine mammal diseases, particularly for pinnipeds. Ocean acidification may affect some marine mammals through negative effects on zooplankton (PMEL 2020). Warming and sea level rise, with their associated consequences, and ocean acidification could lead to long-term impacts on marine mammals. Impacts of climate change would likely be moderate for mysticetes, odontocetes, and pinnipeds and are likely to result in long-term consequences to individuals or populations that are detectable and measurable, except for NARW. Impacts from climate change would likely be major for NARW and have the potential to result in population-level effects through detectable and measurable impacts on the individual that could compromise the viability of the species.

Planned offshore wind is expected to combat the effects from climate change over the long term by providing clean energy and reducing use of fossil fuels. Minor beneficial impacts on mysticetes, odontocetes, and pinnipeds are anticipated because planned offshore wind activities may reduce the ongoing and predicted rate of climate change. Therefore, impacts on marine mammals from climate change may be reduced.

3.15.3.3. Conclusions

Impacts of the No Action Alternative. Under the No Action Alternative, BOEM would not approve Ocean Wind's COP. As such, stressors from construction, operation, and maintenance of the Ocean Wind 1 Project would not occur. Baseline conditions of the existing environment would remain unchanged. Therefore, not approving the COP would have no additional incremental effect on marine mammals. Similarly, NMFS's No Action Alternative (i.e., not issuing the requested incidental take authorization) would also have no additional incremental impact on marine mammals and their habitat.

Under the No Action Alternative, ongoing stressors and activities contributing to baseline conditions would result in a range of temporary to long-term impacts (disturbance, displacement, injury, mortality, and reduced foraging success) on marine mammals. Climate change would continue to affect marine mammal foraging and reproduction through changes to the distribution and abundance of marine mammal prey. Vessel activity (vessel collisions) and gear utilization associated with ongoing non-offshore wind activities would continue to cause long-term detectable and measurable injury and mortality to individual marine mammals. Underwater noise from pile driving during construction of offshore wind structures would also result in detectable impacts on marine mammals; however, these impacts would be short term. Accidental releases and discharges, EMF, the presence of structures, cable emplacement and maintenance, port utilization, and lighting would also result in long-term negligible or minor impacts on marine mammals. Although impacts on individual marine mammals and their habitat are anticipated from offshore wind activities, the level of impacts would be minimized due to the mitigation measures that are being implemented during construction, operation, and maintenance. The No Action Alternative would result in **minor** to **moderate** impacts on mysticetes (with the exception of NARW), odontocetes, and pinnipeds.

Because of the low population size for the NARW and continuing stressors, population-level effects on NARWs are occurring. Vessel activity (vessel collisions) and gear utilization associated with ongoing non-offshore wind activities would continue to result in long-term population-level impacts. The effects of climate change would further exacerbate impacts on NARW. For NARW, the No Action Alternative (in consideration of baseline conditions) would result in **moderate** to **major** long-term impacts. Ongoing offshore wind construction, operation, and maintenance activities would be conducted with applicant-proposed and agency-required mitigation measures developed to avoid and minimize impacts on NARW, so impacts from offshore wind activities are not anticipated to substantially contribute to the major impacts.

Cumulative Impacts of the No Action Alternative. Under the No Action Alternative, existing environmental trends and ongoing activities would continue in addition to impacts from planned offshore wind activities. Mysticetes, odontocetes, and pinnipeds would continue to be affected by natural and human-caused IPFs. Planned non-offshore wind activities would also contribute to impacts on marine mammals. Planned non-offshore wind activities include increasing vessel traffic; new submarine cable and pipeline installation and maintenance; marine surveys; commercial and recreational fishing activities; marine minerals extraction; port expansion; channel-deepening activities; military readiness activities; and the installation of new towers, buoys, and piers. BOEM anticipates that planned non-offshore wind activities would result in moderate long-term impacts on marine mammals (with the exception of NARW) primarily driven by ongoing underwater noise impacts, vessel activity (vessel collisions), entanglement, and seabed disturbance and the lack of knowledge regarding any mitigation and monitoring requirements for these planned non-offshore wind activities. Offshore wind activities would be responsible for a majority of the impacts associated with pile-driving noise, which could lead to moderate short-term impacts on marine mammals in the geographic analysis area. BOEM anticipates that the combined ongoing and planned activities would result in moderate impacts on marine mammals (with the exception of NARW). Additionally, the presence of structures could contribute adverse impacts with potentially beneficial impacts on some marine mammal species.

Impacts are often magnified in severity to major long-term impacts for the NARW due to low population numbers and the potential to compromise the viability of the species from the loss of a single individual. Offshore wind construction, operation, and maintenance activities would be conducted with applicant-proposed and agency-required mitigation measures developed to minimize impacts on NARW, so impacts from offshore wind activities are not anticipated to substantially contribute to the major impacts.

BOEM anticipates that the cumulative impacts of the No Action Alternative would result in **moderate** impacts on mysticetes, odontocetes, and pinnipeds, with the exception of the NARW, on which impacts could be **moderate** t**o major**. Impacts on individual NARWs could have population-level effects, and it is unknown whether the population can sufficiently recover from the loss of an individual to maintain the viability of the species.

3.15.4 Relevant Design Parameters & Potential Variances in Impacts for the Action Alternatives

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than those described in the sections below. The following PDE parameters (Appendix E) would influence the magnitude of the impacts on marine mammals:

- The number and size of WTG foundations, including scour protection;
- The number, size, and type of OSS foundations, including foundations and scour protection;
- The number and location of inter-array cables, OSS cables, and offshore export cables, including landfall and scour protection;
- The number of vessels, number of trips, and size of the vessels;
- The vessels and gear utilized to sample environmental parameters in the project area through HRG surveys, fisheries, and biological monitoring; and
- Number, size, and location of UXO detonations;

Ocean Wind has committed to measures to minimize impacts on marine mammals. The APMs are considered part of the Proposed Action and applicable action alternatives and are assessed within each IPF. The measures outlined in the COP include adhering to vessel speed restriction requirements and maintaining reasonable distances from marine mammals (MMST-01); adhering to NMFS Regional Viewing Guidelines to minimize the risk of vessel collision (MMST-02); monitoring NMFS NARW reporting systems (MMST-03); posting protected species observers as required by NMFS during construction activities (MMST-04); obtaining necessary permits and establishing appropriate and practicable mitigation and monitoring measures (MMST-05); and developing and implementing a Protected Species Mitigation and Monitoring Plan (MMST-06). A detailed list of the APMs is provided in Appendix H, Table H-1. Several monitoring programs may require the use of additional vessels beyond those noted in Table 3.15-15, Table 3.15-16, and Table 3.15-17. These include:

- Monitoring of marine mammals during construction activities including visual (e.g., protected species observers) and passive acoustic monitoring on the construction vessels as well on a secondary vessel as noted in Appendix H
- Benthic monitoring of the seafloor habitat as described in the Benthic Monitoring Plan (see Section 3.6.4 in Section 3.6, *Benthic Resources*, for additional details)
- SAV monitoring in Barnegat Bay as described in the SAV Monitoring and Mitigation Plans (see Section 3.6.4 in Section 3.6, *Benthic Resources*, for additional details)
- Fisheries monitoring as described in the Fisheries Monitoring Plan (see Section 3.9.4 in Section 3.9, *Commercial Fisheries and For-Hire Recreational Fishing*, for additional details). Fisheries monitoring would employ the use of trawling methods, underwater video and chevron traps, clamming methods using a towed fishing dredge, and tagging methods using a towed omni-directional hydrophone. See the *Gear Utilization* section for additional details.
- HRG surveys and monitoring would involve 88 survey days annually in years 1, 4, and 5, and 180 survey days per year in years 2 and 3 (see Chapter 2, Section 2.1.2.2.1 for details). Up to three vessels may be active concurrently to support HRG surveys for the Project.

In addition to the measures outlined in Table 1.1-2 of COP Volume II, Ocean Wind has committed to measures to minimize impacts on marine mammals in COP Appendix AA, Protected Species Mitigation and Monitoring Plan: Marine Mammals, Sea Turtles, and ESA-Listed Fish Species (Ocean Wind 2023), and as part of its MMPA Incidental Take Authorization application (Ocean Wind 2022). These measures are listed in Appendix H, Table H-1. The marine mammal section of the Protected Species Mitigation and Monitoring Plan, appended to the draft Incidental Take Authorization application as Appendix B,[4] provides a full description of these measures. The measures to be implemented include noise attenuation through use of a noise mitigation system; seasonal restrictions; standard protected species observer training and equipment requirements; visual monitoring, including low-visibility monitoring tools; passive acoustic monitoring; establishment and monitoring of shutdown zones; pre-start clearance; ramp-up procedures; operations monitoring; operational shutdowns and delay; sound source measurements of at least one foundation installation; survey sighting coordination; vessel strike avoidance procedures; and data recording and reporting procedures.

3.15.5 Impacts of the Proposed Action on Marine Mammals

3.15.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.15.8, *Impacts of Alternative E on Marine Mammals*. The sections below summarize the potential impacts of the Proposed Action on marine mammals during the various phases of the Project. Routine activities would include construction, O&M, and decommissioning of the Proposed Action, as described in Chapter 2, *Alternatives*. The Proposed Action would have the same IPFs as those described in Section 3.15.3.2, *Cumulative Impacts of the No Action Alternative*, because that analysis considers full build-out of all other wind farms and wind farm construction, operation, and decommissioning generally include the same (or similar) activities (e.g., pile driving, UXO detonation, site preparation work, vessel use) regardless of the specific project. The magnitude of impacts in this

[4] Ocean Wind's Incidental Take Authorization application is available on NMFS's website at: https://www.fisheries.noaa.gov/action/incidental-take-authorization-ocean-wind-lcc-construction-ocean-wind-1-wind-energy-facility.

section pertain to the construction, operation, and decommissioning of the Ocean Wind 1 Project. The analysis and conclusions regarding the impacts in this section, when compared with the analysis in Section 3.15.3.1, *Impacts of the No Action Alternative*, reflect the incremental impacts of the Proposed Action.

As described above, all IPFs apply to marine mammals. The most impactful construction-phase IPFs include noise (from pile driving, HRG surveys, and UXO detonation) and traffic (vessel strike). The IPFs of greatest concern during operations include noise (from operations), traffic (vessel strike), and presence of structures.

Noise: Activities associated with the Proposed Action that could cause underwater noise effects on marine mammals are impact pile driving (for the installation of WTGs and OSS), impact and vibratory pile driving (for the installation and removal of casing pipes, goal posts, or cofferdams at landfall sites), geophysical (HRG surveys) and geotechnical surveys, detonations of UXO, vessel traffic, aircraft, cable laying or trenching, and dredging. While all of these noise sources occur during construction, only WTG operation, HRG surveys, vessel traffic, and cable laying or trenching for cable repairs, if necessary, would occur during operation. Decommissioning activities related to noise would likely be similar to or less than those outlined for construction activities (with the exception of impact pile driving for foundations). Project construction activities could generate underwater noise and result in auditory injury, behavioral disturbance, and masking effects on marine mammals. WTG operations have the potential to result in long-term behavioral disturbance and masking effects on marine mammals.

Assessment of the potential for underwater noise to injure or disturb a marine mammal requires acoustic thresholds against which received sound levels can be compared. The thresholds used to assess the potential for Project-generated underwater noise to cause PTS and behavioral disturbance in marine mammals are outlined in Section 3.15.1.

The assessment of underwater noise in this EIS uses modeling, exposure estimates, and take numbers presented in Ocean Wind's application for a Letter of Authorization dated February 2022, and supplemented with an update memorandum submitted to NMFS in August 2022 (see Appendix J, Attachment J-1). In total, 17 marine mammal species (comprising 18 stocks) are likely to be affected by construction-related noise activities.

Impact pile-driving noise: Noise from impact pile driving for the installation of 98 WTGs and 3 OSS foundations would occur intermittently over 1 to 2 years. Pile driving would involve two pile types: monopiles and pin piles. For the WTGs, a single (8-meter diameter at top, 11-meter diameter at seafloor) vertical hollow steel monopile would be installed for each location using an impact hammer (IHC-4000 or IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 50 meters. Installation of a single monopile is expected to take 9 hours (1 hour clearance period, 4 hours piling, and 4 hours moving to the next location). Up to two piles are expected to be installed per 24-hour period. Concurrent monopile installation at more than one location is not planned. For the OSS, a piled jacket foundation is being considered. This would involve installing 16 2.44-meter-diameter pin piles as a foundation for each OSS foundation using an impact hammer (IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 70 meters. Alternatively, a single monopile like the ones used for WTGs may be used for each OSS. Each pin pile takes approximately 4 hours to install and a single OSS foundation is expected to take 6 days to install. For installation of both the WTG and OSS monopile foundations, 24-hour-per-day pile driving is expected to occur. A total of 98 monopiles would be installed for WTGs and 48 pin piles (or three monopiles) would be installed for OSS, constituting about 584 hours of active pile driving (404 if monopiles are used, assuming OSS monopile installation is identical to that for WTGs).

For both WTG and OSS installations, concurrent installation of more than one pile is not expected to occur. Ocean Wind has committed to using a noise mitigation system (also termed *noise abatement system*) during installation of both monopiles and pin piles (see Section 3.15.5 for a summary and Appendix H, Table H-1 for additional details). The noise mitigation system would be a combination of two devices that function together as a system to reduce noise propagation during pile driving. The same or a different noise mitigation system would be used during UXO detonations. The noise mitigation system ultimately selected for the Project would be tailored to and optimized for site-specific conditions, but the exact system to be used is not specified at this time. Bellmann et al. (2020) found three noise abatement systems to have proven effectiveness and to be offshore suitable: (1) the near-to-pile noise abatement systems – noise mitigation screen; (2) the near-to-pile hydro sound damper; and (3) for a far-from-pile noise abatement system, the single and double big bubble curtain. With the near-to-pile noise abatement systems – noise mitigation screen or the single big bubble curtain, noise reductions of approximately 15 to 17 dB in depths of 82 to 131 feet (25 to 40 meters) could be achieved. The near-to-pile hydro sound damper system, independent of the water depth, demonstrated noise reductions of 10 dB with an optimum system design. The achieved broadband noise reduction with a single or double big bubble curtain was dependent on the technical-constructive system configuration. Based on Bellmann et al. (2020), the noise mitigation system performance of 10 dB broadband attenuation assumed for the Project is considered achievable with currently available technologies for pile-driving activities. Ocean Wind has committed to achieving a minimum 10 dB broadband noise reduction during impact pile-driving operations (Appendix H, Table H-1).

Acoustic source level, propagation, and animal movement modeling of the impact pile-driving activities for the Proposed Action was undertaken by JASCO Applied Sciences to determine ranges to established PTS and disturbance thresholds and exposure estimates (Küsel et al. 2022). The modeling assumed a 10-dB-per-hammer-strike noise attenuation rate.

Simplistic acoustic modeling methods used to identify distances to PTS thresholds assume that marine mammals remain stationary for the duration of the sound event (i.e., acoustic range). However, the pathway a marine mammal travels through the sound field determines the accumulated received sound levels; therefore, treating marine mammals as stationary may not produce realistic estimates for the monitoring zones. For the Project, animal movement modeling was used to estimate the distance to the closest point of approach for each of the species-specific animats (simulated animals) during a simulation. The resulting values are termed *exposure ranges* (ER). To estimate exposure ranges, a conservative hammer schedule and sophisticated site-specific propagation modeling was applied. To estimate exposures from WTG installation, the Project assumed that 60 WTG monopiles (two per day for 30 days) would be installed in the highest-density month of each species and the remaining 38 WTG monopiles (two per day for 19 days) would be installed during the month with the second highest animal density. To estimate exposures from OSS foundation installation, the Project assumed either three monopiles (two per day for 1 day and one on a third day) or 48 pin piles (three per day for 16 days) would be installed in the highest-density month. Both OSS scenarios were modeled and evaluated and the worst-case scenario was applied to estimate exposure ranges and the number of animals exposed to underwater noise above acoustic thresholds.

Results of the acoustic and exposure modeling are presented in Appendix J and include $ER_{95\%}$ values as the horizontal distance that includes 95 percent of the closest point of approach of animats exceeding a PTS and behavioral threshold and the numbers of individual marine mammal species predicted to receive sound levels above PTS (e.g., injury) and behavioral exposure criteria.

The APMs outlined for impact pile driving include seasonal clearance zones and shutdown zones and specific monitoring requirements for NARW and are provided in Appendix H, Table H-1. As outlined in Table 3.15-6 below, the clearance zones and shutdown zones are based upon the maximum PTS zones for each species group and specific to seasonal variation (e.g., one for summer and one for winter months).

This is particularly important due to the larger exposure ranges expected during the winter months. These zones would be monitored by protected species observers on the pile-driving vessel and a separate, dedicated protected species observer vessel. In addition to visual monitoring, Ocean Wind would conduct passive acoustic monitoring as described in the APMs in Appendix H. Ocean Wind would acoustically monitor a clearance zone of 3,500 meters during summer (May–November) and 3,800 meters during winter (December) to minimize exposures. Ocean Wind would also implement a passive acoustic monitoring shutdown zone for NARWs of 1,650 meters in summer and 2,500 meters in winter.

Soft-start procedures are proposed in Appendix H and would occur over a 20-minute period. Soft starts can be an effective mechanism to reduce the potential for PTS by deterring species from the area. They are considered highly effective in deterring harbor porpoises from the area but not as effective in deterring pinnipeds, as described in Southall et al. 2021 and outlined below. The efficacy of deterring other marine mammal species through pile driving soft-start procedures is less clear.

As the clearance and shutdown zones are based on the maximum PTS zones modeled for LFC and separated by season, the potential for PTS effects is reduced. The extended NARW clearance zones to be implemented during all impact pile-driving operations would further reduce the potential for PTS. This also reduces exposure to higher noise levels considered to potentially result in behavioral disturbance, thereby minimizing the severity of any behavioral reaction on NARWs. In addition, no pile installation would occur from January 1 to April 30 during the time of year when NARWs are present in the region in higher numbers, further reducing effects on this species. Ocean Wind has proposed nighttime pile driving; however, no nighttime pile driving would be allowed unless Ocean Wind demonstrates the ability to effectively monitor clearance and shutdown zones. In addition to passive acoustic monitoring, other visual monitoring techniques would be implemented during any possible nighttime installation or during periods of daytime low visibility. These techniques include electro optical/infrared camera systems, thermal or infrared cameras, night vision devices, and infrared spotlight. As outlined in the Letter of Authorization application submitted to NMFS (Ocean Wind 2022), piling during the night would reduce the total duration of construction activities and limit crew transfers and vessel trips and allow the work to be conducted during low NARW density months in the summer, which would reduce the overall potential impact on this species.

Table 3.15-6 $ER_{95\%}$ PTS Zones and Applicable Clearance and Shutdown Zones to Be Applied during Impact Pile Driving (with 10-dB attenuation)

Hearing Group	Max. PTS Zones – $ER_{95\%}$ (m)		Clearance/Shutdown Zones (m)		Behavior zones – $ER_{95\%}$ (m)	
	Summer	Winter	Summer	Winter	Summer	Winter
LFC (excluding NARW)	1,650	2,490	1,650	2,490	3,130	3,450
NARW	1,650	2,490	3,500	3,800	3,130	3,450
MFC	0	0	1,650	2,490	3,090	3,410
HFC	880	1,430	880	1,430	3,070	3,370
PW	80	240	80	240	3,090	3,420

$ER_{95\%}$ represents the 95^{th} percentile of the maximum exposure ranges calculated for each hearing group for each scenario that was modeled. See Appendix R of the COP for more detail.
m = meters; PW = phocid pinnipeds in water

The results of marine mammal exposure modeling for the full monopile scenario (WTG and OSS) and joint foundation approach (WTGs use monopiles; OSS use jackets with pin piles) over 5 years assuming 10 dB attenuation only are shown in Table 3.15-7 and Table 3.15-8 below.

Table 3.15-7 Modeled Potential Level A and Level B Harassment Exposures (Assuming 10 dB Sound Attenuation) Due to Impact Pile Driving of a Monopile Foundation (Assuming 98 Total Monopiles for WTGs) Over 5 Years

Marine Mammal Species	Population Estimate	Level A Harassment (SEL_{cum})	Level B Harassment (160 dB RMS)
NARW[1]	338	0.9[3]	3.11
Blue whale[1]	Unknown[2]	N/A[5]	N/A[5]
Fin whale[1]	6,802	3.69	7.05
Sei whale[1]	6,292	0.89	2.00
Minke whale	21,968	18.42	52.25
Humpback whale	1,396	4.24	13.82
Sperm whale[1]	4,349	0	0
Atlantic white-sided dolphin	93,233	0	71.5
Atlantic spotted dolphin	39,921	N/A[5]	N/A[5]
Bottlenose dolphin (offshore stock)	62,851	0	935.91
Bottlenose dolphin (coastal stock)	6,639	0	0
Short-finned pilot whale	28,924	0	0.04
Long-finned pilot whale	39,215	0	0
Risso's dolphin	35,215	0	7.06
Common dolphin	172,974	0	1,229.37
Harbor porpoise[4]	95,543	51.31	233.89
Gray seal	27,300	3.04	197.56
Harbor seal	61,336	12.16	554.22

Source: Taking Marine Mammals Incidental to the Ocean Wind 1 Wind Energy Facility Offshore of New Jersey, 87 *Federal Register* 64868–65009 (October 26, 2022)

[1] Listed as endangered under the ESA.

[2] The minimum blue whale population is estimated at 412, although the exact value is no known. NMFS is utilizing this value for the preliminary small numbers determination, as shown in parentheses.

[3] Level A harassment exposures were initially estimated for this species, but due to mitigation measures that Ocean Wind would be required to abide by, no Level A harassment take would be requested or expected. Instead, the requested Level A harassment take from these exposure estimates was added to the requested Level B harassment take.

[4] The calculated Level A harassment exposures are likely an overestimate, as the modeled 10 dB sound reduction from the noise mitigation systems does not take into account that the reduction is greater at higher frequencies, which are best heard by harbor porpoises.

[5] Exposure modeling for blue whales and Atlantic spotted dolphins was not conducted because the impacts on the species approached zero due to the low density estimates. Because of this, values for these species have been excluded from the quantitative analyses and subsequent tables.

Table 3.15-8 Modeled Potential Level A and Level B Harassment Exposures (Assuming 10 dB Sound Attenuation) Due to Impact Pile Driving of OSS Foundations (Assuming Three Monopiles or Three Jackets with 48 Pin Piles) Over 5 Years

Marine Mammal Species	Population Estimate	8-/11-meter Monopile Foundation Scenario		2.44 Pin Pile for Jacket Foundation Scenario	
		Level A Harassment (SEL_{cum})	Level B Harassment (160 dB RMS)	Level A Harassment (SEL_{cum})	Level B Harassment (160 dB RMS)
NARW[1]	338	0.04[3]	0.14	0.10[3]	0.75
Blue whale[1]	Unknown[2]	N/A[5]	N/A[5]	N/A[5]	N/A[5]
Fin whale[1]	6,802	0.15	0.27	0.48	1.20
Sei whale[1]	6,292	0.04	0.08	0.14	0.45
Minke whale	21,968	0.76	2.32	2.29	15.81
Humpback whale	1,396	0.18	0.51	0.54	3.63
Sperm whale[1]	4,349	0	0	0	0
Atlantic white-sided dolphin	93,233	0	2.37	0	16.20
Atlantic spotted dolphin	39,921	N/A[5]	N/A[5]	N/A[5]	N/A[5]
Bottlenose dolphin (offshore stock)	62,851	0	30.44	0	168.23
Bottlenose dolphin (coastal stock)	6,639	0	0	0	0
Short-finned pilot whale	28,924	0	Less than 0.01	0	0
Long-finned pilot whale	39,215	0	0	0	0
Risso's dolphin	35,215	0	0.26	0	1.79
Common dolphin	172,974	0	40.51	0	293.89
Harbor porpoise[4]	95,543	2.38	10.004	16.60	70.97
Gray seal	27,300	0.08	6.98	0.32	38.59
Harbor seal	61,336	0.37	19.76	0.43	99.14

Source: Taking Marine Mammals Incidental to the Ocean Wind 1 Wind Energy Facility Offshore of New Jersey, 87 *Federal Register* 64868-65009 (October 26, 2022)
[1] Listed as endangered under the ESA.
[2] The minimum blue whale population is estimated at 412, although the exact value is no known. NMFS is utilizing this value for the preliminary small numbers determination, as shown in parentheses.
[3] Level A harassment exposures were initially estimated for this species, but due to mitigation measures that Ocean Wind would be required to abide by, no Level A harassment take would be requested or expected. Instead, the requested Level A harassment take from these exposure estimates was added to the requested Level B harassment take.
[4] The calculated Level A harassment exposures are likely an overestimate, as the modeled 10 dB sound reduction from the noise mitigation systems does not take into account that the reduction is greater at higher frequencies, which are best heard by harbor porpoises.
[5] Exposure modeling for blue whales and Atlantic spotted dolphins was not conducted because the impacts on the species approached zero due to the low density estimates. Because of this, values for these species have been excluded from the quantitative analyses and subsequent tables.

Based on the literature reviewed in Section 3.15.3.2, *Cumulative Impacts of the No Action Alternative*, it is possible that impact pile driving could cause behavioral effects such as short-term habitat avoidance, decreases in foraging success, or a change in vocal behavior in HFC. Baleen whales have exhibited similar behaviors in response to other impulsive sound sources, so it is possible that these effects could occur during impact pile driving as well. Acoustic masking is possible over larger spatial scales and is likely to occur over long periods of time when vibratory pile driving is in use. Only certain sound sources used throughout the Project would overlap with the vocalization range of marine mammals. As a result, a complete masking of all marine mammal communications would not be expected. In addition, the duty cycle of sound sources is also important when considering masking effects. Low-duty cycle sound sources such as impact pile driving are less likely to mask marine mammal communications, as the sound transmits less frequently with pauses or breaks between impacts, providing opportunities for communications to be heard. Modeling results indicate that dominant frequencies of impact pile driving activities for the Proposed Action were concentrated below 1 kilohertz. Based on these results, LFC and pinnipeds are more likely to experience acoustic masking from impact pile driving than MFC and HFC. Masking from impact pile driving would occur only during times pile driving would be occurring (4–8 hours per day). Pile driving is unlikely to occur every day from May 1 through November 31 due to weather and logistical constraints. Furthermore, marine mammals such as whales are likely to be moving through the area or remaining for short periods of time (days to weeks). Therefore, it is highly unlikely individual marine mammals would experience masking during the duration of pile installation. As a result, more severe impacts such as those listed above are unlikely to occur.

Vibratory pile installation noise: Temporary cofferdams are being considered at four locations to connect the cables to shore:

- Oyster Creek HDD, two cofferdams (Atlantic Ocean to Island Beach State Park; sea-to-shore)
- Island Beach State Park Barnegat Bay HDD, two cofferdams or sheet piling for temporary shoring (Barnegat Bay onshore; bay-to-shore)
- Farm Property HDD, two cofferdams or sheet piling for temporary shoring (bayside of Oyster Creek; shore-to-bay)
- BL England HDD, one cofferdam (sea-to-shore)

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

Installation and removal of sheet piles would require the use of a vibratory hammer. The level (at 10 meters) of the vibratory pile driver was assumed to be 165 dB re 1 µPa squared (JASCO 2022a). Ocean Wind assumed sound levels during cofferdam removal would be similar to those during installation and therefore this source level was applied to both installation and removal activities. A practical spherical spreading model was used by JASCO (JASCO 2022a) to estimate the extent of potential underwater noise effects as a result of vibratory driving of sheet piles. The modeling assumed that the installation and removal of cofferdams would require 18 hours over 2 days to complete, with vibratory pile driving taking place for no longer than 12 hours each 24-hour period over the installation period. Cofferdam installation using vibratory pile driving would only take place during daylight hours. Appendix J summarizes the maximum distances to injury (e.g., PTS) and behavioral thresholds (e.g., TTS and behavior) per hearing group. The number of marine mammal species potentially exposed to noises above thresholds for vibratory sheet installation was estimated by multiplying the maximum distances to thresholds by the highest monthly species density by 4 days of vibratory pile driving, as summarized in Attachment J-1 of Appendix J. Due to lower densities of marine mammals in the nearshore areas of the cofferdam installation and removal, the transitory nature of marine mammals, and the very short duration of vibratory pile driving, these estimates are likely conservative.

Estimated PTS exposures to marine mammal species by month resulting from vibratory installation and removal of cofferdams was less than one in all cases and are not expected to occur. However, Ocean Wind has requested PTS (Level A harassment) takes in its Letter of Authorization application for coastal common bottlenose dolphins and gray and harbor seals due to the tendency for seals to actively investigate construction disturbances and in recognition that some coastal common bottlenose dolphins are likely to be encountered in higher numbers in the nearshore environment.

The APMs outlined for vibratory pile driving include clearance zones, shutdown zones, and ramp-up procedures and are provided in Appendix H, Table H-1. As outlined in Table 3.15-9 below, the clearance zones and shutdown zones cover the largest PTS zone modeled for each species group. Due to the relatively small PTS zones and the application of APMs including the zones outlined in Table 3.15-9, the potential for PTS effects on all marine mammal species would be greatly reduced. Although some auditory injury (PTS) and behavioral disturbance effects on marine mammals as a result of vibratory pile driving are possible, the work is only expected to occur over a 4-day period, limiting the potential for effects. Furthermore, this work would only occur during daylight hours when monitoring would be effective in detecting marine mammals to implement clearance and shutdown zones. For vibratory pile driving, masking effects are possible and would be greater due to the continuous nature of the sound. However, the activity is only expected to occur over a 4-day period, reducing the potential for masking to occur.

Table 3.15-9 Maximum PTS Zones and Applicable Clearance and Shutdown Zones to Be Applied during Vibratory Pile Driving[1]

Hearing Group	Max. PTS Zone (m) from $SEL_{cum24hr}$ Thresholds	Clearance Zone (m)	Shutdown Zone (m)	Max. Behavior Zone (m)	Area of Level A Harassment Zone (km^2)
LFC	86.7	150	100	10,000	0.024
NARW	86.7	150	100	10,000	0.024
MFC	7.7	150	50	10,000	Less than 0.000
HFC	128.2	150	150	10,000	0.052
PW	52.7	150	60	10,000	0.009

[1] Area of Level B Harassment Zone (km^2) varies by location but does not vary by hearing group. Ocean City HDD: 163.75; BL England HDD: 158.59; Holtec/Farm HDD: 77.01; Island Beach State Park Barnegat Bay HDD: 76.70
m = meter; PW = phocid pinnipeds in water

Ocean Wind's proposed Level A and Level B harassment takes resulting from vibratory pile driving for installation and removal of temporary cofferdams are shown in Table 3.15-10. For some species, calculated Level B harassment exposures were zero or very low, but Ocean Wind requested take of an average group size and NMFS concurred this was appropriate given the species potential occurrence in the area.

Table 3.15-10 Proposed Level A and Level B Harassment Take Resulting from Vibratory Pile Driving Associated with the Installation and Removal of Temporary Cofferdams Over 5 Years

Marine Mammal Species	Population Estimate	Requested Level A Harassment	Requested Level B Harassment
NARW[1]	338	0	1
Blue whale[1]	Unknown	0	0

Marine Mammal Species	Population Estimate	Requested Level A Harassment	Requested Level B Harassment
Fin whale[1]	6,802	0	2
Sei whale[1]	6,292	0	1
Minke whale	21,968	0	3
Humpback whale	1,396	0	3
Sperm whale[1]	4,349	0	0
Atlantic white-sided dolphin	93,233	0	5
Atlantic spotted dolphin	39,921	0	45[2]
Bottlenose dolphin (offshore stock)	62,851	0	472
Bottlenose dolphin (coastal stock)[6]	6,639	11[3]	1,031
Short-finned pilot whale	28,924	0	10[4]
Long-finned pilot whale	39,215	0	10[4]
Risso's dolphin	35,215	0	30[4]
Common dolphin	172,974	0	13
Harbor porpoise	95,543	0	28
Gray seal	27,300	28[5]	115
Harbor seal	61,336	28[5]	320

Source: Taking Marine Mammals Incidental to the Ocean Wind 1 Wind Energy Facility Offshore of New Jersey, 87 *Federal Register* 64868-65009 (October 26, 2022)
[1] Listed as endangered under the ESA.
[2] No Level B harassment exposures were estimated for Atlantic spotted dolphins, but Ocean Wind has requested a group size estimate of up to 45 Level B harassment takes.
[3] No Level A harassment exposures were estimated for bottlenose dolphins of the coastal stock but a group size estimate of 11 Level A harassment takes has been requested by Ocean Wind.
[4] Level B harassment takes for pilot whales (short-finned and long-finned) and Risso's dolphins were adjusted to account for an average pod size.
[5] No Level A harassment exposures were estimated for gray seals and harbor seals, but 28 Level A harassment takes have been requested in the event up to two animals are taken during either removal or installation of cofferdams due to the nearshore location of the cofferdams and seal haul-outs.
[6] The estimate for coastal bottlenose dolphins (bayside versus Atlantic Ocean-facing) is likely an overestimate, as this stock has demonstrated a preference for coastal environments as opposed to estuarine.

G&G survey noise (HRG surveys and geotechnical drilling activities): A total of 31,375 kilometers of HRG surveys are estimated to be required in the Project area and export cable route area, with a single vessel being able to cover 43.5 miles (70 kilometers) per day. As a result, up to three vessels may be active concurrently within a 24-hour period and would transit at speeds of 4 knots (2 meters per second). In certain shallow-water areas, vessels may conduct surveys during daylight hours only, with a corresponding assumption that the daily survey distance would be halved (35 kilometers). However, for purposes of analysis, a single vessel survey day is assumed to cover the maximum 70 kilometers. In years 1, 4, and 5, 88 survey days per year are expected. It is estimated that a total of 6,110 linear kilometers would be needed within the Wind Farm Area and export cable route area during this time. Survey effort would be split between the Wind Farm Area and the export cable route area: 3,000 kilometers for the array cable, 2,300 kilometers for the Oyster Creek export cable, 510 kilometers for the BL England export cable, and 300 kilometers for the OSS interconnector cable. During years 2 and 3 (when construction would occur), 180 survey days per year would be required. HRG surveys during WTG and OSS construction and operation would include up to 11,000 kilometers of export cable surveys, 10,500 kilometers of array cable surveys, 1,065 kilometers of foundation surveys, 250 kilometers of WTG surveys, and up to 2,450 kilometers of monitoring and verification surveys. To cover the requirements of the Project, several HRG surveys were considered in the modeling:

- Shallow-penetration, non-impulsive, non-parametric sub-bottom profilers (compressed high-intensity radiated pulses), 2 to 20 kilohertz
- Medium-penetration, impulsive boomers, 3.5 Hz to 10 kilohertz
- Medium-penetration, impulsive sparkers, 50 Hz to 4 kilohertz

Equipment with operating frequencies above 180 kilohertz would be used but were not considered in modeling, as it is above the hearing ranges of marine mammals (see Table 3.15-1) and therefore not anticipated to cause injury or disturbance.

For HRG surveys, the NMFS User Spreadsheet Tool and transmission loss equations were used to estimate the distances to PTS and behavioral thresholds, respectively. Source levels relied upon measurements recorded from equipment, the best available manufacturer specifications (representing maximum output), or the closest proxy source (Crocker and Fratantonio 2016). The largest injury isopleth distance calculated for HRG surveys is 36.5 meters for HFC and for all other hearing groups is less than 2 meters (see Table 3.15-11 below Appendix J). Appendix J summarizes the number of marine mammals potentially exposed to underwater noise exceeding acoustic thresholds per species and maximum distances to injury and behavioral effects per marine mammal hearing group. A small number of Level A exposures were estimated based on density calculations for common bottlenose dolphins (offshore population), harbor porpoise, and gray and harbor seals; however, no Level A takes are being requested by Ocean Wind as part of its Letter of Authorization. The spreadsheet calculations are overly conservative and actual potential for a marine mammals to incur PTS from HRG surveys is discountable. Regardless, Ocean Wind has proposed APMs to minimize the potential and severity of any behavioral harassment.

The APMs outlined for HRG surveys include clearance zones, shutdown zones, and ramp ups as detailed in Appendix H. Pre-start clearance surveys and ramp-ups would be conducted for non-impulsive, non-parametric sub-bottom profilers and impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kilohertz. Shutdowns would be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kilohertz. The clearance zones and shutdown zones proposed for the selected HRG surveys cover the maximum PTS zones modeled, part of the behavioral zones for most species, and the entire behavioral zone for NARWs (Table 3.15-11). In addition, the clearance and shutdown zones would limit the potential for behavioral effects on NARW.

For HRG surveys, masking of communications would depend on the frequency at which the survey is completed and the frequency range of the sound sources being used. A total of 88 survey days (annually) in years 1, 4, and 5 and 180 days (annually) in years 2 and 3 would include non-impulsive sources in the 2- to 20-kilohertz range and impulsive boomers and sparkers in the 3.5-Hz to 10-kilohertz and 50-Hz to 4-kilohertz range. Due to the range of frequencies emitted during HRG surveys, masking of all hearing groups is considered possible. However, masking of LFC communications is considered more likely due to the overlap of these surveys with lower-frequency signals produced by these species. Masking of high-frequency echolocation clicks used by MFC and HFC is not anticipated; however, some masking of other communication used by these species is possible.

Table 3.15-11 Maximum PTS Zones and Applicable Clearance and Shutdown Zones to Be Applied during HRG Surveys

Hearing Group	Max. PTS Zone (m) using $SEL_{cum, 24hr}$ Thresholds	Max. Behavioral Disturbance Zone (m)[1]	Shutdown/Clearance Zone (m)
LFC	1.5	141	100
NARW	1.5	141	500
MFC	<1	141	100
HFC	36.5	141	100
PW	<1	141	100

Source: Ocean Wind 2022 (Table 1 of Appendix B, Protected Species Monitoring and Mitigation Plan).
Note: Pre-start clearance surveys and ramp-ups would be conducted for non-impulsive, non-parametric sub-bottom profilers and impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kilohertz. Shutdowns would be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies of less than 180 kilohertz.
[1] The maximum behavioral disturbance zone is generated by the AA Dura-Spark.
m = meter; PW = phocid pinnipeds in water

Modeled Level A and Level B harassment exposures for marine mammals resulting from HRG survey activities are shown in Table 3.15-12.

Table 3.15-12 Calculated Annual Maximum Level A and Level B Harassment Exposures of Marine Mammals Resulting from HRG Surveys

Marine Mammal Species	Population Estimate	Estimated Level A Harassment Exposures[2]		Estimated Level B Harassment Exposures	
		Years 1, 4, & 5 (88 days annually)	Years 2 & 3 (180 days annually)	Years 1, 4, & 5 (88 days annually)	Years 2 & 3 (180 days annually)
NARW[1]	338	less than 0.01	0.01	0.46	0.94
Blue whale[1]	Unknown	less than 0.01	less than 0.01	0.02	0.03
Fin whale[1]	6,802	0.01	0.02	1.24	2.56
Sei whale[1]	6,292	less than 0.01	less than 0.01	0.33	0.68
Minke whale	21,968	0.02	0.04	2.40	4.98
Humpback whale	1,396	0.01	0.02	1.10	2.27
Sperm whale[1]	4,349	less than 0.01	less than 0.01	0.04	0.09
Atlantic white-sided dolphin	93,233	0.03	0.05	4.79	10.04
Atlantic spotted dolphin	39,921	N/A	N/A	N/A	N/A
Bottlenose dolphin (offshore stock)	62,851	1.23	2.46	173.84	348.37
Bottlenose dolphin (coastal stock)	6,639	3.28	6.60	464.18	933.46
Short-finned pilot whale	28,924	less than 0.01	less than 0.01	0.14	0.29

Marine Mammal Species	Population Estimate	Estimated Level A Harassment Exposures[2]		Estimated Level B Harassment Exposures	
		Years 1, 4, & 5 (88 days annually)	Years 2 & 3 (180 days annually)	Years 1, 4, & 5 (88 days annually)	Years 2 & 3 (180 days annually)
Long-finned pilot whale	39,215	less than 0.01	less than 0.01	0.19	0.40
Risso's dolphin	35,215	less than 0.01	less than 0.01	0.31	0.65
Common dolphin	172,974	0.20	0.42	28.38	59.52
Harbor porpoise	95,543	5.60	11.59	21.69	44.88
Gray seal	27,300	0.23	0.48	33.23	67.56
Harbor seal	61,336	0.66	1.34	92.88	188.83

Source: Taking Marine Mammals Incidental to the Ocean Wind 1 Wind Energy Facility Offshore of New Jersey, 87 *Federal Register* 64868-65009 (October 26, 2022)
[1] Listed as endangered under the ESA.
[2] Some Level A harassment exposures were estimated to occur during HRG surveys, but due to the proposed mitigation measures Ocean Wind would be required to undertake, no Level A harassment takes were carried forward.

Geotechnical surveys for engineering purposes and to resolve adverse effects on archaeological resources would take place prior to construction. The environmental consequences of these surveys were analyzed in BOEM's *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia Final Environmental Assessment*. Acoustic impacts associated with this work would be minor and ensonify only a localized area. No geotechnical surveys are planned for the construction or post-construction phases.

UXO detonation noise: Ocean Wind may encounter UXO on the seabed in the Wind Farm Area and along export cable routes. While non-explosive methods may be employed to lift and move these objects, some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could cause disturbance, injury, and mortality to marine mammals. Ocean Wind conducted modeling of acoustic ranges to thresholds for UXO, which included three sound pressure metrics (peak pressure level, SEL, and acoustic impulse), four different depths at four different sites, and five charge weight bins (ranging from 2.3 kilograms [bin E4] up to 454 kilograms [bin E12]). The modeling of acoustic fields was performed using a combination of semi-empirical and physics-based computational models. The modeling assumed that the full weights of UXO explosive charges are detonated together with their donor charges and that no shielding by sediments occurs. It also assumed that up to 10 UXOs may need to be detonated in place and that these detonations would occur on different days, such that only one UXO would be detonated within a 24-hour period. UXO detonations would only occur during daylight hours and would not be planned between January 1 and April 30. Ocean Wind is committing to the use of a noise mitigation system during all detonations (see Appendix H, Table H-1) and, based on previous experience, 10 dB minimum of attenuation is possible with the use of a noise mitigation system (review provided in Hannay and Zykov 2022). Modeling of mitigated (10 dB attenuation) and unmitigated scenarios were conducted of detonations of all charge weights, with the largest charge weight being 454 kilograms (category E12) defined by the U.S. Navy (Table 3.15-13). As Ocean Wind has committed to attaining a 10-dB attenuation for all UXO detonation events, mitigated values are presented herein (Appendix J). The largest distance to auditory injury (PTS) thresholds was 6,200 meters for HFC (Hannay and Zykov 2022). The PTS distances for LFC and NARW were 3,780 meters, for MFC 461 meters, and for pinnipeds in water 1,600 meters (Hannay and Zykov 2022). Auditory injury thresholds (PTS PK or SEL noise metrics) were larger than modeled distances to mortality and non-auditory injury criteria and are presented in Table J-19 (Hannay and Zykov 2022).

Maximum ranges to mortality and non-auditory injury were based on worst-case scenario modeling results for charge size E12 (454 kilograms) and deepest water depth (45 meters) based on 1 percent of animals exposed (mortality/lung and gastrointestinal injury). The largest mortality distance was estimated for porpoise pup/calf at 353 meters; for lung injury at 648 meters for porpoises pup/calf; and for gastrointestinal injury at 125 meters for all marine mammal species (Hannay and Zykov 2022).

The APMs outlined for UXO detonation surveys include sound attenuation devices during all detonations, clearance zones, detonations occurring only during daylight, and the potential inclusion of aerial surveys to cover clearance zones as detailed in Appendix H (see Table 3.15-13 for clearance zones). Ocean Wind has committed that a sufficient number of vessels would be deployed to provide 100-percent temporal and spatial coverage of the clearance zones and, if necessary, aerial survey would be used to provide coverage. APMs are designed to avoid mortality and non-auditory injury; therefore, these impacts would be avoided. Passive acoustic monitoring would also occur to acoustically monitor a zone that encompasses a minimum of a 10-kilometer radius around the source for all detonations. Due to the large PTS zones estimated for HFC, LFC/NARW, and pinnipeds in water, some PTS effects are considered possible, particularly if larger charge detonations are encountered (e.g., E12). With implementation of vessel-based monitoring or aerial surveys to cover the clearance zones, the potential for PTS effects would be reduced. As the TTS zones are considerably larger than the PTS zones, TTS (and any associated behavioral disturbance) may occur. Marine mammals are likely to be startled and move away from the area temporarily; a small amount of TTS may occur. Severe, long-term reactions are not anticipated, as the stimulus would be short (seconds) and implementation of the clearance zone would be designed such that any marine mammal exposed would be receiving relatively low levels of noise. The low number of potential UXOs identified in the Project area and Ocean Wind's commitment to using a dual noise-mitigation system for all detonations would further reduce all potential underwater noise effects associated with UXO detonations. For UXO detonation, masking is not anticipated to occur due to the very short time frame (seconds) over which the noise would occur.

Table 3.15-13 Maximum PTS Zones and Applicable Clearance Zones to Be Applied during UXO Detonations: Mitigated

Hearing Group	Charge Size									
	E4 (2.3 kilograms)		E6 (9.1 kilograms)		E8 (45.5 kilograms)		E10 (227 kilograms)		E12 (454 kilograms)	
	Max. PTS/ Clearance Zone (m)	Max. Behavioral Zone (m)	Max. PTS/ Clearance Zone (m)	Max. Behavioral Zone (m)	Max. PTS/ Clearance Zone (m)	Max. Behavioral Zone (m)	Max. PTS/ Clearance Zone (m)	Max. Behavioral Zone (m)	Max. PTS/ Clearance Zone (m)	Max. Behavioral Zone (m)
LFC	552	2,820	982	4,680	1,730	7,490	2,970	10,500	3,780	11,900
NARW	552	2,820	982	4,680	1,730	7,490	2,970	10,500	3,780	11,900
MFC	50	453	75	773	156	1,240	337	2,120	461	2,550
HFC	1,820	6,160	2,590	8,000	3,900	10,300	5,400	12,900	6,200	14,100
PW	182	1,470	357	2,350	690	3,820	1,220	5,980	1,600	7.020

Note: Pre-start clearance zones were calculated by selecting the largest PTS threshold (the larger of either the PK or SEL [$R_{95\%}$] noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.
Behavioral monitoring zones were calculated by selecting the largest TTS threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.
The maximum PTS zones shown here are the largest zones associated with injury (auditory or non-auditory) associated with UXO detonations.
m = meters; PW = phocid pinnipeds in water

Level A harassment exposures resulting from UXO/MEC detonations are considered unlikely but possible. To reduce impacts, Ocean Wind would use a noise abatement system capable of achieving 10 dB of sound attenuation. The estimated maximum PTS and TTS exposures assuming 10 dB of sound attenuation are presented in Table 3.15-14.

Table 3.15-14 Estimated Potential Maximum PTS and TTS Exposures of Marine Mammals Resulting from the Possible Detonations of up to 10 UXOs/MECs Assuming 10 dB Sound Attenuation

Marine Mammal Species	Population Estimate	Level A Harassment (PTS SEL)	Level B Harassment (TTS SEL)
NARW[1,3]	338	0.03	0.35
Blue whale[1]	Unknown[2]	Less than 0.01	0.04
Fin whale[1]	6,802	0.28	2.87
Sei whale[1]	6,292	0.08	0.87
Minke whale	21,968	2.53	26.42
Humpback whale	1,396	0.33	3.41
Sperm whale[1]	4,349	Less than 0.01	0.01
Atlantic white-sided dolphin	93,233	0.03	1.05
Atlantic spotted dolphin	39,921	N/A	N/A
Bottlenose dolphin (offshore stock)	62,851	0.68	24.36
Bottlenose dolphin (coastal stock)	6,639	3.84	137.31
Short-finned pilot whale	28,924	Less than 0.01	0.02
Long-finned pilot whale	39,215	Less than 0.01	0.02
Risso’s dolphin	35,215	Less than 0.01	0.04
Common dolphin	172,974	0.13	4.65
Harbor porpoise	95,543	9.49	46.50
Gray seal	27,300	2.28	50.98
Harbor seal	61,336	6.39	142.49

[1] Listed as endangered under the ESA.
[2] The minimum blue whale population is estimated at 412, although the exact value is no known. NMFS is utilizing this value for the preliminary small numbers determination, as shown in parentheses.
[3] Level A harassment exposures were initially estimated for this species, but due to mitigation measures, no Level A harassment take would be requested or expected.

Vessel noise: There are several types of vessels that would be required throughout the life of the Project. Table 3.15-15 and Table 3.15-16 outline the type of vessels that would be required for Project construction and operations as well as the maximum number of vessels required by vessel type. Additional activities that may require vessels not outlined in Section 3.15.3 include monitoring initiatives (e.g., marine mammals and fisheries) and HRG surveys. For a physical description of the sounds from vessels, see Appendix J, *Underwater Sound and Acoustic Modeling Results*. The effects of vessel noise on marine mammals under the Proposed Action are expected to be similar to those outlined in Section 3.15.3.2, *Cumulative Impacts of the No Action Alternative*. BOEM anticipates that underwater noise generated by larger vessels used for Project activities would overlap the hearing range of all marine mammals but particularly mysticetes (e.g., LFC) including the blue, fin, humpback, sei, and minke and NARW. As outlined in Section 3.15.3.2, vessel noise could result in a range of behavioral responses, including the onset of avoidance behavior (e.g., heading away or increasing range from the source), changes in acoustic behavior (brief or minor changes in vocal rates or signal characteristics potentially related to higher auditory masking potential), diving and subsurface interval behavior (increased interval between surfacing bouts), and brief or minor changes in vocal rates or signal characteristics potentially related to higher auditory masking potential (Southall et al. 2021). Marine mammals may also not exhibit any detectable response (Southall et al. 2021). Any noise-related effects would be expected to dissipate once the vessel or individual has left the area or the animal has moved away from the immediate vicinity of the vessel.

Aircraft noise: Fixed-wing aircraft may be utilized for monitoring activities during construction, O&M, and decommissioning (see Appendix H). BOEM would require all aircraft operations to comply with current approach regulations for any sighted NARWs or unidentified large whale. Current regulations (50 CFR 222.32) prohibit aircraft from approaching within 1,500 feet (457 meters) of NARW. BOEM expects that most aircraft operations would occur above this altitude limit. No PTS or TTS effects on marine mammals are anticipated as a result of Project aircraft. Behavioral impacts are unlikely to occur given operational altitudes.

Cable-laying or trenching noise: Cables would typically be laid and post-lay burial would be performed using a jetting tool, if seabed conditions allow. Cables may remain on the seabed within the Wind Farm Area for up to 2 weeks. Alternatively, the array cables may be simultaneously laid and buried. Array cables can be installed using a tool towed behind the installation vessel to simultaneously open the seabed and lay the cable, or by laying the cable and following with a tool to embed the cable. Possible installation methods for these options include jetting, vertical injection, controlled-flow excavation (covered below under *site preparation noise*), trenching, and plowing. Dynamic positioning vessels rated DP2 with associated support craft would be used to install the array cables. Cable failures (i.e., reduction or loss in transmission) are expected to occur over the life of the Project, and noise associated with repair of cable failures would be similar to that of cable laying and trenching.

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

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

Modeling results indicate that Project-generated noise from cable-laying operations would exceed the disturbance threshold for marine mammals (120 dB re 1 µPa SPL_{RMS}) at distances up to 7.5 kilometers for cable-laying operations (with support vessels) and up to 7.4 kilometers for jet sled trenching (e.g., jetting). Expected acoustic frequencies emitted by these sound sources are more likely to overlap with the hearing range of baleen whales (LFC). These noise levels and characteristics are comparable to those of transiting vessels and dredges. While some low-level behavioral reactions may occur, the degree of disturbance is not anticipated to rise to a level considered harassment. Any slight behavioral changes resulting from exposure to cable-laying noise are likely to have minimal effects on marine mammals.

Site preparation (e.g., boulder clearance, sandwave clearance, pre-lay grapnel run, dredging) noise: Boulder clearance would take place prior to construction to clear the cable corridor in preparation for trenching and burial operations. A combination of displacement plow, subsea grab, or, in shallower waters, a back hoe dredger may be used to clear boulders and undertake route clearance activities. Noise generated by boulder clearance is likely similar to that for mechanical dredging (e.g., clamshell). Dredging may be done in the Wind Farm Area and export cable corridors for sandwave clearance. Ocean Wind has indicated that sandwave clearance work could be undertaken by traditional dredging methods such as a mechanical clamshell dredge, or sand wave removal plow as well as hydraulic trailing suction hopper, or controlled-flow excavator. Dredging would also be required at the HDD in-water exit pit at the Oyster Creek landfall site on the east side of Island Beach State Park and at the HDD in-water exit pit for the BL England site.

Dredging may also be required in the shallow areas of Barnegat Bay to allow vessel access for export cable installation. Locations include the prior channel (west side of Island Beach State Park/east side of Barnegat Bay), the west side of Barnegat Bay at the export cable landfall, and the Oyster Creek section of the federal channel in Barnegat Bay if USACE is unable to conduct dredging in this area as part of the federal channel dredging that is currently under contract. In 2020, USACE completed an environmental assessment, Section 7 ESA consultation, and an EFH Assessment for maintenance dredging of the Barnegat Inlet Federal Navigation Project and use of maintenance material for shoreline protection and habitat creation/restoration in Barnegat Bay. This analysis concluded that dredging Oyster Creek channel and beneficial use placement operations were not anticipated to result in significant direct, indirect, or cumulative adverse impacts on federally or state-listed threatened or endangered species (USACE 2020). NMFS concurred that the action was not likely to adversely affect listed species or critical habitat. The environmental assessment and ESA consultation for maintenance dredging of the Barnegat Inlet Federal Navigation Project did not assess the transfer of dredged materials via pipeline for upland facility disposal.

A physical description of the sounds produced during dredging can be found in Appendix J, *Underwater Sound and Acoustic Modeling Results*. The effects of site preparation noise on marine mammals under the Proposed Action are expected to be similar to those outlined in Section 3.15.3.2, *Cumulative Impacts of the No Action Alternative*. It is unlikely PTS thresholds would be exceeded in any marine mammals from dredge noise. This could be due to source levels being low enough to never accumulate to levels that would exceed PTS thresholds or that animals would have to remain at very close distances to the dredge for several hours, which is unrealistic. The same concepts applies to TTS; therefore, TTS is also unlikely. Source levels generated by mechanical or hydraulic dredges are likely to exceed behavioral thresholds and could result in masking of marine mammal communications (Todd et al. 2015; NMFS 2018a). However, any short duration and small spatial extent of masking or any slight behavioral changes resulting from dredge exposure are likely to be minimal. While some low-level behavioral reactions may occur, the degree of disturbance is not anticipated to rise to a level considered harassment.

Turbine operation noise: Current and near-term commercially available WTGs likely used for the Project range from 12.4-MW to 14.7-MW WTGs using the direct-drive GE Haliade-X 12-MW WTG. SPLs measured from direct-drive WTGs within this size range do not currently exist in the literature and modeling scenarios are limited to two studies with a high degree of uncertainty. Based on the currently available data on underwater noise from turbine operations, effects of the Project’s large direct-drive WTGs on marine mammals would likely be similar to the effects outlined for planned offshore wind activities in Section 3.15.3.2, *Cumulative Impacts of the No Action Alternative*. Turbine operation noise is unlikely to cause PTS or TTS in marine mammals but could cause behavioral and masking effects. Masking of the low-frequency calls emitted from LFC and phocid pinnipeds in water would be more likely to occur. It is expected that these effects would be at relatively short distances from the foundations and would reach ambient underwater noise levels within relatively short distances of the foundations (Miller and Potty 2017; Tougaard et al. 2009b, 2020).

Summary of noise impacts: Noise generated from Project construction would include impact pile driving, UXO detonations, HRG survey sources, vibratory pile driving, vessels, aircraft, cable laying or trenching, boulder removal, and dredging. Noise sources during operation would include turbine operation, vessels, and HRG surveys. Of those activities, the sophisticated modeling conducted by Ocean Wind on construction noise sources indicates that only impact pile driving and UXO detonations could cause PTS in marine mammals (see Appendix J). In general, UXO detonation may also cause mortality and non-auditory injury (lung and gastrointestinal injuries) and this impact would be permanent and severe. However, mortality and non-auditory injury impacts would be avoided through implementation of required mitigation measures; therefore, they would not occur due to the Proposed Action.

Foundation installation and UXO detonation could result in PTS, which is a long-term, permanent impact. However, the auditory damage would be concentrated in the frequencies of the noise source and would not span entire hearing ranges for any given marine mammal hearing group. In addition, the shift in hearing would be expected to be small (only a few dB) given the nature of sources and, for pile driving, the animal's ability to move away from the source before incurring more severe PTS. Only a few marine mammals of select species are anticipated to incur PTS incidental to impact pile driving and UXO detonation (Appendix J). APMs are designed to avoid PTS to NARWs. MFCs are unlikely to incur PTS from pile driving and UXO detonation given their thresholds. Some phocids may experience PTS. TTS may also result from these activities, as well as others; however, TTS is recoverable. Similar to PTS, hearing shift would be concentrated in the frequencies of the sound source and is anticipated to be small.

All audible noise sources have the potential to result in behavioral responses. Exposure to a noise source could result in no reaction to more severe reactions such as prolonged avoidance; cessation of behaviors such as foraging, socializing, and communication; and stress. Noise from construction is also likely to mask marine mammal communication to varying spatial and temporal degrees. No displacement or avoidance of critical habitat areas is expected, as no critical habitat for any marine mammal species is designated in the Project area. Critical habitat for NARW is approximately 418.43 kilometers north of the Project area and 396 kilometers north of the cofferdam installation area (e.g., from vibratory pile-driving work). The Project area is a migratory BIA for NARWs. Animals migrating through the Project area are likely to be exposed to noise; however, it is anticipated that the amount of deflection from the migratory path would be minimal. No concentrated foraging areas for NARWs are present with the Project area. Other marine mammals are likely foraging in the Project area, particularly odontocetes; however, ample foraging habitat not affected by the Project would remain. For these reasons, any temporary avoidance of the area by marine mammals during construction is not anticipated to result in any fitness consequences.

PTS and behavioral responses of LFC, MFC, HFC, and phocid pinnipeds to construction activities in water are considered likely, varying by population. With implementation of known and highly effective APMs such as a noise mitigation system (for impact pile driving), protected species observers programs, clearance and shutdown zones based on maximum PTS zones, ramp-ups, and implementation of passive acoustic monitoring, the impact of all underwater noise activities is considered moderate and short term for LFC, MFC, HFC, and phocid pinnipeds in water.

During operations, noise sources would be primarily limited to WTG operation, vessel use, HRG surveys, and cable laying or trenching for cable repairs, if necessary. Impacts from these sources are anticipated to be minor for all marine mammals.

Presence of structures: Under the Proposed Action, Ocean Wind proposes to install up to 98 WTGs, up to three OSS, and up to 77 acres (0.31 km^2) of inter-array cable hard protection, and 84 acres (0.34 km^2)

of foundation and scour protection, for a total of 161 acres (0.65 km^2) of new hard scour/cable protection. The structures and scour/cable protection, and the potential consequential impacts, would remain at least until decommissioning of each facility is complete. The 98 monopile foundations would be placed in a grid-like pattern with approximate spacing of 1 by 0.8 nm (1.85 kilometers) between WTGs. Based on documented lengths (Wynne and Schwartz 1999), the largest NARW (59 feet [18 meters]), fin whale (79 feet [24 meters]), sei whale (59 feet [18 meters]), and sperm whale (59 feet [18 meters]) would fit end to end between two foundations spaced at 1 nm (1.9 kilometers) 100 times over. This simple assessment of spacing relative to animal size indicates that the physical presence of the monopile foundations is unlikely to pose a barrier to the movement of large marine mammals, and even less likely to impede the movement of smaller marine mammals.

The presence of the monopile foundations over the life of the Project would alter the character of the ocean environment that could indirectly affect marine mammals; however, the likelihood and significance of these effects are difficult to determine. The various types of impacts on marine mammals that could result from the presence of structures (i.e., hydrodynamic and artificial reef effects and their influence on the availability of prey and forage resources, potential for interaction with active or abandoned fishing gear, and displacement) are described in detail in Section 3.15.3.2. The strong seasonal stratification of the Mid-Atlantic Bight is the dominant oceanographic feature limiting phytoplankton productivity, which then affects zooplankton prey productivity (Schofield et al. 2008). Localized turbulence and upwelling effects around the monopiles are likely to transport nutrients into the surface layer, potentially increasing primary and secondary productivity. That increased productivity at a local scale could be partially offset by the formation of abundant colonies of filter feeders on the monopile foundations. While the net impacts of these interactions are difficult to predict, they are not likely to result in more than localized effects on the abundance of zooplankton. Turbulent mixing would be increased locally within the flow divergence and in the wake, which would enhance local dispersion and dissipation of flow energy. However, because the monopiles would be spaced between 0.8 and 1 nm (1.3 and 1.6 kilometers) apart, there would be less than 1 percent areal blockage and the net effect over the spatial scale of the Project would be negligible. When considered relative to the broader oceanographic factors that determine primary and secondary productivity in the region, localized impacts on zooplankton abundance and distribution associated with the WTG structures are not likely to measurably affect the availability of prey resources for marine mammals.

Long-term reef effects resulting from the Proposed Action could result in negligible beneficial effects on fish-eating odontocetes and pinnipeds that benefit from increased prey abundance around the structures. Conversely, minor adverse effects due to disruption in hydrodynamics from the Proposed Action could result in impacts on mysticetes that forage on plankton and forage fish. Structures associated with the Project would be expected to provide some level of reef effect and may result in long-term, minor beneficial impacts on pinniped and small odontocete foraging and sheltering. Long-term, minor, adverse impacts could occur as a result of increased interaction with active or abandoned fishing gear.

Traffic (vessel strikes): All vessels associated with all phases of the Project (construction, operation, and decommissioning) pose a potential collision risk to marine mammals. Vessel use would peak during the construction phase. A summary of construction vessel types and sizes is presented in Table 3.15-15. Typical large construction vessels used in this type of project range from 325 to 350 feet (99 to 107 meters) in length, from 60 to 100 feet (18 to 30 meters) in beam, and draft from 16 to 20 feet (5 to 6 meters) (Denes et al. 2021). In total, the Proposed Action would generate approximately 2,870 vessel trips during the construction and installation phase. A breakdown of the maximum number of simultaneous vessels and maximum number of round trips per vessel type is presented in Table 3.15-16. The construction vessels that would be used for Project construction are described in Section 6.1.2.4.2 and Tables 6.1.2-1 to 6.1.2-4 in the COP (Ocean Wind 2023). Construction activities (including offshore installation of WTGs, substations, array cables, interconnection cable, and export cable) would require up to 20 to 65 simultaneous construction vessels (COP Volume I, Tables 6.1.2-1 to 6.1.2-4; Ocean Wind 2023).

When the areas of densest vessel traffic in the Project area were analyzed, three were shown to have greater than 10 transits per day or 3,650 transits per year: the entrance to Delaware Bay, with an average of 18 transits per day; Barnegat Inlet, with an average of 16 transits per day; and the eastern end of Delaware Bay, with an average of 11 transits per day (COP Volume III, Appendix M; Ocean Wind 2023).

Table 3.15-15 Construction Vessel Size Summary

Construction Activity	Vessel Type
WTG installation	**Installation Vessel:** 476 by 197 feet (145 by 60 meters) (not including helideck, crane); displacement: 43000t
	Unpowered Feeder Barges: 410 by 115 feet (125 by 35 meters); displacement: 21000t
	Tug: 148 by 49 feet (45 by 15 meters)
Foundations	**MP Installation: Floating Heavy Lift Vessel:** 787 by 164 feet (240 by 50 meters); displacement: 61.000T
	SS Installation: Jack-Up Vessel: 459 by 131 feet (140 by 40 meters); displacement: 8.000T
	Noise Mitigation Vessel: 295 by 66 feet (90 by 20 meters); displacement: 4900T
Export Cable Installation	
Export cable lay (offshore)	Approx. Length: 427 feet (130 meters); beam: 98 feet (30 meters); deadweight: 10,800Te
Trenching support	Approx. Length: 328 feet (100 meters); beam: 66 feet (20 meters); deadweight: 3,000Te
Export cable lay (inshore)	Approx. Length: 410 feet (125 meters); beam: 115 feet (35 meters); depth: 26 feet (8 meters) plus anchor handler support vessels
Export Cable Installation: Secondary Support Vessels	
Pre-lay grapnel runs, boulder removal, mattressing, surveys	Approx. length: 262 feet (80 meters); beam: 66 feet (20 meters); gross: 2,400 GT
Survey	Approx. length: 164 feet (50 meters); beam: 33 feet (10 meters); gross 615 GT
Anchor-handling tug	Approx. length: 98 feet (30 meters); beam: 49 feet (15 meters); gross: 345 GT
Rock installation	Approx. length: 525 feet (160 meters); beam: 131 feet (40 meters); cargo: 24,000Te
Crew transfer vessel	Approx. length: 89 feet (27 meters); beam: 36 feet (11 meters); gross: 235
Array Cable Installation: Primary Array Cable Installation Vessels	
Array cable lay	Approx. length: 459 feet (140 meters); beam: 98 feet (30 meters); deadweight: 10,000Te
Trenching support	Approx. length: 328 feet (100 meters); beam: 98 feet (30 meters); displacement: 12,200Te
Array Cable Installation: Secondary Support Vessels	
Pre-lay grapnel runs	Approx. length: 230 feet (70 meters); beam: 66 feet (20 meters); gross: 1,660 ITC
Boulder removal	Approx. length: 312 feet (95 meters); beam: 66 feet (20 meters); deadweight: 3,285 LT

Construction Activity	Vessel Type
Survey	Approx. length: 164 feet (50 meters); beam: 39 feet (12 meters); gross: 615 GT
Crew transfer vessel	Approx. length: 98 feet (30 meters); beam: 36 feet (11 meters); gross: 235
Crew transfer and accommodation	Approx. length: 295 feet (90 meters); beam: 66 feet (20 meters); deadweight: 4,870 LT
Rock installation	Approx. length: 525 feet (160 meters); beam: 118 feet (36 meters); cargo: 24,000Te

Source: COP Volume I, Section 6.1, Tables 6.1.2-2, 6.1.2-6, 6.1.2-9; Ocean Wind 2023
GT = gross tonnage; ITC = International Convention on Tonnage Measurement; LT = long ton; t = tonnes; T = tons; Te = tonne

Table 3.15-16 Construction Vessel Trip Summary

Vessel Type	Maximum Number of Simultaneous (at any one time) Vessels in the Project Area	Maximum Number of Round Trips per Vessel Type[1]
WTG Foundation Installation		
Scour protection vessel	1	50
Installation vessel	4	99
Support vessels	16	396
Transport/feeder vessels (including tugs)	40	396
number of which are anchored	2	198
WTG Structure Installation		
Installation vessels	2	99
Transport/feeder vessels	12	99
Other support vessels	24	594
Substation Installation[2]		
Primary installation vessels	2	12
Support vessels	11	72
Transport vessels	4	24
Array Cable Installation[3]		
Main laying vessels	3	99
Main burial vessels	3	99
Support vessels	12	594
Substation Inter-link Cable Installation[4]		
Main laying vessels	Included in numbers for export and array cables	8
Main burial vessels		8
Support vessels		12
Offshore Export Cable Installation[5]		
Main laying vessels	3	48
Main cable-joining vessels	3	36
Main burial vessels	3	48
Support vessels	15	72
Federal Channel Dredging		

Vessel Type	Maximum Number of Simultaneous (at any one time) Vessels in the Project Area	Maximum Number of Round Trips per Vessel Type[1]
Dredging	1	1
Scow/barge/tug	2	4

Source: COP Volume I, Section 6.1, Tables 6.1.2-1, 6.1.2-3, 6.1.2-5, 6.1.2-7, and 6.1.2-8; Ocean Wind 2023
[1] Total number of trips to complete entire construction activity.
[2] Substation installation is anticipated to occur over a maximum duration of 67 days.
[3] Array cable installation is anticipated to occur over a maximum duration of 12 months. Installation of each cable section is anticipated to occur over 3.5 days.
[4] Substation inter-link cable installation is anticipated to occur over a maximum duration of 1 month. Installation of each cable section is anticipated to occur over 20 days.
[5] Offshore export cable installation is anticipated to occur over a maximum duration of 6 months. Installation of each cable section is anticipated to occur over 59 days.

The associated vessel trips to execute monitoring for the Project (passive acoustic monitoring, HRG surveys, benthic, and fisheries) would include:

- 624 days of HRG surveys totaling approximately 16,942 nm (31,376 kilometers) in distance traveled, not including round-trip vessel transit to the survey site
- The Benthic Monitoring Plan is composed of five separate surveys with varying levels of effort pre-, during, and post-construction. Vessel traffic for these surveys was analyzed based on the number of stations visited during each survey event. Surveys would deploy visual equipment at 162 stations for pre-construction, 500 stations for immediately after construction, 662 stations 1 year post-construction, 112 stations 2 years post-construction, 662 stations 3 years post-construction, and 112 stations 5 years post-construction. A minimum total of 2,210 stations would require visitation over the 5-year post-construction period (sand ridge and cable-associated benthic surveys have the potential to be extended if benthic organism densities and assemblages continue to differ from the baseline after 3 years). Hard-bottom and structure-associated soft-bottom surveys would overlap at the same sites and were considered together. Exact vessel details such as homeport were not included in the plan and distance transited to complete surveys was not analyzed.
- 960 separate trawl surveys with 20-minute tows (320 hours total) over a 6-year period with an approximately 428-nm (793-kilometer) round-trip vessel transit to the site for each seasonal survey
- 24 separate survey events for structure-associated fishes survey that span 3 days each at 12 to 15 locations over a 6-year period with a 90-minute soak time on six baited traps and an approximately 90-nm (167-kilometer) area for each survey event
- Six separate clam dredge survey events with 40 minutes total of dredge time across three sites over a 6-year period with an approximately 44-nm (81-kilometer) round-trip vessel transit for each survey event
- 24 separate acoustic telemetry tows of an omni-directional hydrophone for an unspecified amount of time per survey event over a 6-year period with an approximately 42- to 46-nm (78- to 85-kilometer) round-trip vessel transit per survey event (transits for the telemetry tow vessel are unclear, as it can be driven on a trailer to a nearby boat ramp; BOEM assumes that a nearby boat ramp from Ocean City or Atlantic City would be chosen)

Regular maintenance during O&M would require the use of a variety of support vessels including crew transfer vessels, service operation vessels, jack-up vessels, and supply vessels. Annual vessel trips for O&M are summarized in Table 3.15-17.

Table 3.15-17 Operations and Maintenance Vessel Trip Summary

Vessel Type	Average/Normal Operating Speed (knots)	Number of Expected Round Trips
Crew transfer vessel or service operation vessel	23	2,278
Jack-up vessel	10	102
Crew vessel	23	908
Supply vessel	11	104

The Project would result up to 2,870 vessel trips during construction and installation, up to 3,392 vessel trips per year during O&M, and approximately 120 vessel trips during decommissioning. The vessels that would be used for Project O&M are described in Table 3.15-15, Table 3.15-16, and Table 3.15-17. During O&M, a crew transfer vessel or Surface Effect Ship would be active daily except in severe weather, and round trips would originate from the Atlantic City O&M facility. Surface Effect Ships are high-speed crew transfer air-cushion catamarans. While the lack of in-water hull from the Surface Effect Ships would reduce the likelihood of a subsurface collision, marine mammals resting or breathing on the surface could be affected. Additionally, the high rate of speed of these vessels allows less reaction time from the marine mammal and for the vessel operator conducting a maneuver to avoid the marine mammal. Conceptual decommissioning would require marine construction vessels of the same or similar class as those used during construction (see Table 3.15-15 and Table 3.15-16). The area around the Project area (including Project vessel transit routes) is used by a number of different vessels including tugs, fishing vessels, and large, deep-draft vessels operating to and from ports in Delaware, New Jersey, New York, and abroad (COP Volume III, Appendix M, Ocean Wind 2023). The vessel trips associated with the Proposed Action would be relatively small when compared to the number of vessel trips associated with ongoing non-offshore activities throughout the marine mammal geographic analysis area.

Vessel collisions are a major source of mortality and injury for many marine mammal species (Hayes et al. 2021; Laist et al. 2001). A summary of vessel collision data and a description of the effects of vessel collisions on marine mammals are presented in Section 3.15.3.2, *Cumulative Impacts of the No Action Alternative*. The geographic extent is considered localized to the vessel transit routes and the Project area. As Project vessels would operate throughout the construction, O&M, and decommissioning phases, the potential for a vessel to strike a marine mammal is considered continuous (life of Project). If a vessel strike does occur, the impact on individual marine mammals would be severe (ranging from injury to mortality); however, the population-level impacts would range from negligible to major, depending on the species and severity of the strike. However, Ocean Wind has committed to a range of APMs to avoid vessel collisions with marine mammals (Appendix H, Table H-1). These APMs would minimize encounters that have a high risk of resulting in collision or injury by reducing both the encounter potential (e.g., vessel separation distances, seasonal restrictions, avoidance of aggregations, strict adherence to NMFS Regional Viewing Guidelines for vessel strike avoidance) and severity potential (e.g., vessel speed reduction, vessel positioning parallel to animals).

The standard vessel speed restriction plan includes a speed restriction of less than 10 knots for all Project vessels between November 1 and April 30 when NARW are likely to be present in higher densities. Year-round restrictions include vessels of all sizes operating at 10 knots or less in any Dynamic Management Areas. In addition, between May 1 and October 31, all vessels traveling at greater 10 knots will have a dedicated visual observer (or NMFS-approved automated visual detection system) on duty at all times to monitor for marine mammals. An additional adaptive vessel speed restriction plan is also outlined and includes measures to be implemented when crew safety is at risk, or labor restrictions, vessel availability, costs to the Project, or other unforeseen circumstances make the standard plan impracticable. Adaptive measures include the installation of a semi-permanent acoustic network comprising a near real-time acoustic monitoring system to monitor for the presence of NARWs year-round. When NARWs are detected in the area, slow-down to 10 knots would be required for the following 12-hour period. All vessel operators would receive training to ensure these APMs are fully implemented for vessels in transit. Vessel operators would monitor the NMFS NARW reporting systems during planning, construction, and operations. Ultimately, the reduction in strike/injury risk relies on the ability for a responsive action to be taken if a marine mammal is detected. The APM for deployment of trained observers on all vessels along with effective monitoring equipment would minimize the collision and injury risk. APMs to minimize vessel-marine mammal strikes are expected to be highly effective and reduce the likelihood of occurrence to low.

Therefore, with implementation of known and highly effective measures such as reduced vessel speeds and ships maintaining minimum distances from marine mammals, vessel strikes are not anticipated to occur; as such, there would be no effect. However, if a vessel strike of a NARW were to occur, this impact could be major and long term. The risk of vessel strike would be long term because vessel interactions with marine mammals could occur during construction, O&M, or decommissioning of the Project. Given general population status, any vessel strikes to non-NARW mysticetes would be minor to moderate and vessel strikes to odontocetes and pinnipeds would be negligible to minor. However, again, given implementation of the APMs, vessel strike risk is very low and not anticipated to occur. There would be no effect on all marine mammals if no vessel strikes occur.

Accidental releases and discharges: The risk of accidental releases of fuel, fluids, hazardous materials, trash, and debris may increase as a result of the Proposed Action. The effects of accidental releases and discharges on marine mammals are discussed in Section 3.15.3.1, *Impacts of the No Action Alternative*. The risk of any type of accidental release would be increased primarily during construction when additional vessels are present and during the proposed refueling of primary construction vessels at sea, but also during operations and decommissioning. Lessees must conduct all authorized activities in a manner that prevents unauthorized discharge of pollutants including marine trash and debris into the offshore environment (30 CFR 285.105). USCG similarly prohibits the dumping of environmentally damaging trash or debris (International Convention for the Prevention of Pollution from Ships, Annex V, Public Law 100–220 (101 Stat. 1458)). Ocean Wind would establish and implement a Spill Prevention, Control, and Countermeasures Plan, which would include an Oil Spill Response Plan and Spill Prevention, Control, and Countermeasures Plan specific to vessels as part of the APMs (Appendix H, Table H-1, GEN-11). The combined regulatory requirements and APMs would effectively avoid accidental debris releases and avoid and minimize the impacts from accidental spills such that adverse effects on marine mammals are unlikely to occur. Therefore, impacts of accidental releases and discharges as a result of the Proposed Action would be negligible and long term for mysticetes, odontocetes, and pinnipeds, except for NARW. If these releases or discharges were to occur, they would be likely to result in long-term consequences to a few individuals that are detectable and measurable but do not lead to population-level effects. Although they are unlikely to occur, impacts from accidental release and discharges as a result of the Proposed Action would likely be moderate and long term for NARW and have the potential to result in population-level effects through detectable and measurable impacts on the individual, but the population should sufficiently recover.

EMF: BOEM performed literature reviews and analyses of potential EMF effects from offshore renewable energy projects (CSA Ocean Sciences Inc. 2021; Inspire 2019; Normandeau et al. 2011). These and other available reviews and studies (Gill et al. 2005; Kilfoyle et al. 2018) suggest that most marine species cannot sense low-intensity EMF generated by the HVAC power transmission cables commonly used in offshore wind energy projects. Normandeau et al. (2011) concluded that marine mammals are unlikely to detect magnetic field intensities below 50 milligauss, suggesting that these species would be insensitive to EMF effects from the Project's electrical cables. Project-related EMFs would be below this threshold and therefore undetectable, except for in areas where the cables lie on the bed surface. The area exposed to magnetic field effects greater than 50 milligauss would be small, extending only a few feet from the cable. Marine mammal species that are more likely to forage near the benthic organisms, such as certain delphinids, have more potential to experience EMF above baseline levels (Tricas and Gill 2011). The 50-milligauss detection threshold is theoretical and an order of magnitude lower than the lowest observed magnetic field strength resulting in observed behavioral responses (Normandeau et al. 2011). These factors indicate that the likelihood of marine mammals encountering detectable EMF effects is low, and any exposure would be below levels associated with measurable biological effects. Therefore, EMF effects on marine mammals (mysticetes, odontocetes, and pinnipeds) would be negligible.

Cable emplacement and maintenance: The Proposed Action would include up to 3,785 acres (15.3 km^2) of seafloor disturbance by cable installation, which would result in turbidity effects with the potential to have temporary impacts on some marine mammal prey species (see Section 3.13, *Finfish, Invertebrates, and Essential Fish Habitat*). Desktop analyses of similar projects and environmental conditions show that plumes during trenching of offshore areas would be limited to directly above the seabed and not extend into the water column (COP Volume II; Ocean Wind 2023). This EIS expects plume concentrations of 10 mg/L, extending 164–656 feet (50–200 meters) from the trench centerline for 6 hours, although this may be less extensive at varying locations along the route (COP Volume II; Ocean Wind 2023).

Inshore trenching could result in more extensive suspended sediment, with concentrations above 10 mg/L occurring over 14.6 to 55.3 acres (59,084 to 223,791 m^2) for 1 to 10 hours, respectively (COP Volume II; Ocean Wind 2023). Areas of higher concentrations modeled averaged 4.8 acres (19,425 m^2) at 100 mg/L, 0.7 acre (283.3 m^2) at 1,000 mg/L, and 0.05 acre (202.3 m^2) at 5,000 mg/L. Trenching with a jet plow in areas of shallower water depths could cause plumes to nearly reach the surface of the water (COP Volume II; Ocean Wind 2023). In areas where dredging is required to install cable along sand waves or when crossing federal and state navigation channels, concentrations greater than 10 mg/L filling the water column could reach 10 miles (16 kilometers) and remain for 3 hours (COP Volume II; Ocean Wind 2023). Localized areas up to 15 acres (60,703 m^2) could experience the same elevated concentrations for up to 6 to 12 hours (COP Volume II; Ocean Wind 2023). Elevated turbidity levels would be short term and temporary, and marine mammals often reside in turbid waters, so significant impacts from turbidity are not likely (Todd et al. 2015). The effects of turbidity on marine mammals are described in more detail in Section 3.15.3.1, *Impacts of the No Action Alternative*. Increased turbidity effects could affect the prey species of marine mammals, both in offshore and inshore environments, such as the SAV near the inshore export cable route in Barnegat Bay. Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of mg/L 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.

During construction, turbidity reduction measures would be implemented to the extent practical to minimize impacts (Appendix H, Table H-1, GEN-08 and WQ-01). Therefore, BOEM anticipates short-term and localized water quality impacts from inter-array cable installation and undetectable, negligible impacts on mysticetes, odontocetes, and pinnipeds from turbidity. Suspended sediment concentrations during activities other than dredging would be within the range of natural variability for this location. Any dredging necessary prior to cable installation could generate additional impacts. However, individual marine mammals, if present, would be expected to successfully forage in nearby areas not affected by increased sedimentation, and only non-measurable, negligible to minor impacts, if any, on individuals would be expected given the localized and temporary nature and isolated nature of the potential impacts.

Gear utilization: The presence of gear used for fisheries and benthic monitoring surveys under the Proposed Action could affect marine mammals by entrapment or entanglement. Trawl nets pose a discountable threat to mysticetes (NMFS 2016) and the slow speed of mobile gear and the short tow times (20 minutes) further reduce the potential for entanglements or other interactions. Chevron traps and baited remote underwater video systems and the anchoring lines and buoys used to secure them and passive acoustic monitoring equipment may pose an entanglement risk to marine mammals, although these risks would be reduced through implementation of mitigation procedures included in monitoring plans. Equipment used in the fisheries monitoring surveys would use both weak-link and weak-rope technologies that are consistent with the proposed changes in the Atlantic Large Whale Take Reduction Plan (NOAA 2020b). Additionally, traps and baited remote underwater video systems would have limited soak times of less than 90 minutes and the vessel would remain on location during deployment. Lastly, neither traps nor baited remote underwater video systems would be deployed if marine mammals are sighted near the proposed sampling station. Therefore, impacts on marine mammals from traps and baited remote underwater video systems are expected to be discountable based upon the limited number of associated buoy lines, the implementation of NOAA-required risk reduction measures, and the fact that entanglement in gear would be extremely unlikely to occur. The equipment used in the clam, oceanography, and pelagic fish surveys would pose minimal risks to marine mammals. Tows for the clam surveys would have a very short duration of 120 seconds, and the vessel would be subject to similar mitigation measures as the trawl survey. Both the oceanography and pelagic fish surveys would be non-extractive and also subject to similar mitigation measures as the structure-associated fish surveys. Therefore, the effects of the equipment used in clam, oceanography, and pelagic fish surveys on marine mammals would be discountable. Moored passive acoustic monitoring systems would use the best available technology to reduce any potential risks of entanglement. Passive acoustic monitoring system deployment would follow the same procedures as those described above to avoid and minimize impacts on marine mammals. Given the short-term, low-intensity, and localized nature of the impacts of gear utilization for the Proposed Action, as well as the mitigation procedures included in monitoring plans, it is not likely that marine mammals would be entangled or entrapped in gear used for monitoring. Therefore, there would be no effect from this IPF. However, if entanglement did occur (although it is not anticipated), the most likely species to be entangled would be pinnipeds and odontocetes. Given the population status, it is likely that effects on odontocetes and pinnipeds would be negligible to minor.

Port utilization: Ocean Wind 1's proposed use of the Port of Atlantic City, New Jersey; Paulsboro, Hope Creek, and Port Elizabeth, New Jersey; and Port Charleston, South Carolina would increase vessel traffic in the area and potentially contribute to the need for expansion or increased maintenance of port facilities within the marine mammal geographic analysis area. However, no specific project proposals were developed as part of the Proposed Action; therefore, impacts resulting from potential port expansion or increased maintenance of port facilities cannot be evaluated in this EIS. Expansion could result in adverse effects on coastal and estuarine habitats from shoreline noise during construction and disturbance or loss of habitat for prey species. Increased maintenance such as dredging could expose marine mammals to increased levels of underwater noise and increase turbidity, affecting individual marine mammals or their prey. Increased vessel traffic, port expansion, and port maintenance would likely be extensive and long term. Any future port maintenance or expansion projects would be subject to additional NEPA analysis.

Lighting: The Proposed Action would introduce stationary artificial light sources in the form of navigation, safety, and work lighting. Orr et al. (2013) summarized available research on potential operational lighting effects from offshore wind energy facilities and developed design guidance for avoiding and minimizing lighting impacts on aquatic life, including marine mammals. BOEM concluded that the operational lighting effects on marine mammal distribution, behavior, and habitat use were negligible if recommended design and operating practices are implemented. Therefore, BOEM anticipates that operational lighting effects on mysticetes, odontocetes, and pinnipeds would be negligible.

3.15.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities would contribute to impacts on marine mammals through the primary IPFs of traffic (vessel strikes), gear utilization, noise, accidental releases and discharges, EMF, and climate change. The construction, O&M, and decommissioning of offshore wind activities across the geographic analysis area would also contribute to the primary IPFs of noise, presence of structures, traffic (vessel strikes), accidental releases and discharges, EMF, cable emplacement and maintenance, gear utilization (biological/fisheries monitoring surveys), port utilization, lighting, and climate change. Ongoing and planned offshore wind activities in combination with the Proposed Action would result in an estimated 2,946 WTGs, of which the Proposed Action would contribute 98 WTGs, or 3 percent.

Noise: The Proposed Action would contribute a noticeable increment to the cumulative noise impacts of all future planned non-wind and wind projects. Construction-related noise impacts (from activities including pile driving, UXO detonation, and HRG surveys) would occur within a limited time frame. However, long-term noise sources from operational turbines and vessels would persist. All effects on marine mammals from noise (e.g., some PTS, TTS, behavioral changes, masking) are anticipated to be the same as described in Section 3.15.3.2, *Cumulative Impacts of the No Action Alternative*. The incremental addition of the noise from the Proposed Action is not anticipated to result in cumulative impacts such that the cumulative impacts from the Proposed Action would be appreciably different from the impact findings for the cumulative impacts of the No Action Alternative given the amount of planned offshore wind activities in the Atlantic. Cumulative impacts of the Proposed Action from noise would likely result in moderate short-term impacts for LFC, MFC, HFC, and pinnipeds, with the exception of NARWs. Cumulative noise impacts could be moderate for listed species such as NARW because impacts on an individual could result in population-level effects.

Presence of structures: The incremental impact contributed by the Proposed Action would result in a noticeable increase in the presence of structures in the marine mammal geographic analysis area beyond that described under the No Action Alternative. However, the cumulative impacts from the presence of structures would likely be minor for mysticetes, odontocetes, and pinnipeds, as well as localized and long term. Using the assumptions in Table F2-2 in Appendix F, there is potential for up to approximately 5,743 acres (31 km^2) of new hard protection. Of this area, 161 acres (0.65 km^2) would result from the Proposed Action, and the remainder would result from other offshore wind projects in the geographic analysis area. Of the estimated 3,101 structures, 101 would result from the Proposed Action.

Traffic (vessel strikes): The Proposed Action would contribute a detectable increment to the cumulative traffic (vessel strike) impacts, which would be minor for pinnipeds and odontocetes, major for NARW, and moderate for all other mysticetes. Impacts would occur in close spatial proximity to vessel routes but would be long term in temporal scale.

Accidental releases and discharges: The Proposed Action would contribute an undetectable increment to the cumulative accidental release and discharge impacts, which would likely be negligible for mysticetes, odontocetes, and pinnipeds. An Oil Spill Response Plan and Spill Prevention, Control, and Countermeasures Plan specific to vessels would be implemented for the proposed Project and other planned offshore wind projects. The implementation of these plans and regulatory requirements would effectively avoid accidental debris releases and avoid and minimize the impacts from accidental spills such that adverse effects on marine mammals are unlikely to occur. Impacts would likely occur in close temporal and spatial proximity, although these impacts would not be expected to be biologically significant.

EMF: The incremental impact contributed by the Proposed Action would result in a noticeable increase in EMF in the geographic analysis area beyond that described under the No Action Alternative. However, the cumulative impacts from EMF on mysticetes, odontocetes, and pinnipeds would likely still be negligible, localized, and long term.

Cable emplacement and maintenance: The Proposed Action would contribute an undetectable increment to the cumulative cable emplacement impacts on mysticetes, odontocetes, and pinnipeds, which are expected to be negligible. Some non-measurable, negligible impacts could occur if impacts occur in close temporal and spatial proximity, although these impacts would not be expected to be biologically significant.

Gear utilization (biological/fisheries monitoring surveys: The Proposed Action would contribute an undetectable increment to the cumulative impacts of gear utilization. As described above, entanglement or entrapment in gear is not anticipated to occur. If entanglement or entrapment did occur for other planned offshore wind projects (or from other ongoing non-offshore wind activities), it would likely result in major impacts on NARWs, moderate impacts on non-NARW mysticetes, and negligible to minor impacts on odontocetes and pinnipeds.

Port utilization: The Proposed Action would contribute a noticeable increment to the cumulative impacts of port utilization, which would likely be moderate, extensive, and likely to result in long-term consequences to individuals or populations of mysticetes, odontocetes, and pinnipeds, except the NARW. The Proposed Action would contribute a noticeable increment to the cumulative impacts of port utilization, which would likely be major, extensive, and likely to result in long-term consequences to individuals or the population of the NARW due to low population numbers. However, any future port expansion and associated increase in vessel traffic would be subject to independent NEPA analysis and regulatory approvals requiring full consideration of potential effects on marine mammals regionwide.

Lighting: The Proposed Action would contribute an undetectable increment to the cumulative lighting impacts, which would likely be negligible, localized, and long term for mysticetes, odontocetes, and pinnipeds. The cumulative impacts on mysticetes, odontocetes, and pinnipeds would likely be moderate and long term. BOEM anticipates that impacts from planned non-offshore wind activities would primarily be driven by underwater noise impacts, vessel activity (vessel collisions), entanglement, and seabed disturbance. Impacts from ongoing and planned offshore wind activities, when combined with the Proposed Action, would primarily be driven by pile-driving noise, increased vessel traffic, and port utilization. The presence of structures could contribute adverse impacts with potentially beneficial impacts on some marine mammal species. The moderate impact level conclusion assumes that mortality of individual marine mammals would not have negative significant consequences at the population level and that effects would be recoverable, with the exception of the NARW. Impacts on NARW may be magnified in severity due to low population numbers and the potential to compromise the viability of the species from the loss of a single individual.

3.15.5.3. Conclusions

Impacts of the Proposed Action. Project construction would primarily result in noise that would disturb marine mammals and potentially result in permanent impacts (i.e., PTS). APMs would minimize noise exposure such that any PTS of NARWs would be avoided and, for all marine mammals, the severity of any behavioral responses would be minimized. Therefore, the incremental impact of the Proposed Action when compared to the No Action Alternative would be minor for NARWs from construction given the likely outcome of noise exposure would be a deflection, but not abandonment of their migratory path. More severe impacts on marine mammals such as mortality or serious injury from vessel strikes, UXO detonation, and entanglement are not anticipated to occur due to the APMs and additional measures that would be required as part of the environmental permitting processes. The incremental impact of the

Proposed Action when compared to the No Action Alternative would be minor to moderate for other large whales, minor for small whales and delphinids, and minor for pinnipeds because with the implementation of APMs, mortality and non-auditory injury would not occur as a result of UXO detonation, only a few marine mammals of select species are anticipated to incur PTS incidental to pile driving and UXO detonation, vessel strike risk is very low and not anticipated to occur, and accidental spills are also not anticipated to occur.

When including the baseline status of marine mammals into the impact findings and considering all phases of the Project, the impacts of the Proposed Action on NARW would be long term and **moderate** to **major** (primarily due to ongoing vessel strike and entanglement), and long term and **moderate** for other mysticetes. Impacts of the Proposed Action on odontocetes and pinnipeds would be long term and **minor**. Some **minor beneficial** impacts on odontocetes and pinnipeds could be realized through artificial reef effects. Beneficial effects, however, may be offset given the increased risk of entanglement due to derelict fishing gear on the structures.

Cumulative Impacts of the Proposed Action. Existing environmental trends and ongoing activities would continue, and mysticetes, odontocetes, and pinnipeds would continue to be affected by natural and human-caused IPFs. Planned activities would also contribute to impacts on marine mammals. Although injury or mortality of individuals may occur, long-term population-level effects are not anticipated for marine mammals (with the exception of NARW). Underwater noise impacts, vessel activity (vessel collisions), entanglement, and seabed disturbance, primarily from non-offshore wind activities, would result in moderate impacts. Accidental releases and discharges, EMF, the presence of structures, cable emplacement and maintenance, port utilization, and lighting associated with offshore wind activities would be implemented with measures to minimize impacts on marine mammals. Incremental impacts contributed by the Proposed Action to the cumulative impact on marine mammals would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts for mysticetes, odontocetes, and pinnipeds in the geographic analysis area from the Proposed Action would be **moderate** to **major** and long term for NARW, **moderate** for other mysticetes, and **minor** for odontocetes and pinnipeds. Impacts from the Proposed Action are not anticipated to substantially contribute to the moderate to major long-term cumulative impacts for NARW.

3.15.6 Impacts of Alternatives B-1, B-2, C-1, and D on Marine Mammals

Impacts of Alternatives B-1, B-2, C-1, and D. Impacts resulting from individual IPFs associated with construction and installation, O&M, and conceptual decommissioning of the Project under Alternatives B-1, B-2, C-1, and D would be similar to those described under the Proposed Action. No changes in gear utilization, accidental releases and discharges, or port utilization impacts are anticipated. While the effect of each IPF is anticipated to be similar, the number of instances would decrease slightly given the Project size would also decrease. Alternative B-1 would exclude placement of WTGs at up to 9 WTG positions that are nearest to coastal communities (positions F01 to K01 and B02 to D02). Alternative B-2 would exclude placement of WTGs at up to 19 WTG positions that are nearest to coastal communities (positions F01 to K01, A02 to K02, A03, and C03). Alternative C-1 would exclude 8 WTG positions, relocate up to 8 WTG positions to the northern portion of the Ocean Wind 1 Lease Area, or some combination of exclusion and relocation of WTG positions, to allow for an 0.81-nm to 1.08-nm buffer between WTGs in the Ocean Wind 1 Lease Area and WTGs in the Atlantic Shores South Lease Area. Alternative D would exclude up to 15 WTG positions in the sand ridge and trough area that include A07 to E07, A08 to E08, and A09 to E09. Reductions in the WTGs would also reduce the number of monopiles required. As a result, the number of hours of impact pile driving required to install the WTGs would be reduced. The length of inter-array cable to be installed would also be reduced if fewer WTGs are installed. IPFs that could change as a result include presence of structures, underwater noise from pile driving and vessels during construction activities, habitat alteration, vessel strikes, artificial lighting, decommissioning activities, and cable emplacement and maintenance. The changes in the number of monopiles and associated Project construction vessels between the Proposed Action and each alternative are considered relatively minor to the assessment of effects on marine mammals. A reduction in the duration of the effects from construction would occur; however, the magnitude of the effects would remain unchanged from that of the Proposed Action. Alternatives B-1, B-2, C-1, and D may change the duration for the IPFs in comparison to that described for the Proposed Action in Section 3.15.5, as described in following paragraphs. Table 3.15-18 summarizes the differences in the number of monopiles as they related to each alternative. The corresponding reduction to the number or duration of construction vessels in the Project area is unknown; therefore, the discussion regarding a reduction in vessels during construction is qualitative. The duration of effects from WTG operation would remain the same.

Table 3.15-18 Summary of Changes to Impact Pile Driving Requirements Among Alternatives

Alternative	WTGs	Reduction in Monopiles	Total Number of Monopiles	Total Hours of Impact Pile Driving (4 to 6 hrs/pile)	Number of days
Proposed Action	98	98	98	392 to 588 hours	98
Alternative B-1	exclusion of up to 9 WTG positions	Up to 9 fewer	89	356 to 534 hours	89
Alternative B-2	exclusion of up to 19 WTG positions	Up to 19 fewer	79	316 to 474 hours	79
Alternative C-1	exclusion of 8 WTG positions	Up to 8 fewer	90	360 to 540 hours	90
Alternative D	exclusion of up to 15 WTG positions	Up to 15 fewer	83	332 to 498 hours	83

Notes: Assumes each pile would require 4 to 6 hours of impact pile driving per pile, with a maximum-case scenario of one pile per day.
hrs/pile = hours per pile

Noise: The 10- to 20-percent reduction in the number of monopiles for Alternatives B-1, B-2, C-1, and D would reduce the overall number of impact pile-driving hours required for installation (Table 3.15-18). This would limit the duration of the effect by the hours and days outlined in Table 3.15-18. However, the overall effects would remain the same (e.g., PTS, TTS, disturbance, and masking) as described in Section 3.15.5. Limiting the duration of the effect could reduce the number of marine mammals exposed to underwater sound in excess of acoustic thresholds. This could be particularly important for species who are particularly sensitive to impact pile-driving activities (e.g., harbor porpoise). Taking Alternative B-2 as an example, the number of pile-driving hours would be reduced by between 76 and 114 hours or 19 days in comparison to the Proposed Action. However, the APMs outlined in Appendix H would apply to these action alternatives and are expected to be effective in reducing the potential effects on marine mammals and specifically in limiting the potential for PTS and behavioral effects on NARW (see Section 3.15.5). For other marine mammal species who have large home ranges (e.g., most species of dolphins listed in Appendix I), migrate through the area (e.g., humpback whales), or prefer deeper offshore waters (e.g., blue whales), these action alternatives are unlikely to result in a change to the impact determinations outlined for the Proposed Action.

A reduction in the number of monopiles would result in a reduction in the number of construction vessels or the duration of vessels in the Project area during construction activities that would be required for installation. The magnitude of the effects of underwater noise from Project vessels during construction would remain the same (e.g., disturbance, masking) as described in Section 3.15.5; however, the duration of the effects would be reduced.

A 10- to 20-percent reduction in the number of monopiles would also result in a reduced behavioral disturbance footprint around the total Lease Area during operations. As stated in Section 3.15.5, the noise generated by the proposed WTGs is relatively unknown; however, a reduction in the number of WTGs would reduce the underwater noise footprint and limit the extent of behavioral disturbance and masking effects.

EMF: A 10- to 20-percent reduction in WTGs would result in a reduction of inter-array cable approximately correlated to the 10- to 20-percent reduction of WTGs. This could result in 19 miles (31 kilometers) to 38 miles (61 kilometers) less inter-array cable length within the Project area, which would limit the footprint of potential EMF exposure, particularly for marine mammals that are more likely to forage on the benthic organisms, in closest proximity to the cable, such as odontocetes.

Presence of structures: The 10- to 20-percent reduction in the number of monopiles would reduce the overall footprint on the seafloor of the alternatives, as compared to the Proposed Action. Fewer structures in the water could also reduce the reef effect, indirectly reducing recreational fishing and the subsequent risk to marine mammals from entanglement.

As described in Section 3.15.5, the presence of vertical structures in the water column can cause localized hydrodynamic effects that can influence the distribution and abundance of fish and planktonic prey resources (van Berkel et al. 2020). Turbulence resulting from vertical structures in the water column could lead to localized changes in circulation and stratification patterns, with potential implications for primary and secondary productivity and fish distribution. By reducing the number of monopiles in the water column as a result of Alternatives B-1, B-2, C-1, and D, the potential for localized hydrodynamic effects would be reduced.

Traffic (vessel strikes): A reduction in the number of monopiles would result in a reduction in the number of construction vessels or the duration of vessels in the Project area during construction activities that would be required for installation, O&M, and decommissioning. A 10- to 20-percent reduction in vessel trips would result in 253 to 505 fewer construction-related vessel trips, 111 to 223 fewer O&M-related vessel trips, and a similar reduction in trips for decommissioning as under construction. This could reduce the probability of a vessel strike on a marine mammal during Project construction.

Lighting: A 10- to 20-percent reduction in the number of monopiles would result in a 10- to 20-percent reduction in the amount of artificial light required to install the WTGs and lighting associated with the WTG structures through operations. In addition, a reduction in the number of vessels required for installation or the duration vessels would be required for installation would further limit this effect.

Cable emplacement and maintenance: Alternatives B-1, B-2, C-1, and D would have short-term and localized water quality impacts from inter-array cable installation and undetectable, negligible impacts on marine mammals from turbidity. A 10- to 20-percent reduction in WTGs would result in a reduction of inter-array cable approximately correlated to the 10- to 20-percent reduction of WTGs. This could result in 19 miles (31 kilometers) to 38 miles (61 kilometers) less inter-array cable within the Project area and less area over which the emplacement disturbance and resulting impacts would occur. It would also decrease the amount of time waters in the Project area experience short-term elevated turbidity. This may reduce the number of animals exposed to potentially adverse effects, but some individual animals would still be exposed to those effects at the same levels of significance under the criteria described in Section 3.15.5. Conceptual decommissioning effects would be similar in magnitude but reduced in extent and duration relative to the Proposed Action due to the reduction in number of piles required to be decommissioned. However, in the vicinity of the Project, effects would not be measurably different than under the Proposed Action.

Cumulative Impacts of Alternatives B-1, B-2, C-1, and D. The cumulative impact on marine mammals would range from negligible to major. The incremental impacts contributed by Alternatives B-1, B-2, C-1, and D to the cumulative impacts on marine mammals would be similar to those of the Proposed Action.

3.15.6.1. Conclusions

Impacts of Alternatives B-1, B-2, C-1, and D. As discussed in above sections, the anticipated impacts from these alternatives would reduce the number of WTGs and their associated inter-array cables 10 to 20 percent, which would in turn result in an incremental reduction in effects on marine mammals from certain construction and installation, O&M, and conceptual decommissioning impacts. However, BOEM anticipates that any incremental reduction in impacts would not change the resulting effects on marine mammals to the extent necessary to alter the impact level conclusions for any impact mechanism. The incremental impact of Alternatives B-1, B-2, C-1, and D, when each compared to the No Action Alternative, would be minor to moderate for other large whales, minor for small whales and delphinids, and minor for pinnipeds because with the implementation of APMs, mortality and non-auditory injury would not occur as a result of UXO detonation, only a few marine mammals of select species are anticipated to incur PTS incidental to pile driving and UXO detonation, vessel strike risk is very low and not anticipated to occur, and accidental spills are also not anticipated to occur.

The impacts resulting from Alternatives B-1, B-2, C-1, and D individually, when including the baseline status of marine mammals into the impact findings and considering all phases of the Project, would be similar to those of the Proposed Action and would be **moderate** for mysticetes except for the NARW, which would range from **moderate** to **major**. BOEM anticipates that the impacts resulting from the Proposed Action would be **minor** for odontocetes and pinnipeds and could include **minor beneficial** impacts. Adverse impacts are expected to result mainly from underwater noise (e.g., UXO detonations and impact pile driving) and increased vessel traffic potentially leading to vessel strikes. Beneficial impacts for odontocetes and pinnipeds are expected to result from the presence of structures.

Cumulative Impacts of Alternatives B-1, B-2, C-1, and D. The incremental impacts contributed by Alternatives B-1, B-2, C-1, and D to the cumulative impacts on marine mammals would be similar to those of the Proposed Action and would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts of Alternatives B-1, B-2, C-1, and D when each combined with ongoing and planned activities including offshore wind would be the same level as under the Proposed Action: **moderate** to **major** and long term for NARW, **moderate** for other mysticetes, and **minor** for odontocetes and pinnipeds.

3.15.7 Impacts of Alternative C-2 on Marine Mammals

Impacts of Alternative C-2. The impacts of Alternative C-2 would include no surface occupancy along the northeastern boundary of the Ocean Wind 1 Lease Area to allow for an 0.81-nm to 1.08-nm buffer the boundary between WTGs in the Ocean Wind 1 Lease Area and WTGs in the Atlantic Shores South Lease Area. The wind turbine array layout would be compressed to allow for a full build of up to 98 WTGs. Therefore, no changes to the number of monopiles are anticipated. The Project's turbine array row spacing would be reduced from 1 nm between rows to no less than 0.92 nm between rows. Spacing of 1 by 0.8 nm (1.85 kilometers) was assessed under the seabed disturbance and displacement IPF (Section 3.15.5). Therefore, the effects on marine mammals considered under Alternative C-2 would be the same as for the Proposed Action.

Cumulative Impacts of Alternative C-2. The cumulative impact on marine mammals would range from negligible to major. The incremental impacts contributed by Alternative C-2 to the cumulative impacts on marine mammals would be similar to those of the Proposed Action.

3.15.7.1. Conclusions

Impacts of Alternative C-2. Although Alternative C-2 would result in a decreased construction and operational footprint, BOEM anticipates that the impacts resulting from Alternative C-2 would be similar to those of the Proposed Action. The incremental impact of Alternative C-2, when compared to the No Action Alternative, would be minor to moderate for other large whales, minor for small whales and delphinids, and minor for pinnipeds because with the implementation of APMs, mortality and non-auditory injury would not occur as a result of UXO detonation, only a few marine mammals of select species are anticipated to incur PTS incidental to pile driving and UXO detonation, vessel strike risk is very low and not anticipated to occur, and accidental spills are also not anticipated to occur.

Impacts resulting from Alternative C-2, when including the baseline status of marine mammals into the impact findings and considering all phases of the Project, would be **moderate** to **major** and long term for NARW, **moderate** for other mysticetes, and **minor** for odontocetes and pinnipeds. BOEM anticipates that the impacts for odontocetes and pinnipeds could include **minor beneficial** impacts.

Cumulative Impacts of Alternative C-2. The cumulative impact on marine mammals would be **moderate** to **major** for NARW, **moderate** for other mysticetes, and **minor** for odontocetes and pinnipeds. The incremental impacts contributed by Alternative C-2 to the cumulative impacts on marine mammals would be similar to those of the Proposed Action and would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts of Alternative C-2 would be the same level as under the Proposed Action: **moderate** to **major** and long term for NARW, **moderate** for other mysticetes, and **minor** for odontocetes and pinnipeds.

3.15.8 Impacts of Alternative E on Marine Mammals

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. Alternative E would minimize impacts on SAV within Barnegat Bay. Effects on SAV are summarized below and described in greater detail in Section 3.6. Alternative E would continue to affect SAV at the three landings on the western shore of Barnegat Bay, consistent with the original proposed Oyster Creek route. However, the acreage of SAV affected by cable emplacement and maintenance would be reduced (0.69 acre [2,792 square meters] versus 15.4 acres [62,322 square meters]). Although the acreage of SAV potentially affected by this alternative would be reduced compared to the Proposed Action, recovery of seagrass where it is affected could still take multiple years depending on the nature of damage. Once affected, SAV can be difficult to replace and such efforts are often deemed unsuccessful (Lefcheck et al. 2019). However, seagrasses have varying abilities to withstand at least small changes in their environment; therefore, short-term light reductions or thin smothering from dredging should have only short-term effects (Todd et al. 2015). A study by Wisehart et al. (2007) showed that eelgrass density and seedling recruitment 5 months following disturbance was higher in dredged aquaculture beds than in areas with long-line aquaculture beds. Although losses to a shaded (for a duration of 3 months) Australian seagrass meadow resulted in a significant loss of leaf biomass, recovery of that biomass was achieved in 10 months (McMahon et al. 2011).

The decreased impact on SAV, a critical component of the marine food web, would potentially decrease impacts on marine mammal prey species. Impacts on marine mammal prey availability resulting from SAV disturbance are not expected to be significant under Alternative E. Herbivorous sireniancs that rely entirely on SAV as a food source are not present within the Project area. Similarly, planktonic prey items for mysticetes that occur within the Project area would not be affected by impacts on SAV. Other marine mammals species may feed on prey within SAV beds, but are not restricted to them. In fact, bottlenose dolphins in Clearwater, Florida preferred non-seagrass habitats, suggesting that seagrasses may create an obstruction that could hinder pre-location and capture (Allen et al. 2001). Prey sizes are also bigger outside of seagrass habitats, and therefore potentially more energetically viable (Todd et al. 2015). Marine mammals are not expected to be foraging in the SAV beds potentially affected by the Project area, but may be indirectly affected by a reduction in prey species that utilize the affected SAV as a nursery or for refuge. Section 3.13 examines the impacts of the Proposed Action on marine mammal prey species.

Alternative E would lead to the same types of impacts on marine mammals from construction and installation, O&M, and conceptual decommissioning activities as described for the Proposed Action. Impacts within the Project area would stay the same as under the Proposed Action and would be **moderate**, and **moderate** to **major** and long term for NARW. BOEM anticipates that the impacts resulting from the Proposed Action would be **moderate** for odontocetes and pinnipeds and could include beneficial impacts. Adverse impacts are expected to result mainly from underwater noise (e.g., UXO detonations and impact pile driving) and increased vessel traffic potentially leading to vessel strikes. Minor beneficial impacts for odontocetes and pinnipeds may result from the presence of structures.

Cumulative Impacts of Alternative E. The cumulative impacts on marine mammals would be moderate, and moderate to major and long term for NARW. The incremental impacts contributed by Alternative E to the cumulative impacts on marine mammals would be similar to those of the Proposed Action and would range from undetectable to noticeable.

3.15.8.1. Conclusions

Impacts of Alternative E. The incremental impact of Alternative E, when compared to the No Action Alternative, would be minor to moderate for other large whales, minor for small whales and delphinids, and minor for pinnipeds because with the implementation of APMs, mortality and non-auditory injury would not occur as a result of UXO detonation, only a few marine mammals of select species are anticipated to incur PTS incidental to pile driving and UXO detonation, vessel strike risk is very low and not anticipated to occur, and accidental spills are also not anticipated to occur. Impacts resulting from Alternative E, when including the baseline status of marine mammals into the impact findings and considering all phases of the Project, would likely have the same **moderate** to **major** and long term for NARW, **moderate** for other mysticetes, and **minor** for odontocetes and pinnipeds adverse impacts and could also result in **minor beneficial** impacts on marine mammals, similar to those of the Proposed Action. While Alternative E would result in reduced acreage of SAV potentially affected, the overall impacts on marine mammals from the alternative would not be materially different from those of the Proposed Action.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts on marine mammals would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts of Alternative E when combined with ongoing and planned activities including offshore wind would be the same level as under the Proposed Action: **moderate** to **major** and long term for NARW, **moderate** for other mysticetes, and **minor** for odontocetes and pinnipeds.

3.15.9 Proposed Mitigation Measures

Several measures are proposed to minimize impacts on marine mammals (Appendix H, Table H-2 and H-3). If one or more of the measures analyzed below are adopted by BOEM or cooperating agencies, some adverse impacts could be further reduced.

Table 3.15-19 Measures Resulting from Consultations (Also Identified in Appendix H, Table H-2): Marine Mammals

Measure	Description	Effect
Incorporate LOA requirements	The measures required by the final MMPA LOA would be incorporated into COP approval, and BOEM and/or BSEE will monitor compliance with these measures.	Compliance with LOA requirements would reduce risks for marine mammals under the Proposed Action. However, this measure would not alter impact determinations for marine mammals because analysis of the Proposed Action already includes analysis of the APMs included in Ocean Wind's LOA Application as outlined in Table H-1.
Passive Acoustic Monitoring (PAM) Plan	BOEM, BSEE, and USACE would ensure that Ocean Wind prepares a PAM Plan that describes all proposed equipment, deployment locations, detection review methodology and other procedures, and protocols related to the required use of PAM for monitoring. This plan would be submitted to NMFS, BOEM and BSEE (at OSWsubmittals@bsee.gov) for review and concurrence at least 120 days prior to the planned start of pile driving.	Ocean Wind has committed to implementing passive acoustic monitoring, pile driving monitoring, PSO coverage, sound field verification, and shutdown zones as part of the Proposed Action. Compliance with these APMs would be enforced by BOEM, BSEE, and NMFS as indicated in Table H-1. Implementation and enforcement of these APMs would minimize the potential for Level A or Level B exposures to marine mammals during of impact pile driving, vibratory pile driving, HRG surveys, and UXO detonation, as disclosed in the analysis of the Proposed Action. Agency-proposed mitigation measures would further define how the effectiveness and enforcement of APMs would be ensured, by requiring that Ocean Wind submit PAM and pile driving monitoring plans for approval by BOEM, BSEE, and NMFS and a sound field verification plan for approval by BOEM and BSEE; by ensuring that PSO coverage is sufficient and requiring deployment of additional PSOs or platforms if found
Pile driving monitoring plan	BOEM would ensure that Ocean Wind prepare and submit a *Pile Driving Monitoring Plan* to NMFS and BSEE (at OSWsubmittals@bsee.gov) for review and concurrence at least 90 days before the start of pile driving. The plan would detail all plans and procedures for sound attenuation as well as for monitoring ESA-listed whales and sea turtles during all impact and vibratory pile driving. The plan would also describe how BOEM, BSEE, and Ocean Wind would determine the number of whales exposed to noise above the Level B harassment threshold during pile driving with the vibratory hammer to install the cofferdam at the sea to shore transition. Ocean Wind would obtain NMFS' concurrence with this plan prior to starting any pile driving.	

Measure	Description	Effect
PSO Coverage	BOEM, BSEE, and USACE would ensure that PSO coverage is sufficient to reliably detect whales and sea turtles at the surface in clearance and shutdown zones to execute any pile driving delays or shutdown requirements. If, at any point prior to or during construction, the PSO coverage that is included as part of the proposed action is determined not to be sufficient to reliably detect ESA-listed whales and sea turtles within the clearance and shutdown zones, additional PSOs and/or platforms would be deployed. Determinations prior to construction would be based on review of the *Pile Driving Monitoring Plan*. Determinations during construction would be based on review of the weekly pile driving reports and other information, as appropriate.	insufficient or in the event that clearance or shutdown zones are expanded beyond the distances modeled prior to verification. While adoption of these measures would increase accountability and ensure the effectiveness of APMs, it would not alter the impact determination of moderate for the underwater noise IPF for LFC, MFC, HFC, and phocid pinnipeds in water, because analysis of the Proposed Action already includes analysis of the APMs outlined in Table H-1.
Sound field verification	BOEM, BSEE, and USACE would ensure that if the clearance and/or shutdown zones are expanded, PSO coverage is sufficient to reliably monitor the expanded clearance and/or shutdown zones. Additional observers would be deployed on additional platforms for every 1,500 m that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification.	
Shutdown zones	BOEM, BSEE, and USACE may consider reductions in the pre-start clearance and/or shutdown zones based on the sound field verification measurements. BOEM and BSEE would ensure that Ocean Wind submits a Sound Field Verification Plan for review and approval at least 90 days prior to the planned start of pile driving.	
Sampling gear	All sampling gear would be hauled at least once every 30 days, and all gear would be removed from the water and stored on land between survey seasons to minimize risk of entanglement.	The regular hauling of sampling gear and recovery of lost survey gear would reduce risk of entanglement for marine mammals. Gear identification would improve accountability in the case of

Measure	Description	Effect
Gear identification	To facilitate identification of gear on any entangled animals, all trap/pot gear used in the surveys would be uniquely marked to distinguish it from other commercial or recreational gear. Using yellow and black striped duct tape, place a 3-foot-long mark within 2 fathoms of a buoy. In addition, using black and white paint or duct tape, place 3 additional marks on the top, middle and bottom of the line. These gear marking colors are proposed as they are not gear markings used in other fisheries and are therefore distinct. Any changes in marking would not be made without notification and approval from NMFS.	gear loss. While adoption of these measures would reduce risk and improve accountability under the Proposed Action, it would not alter the impact determination of negligible for gear utilization.
Lost survey gear	If any survey gear is lost, all reasonable efforts that do not compromise human safety would be undertaken to recover the gear. All lost gear would be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) and BSEE (OSWIncidentReporting@bsee.gov) within 24 hours of the documented time of missing or lost gear. This report would include information on any markings on the gear and any efforts undertaken or planned to recover the gear.	
Marine debris awareness training	The Lessee would ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. By January 31 of each year, the Lessee would submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year.	Marine debris and trash awareness training would minimize the risk of marine mammal ingestion of or entanglement in marine debris. While adoption of this measure would decrease risk to marine mammals under the Proposed Action, it would not alter the impact determination of minor for accidental releases.
Monthly/annual reporting requirements	BOEM and BSEE would ensure that Ocean Wind submits regular reports (in consultation with NMFS) necessary to document the amount or extent of take that occurs during all phases of the proposed action.	Reporting requirements to document take would improve accountability for documenting marine mammal take associated with the Proposed Action. While adoption of these measures would improve accountability, it would not alter the overall impact determination for the Proposed Action.

Measure	Description	Effect
Data Collection BA BMPs	BOEM would ensure that all Project Design Criteria and Best Management Practices incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (June 2021) shall be applied to activities associated with the construction, maintenance and operations of the Ocean Wind project as applicable.	Compliance with project design criteria and BMPs for protected species would minimize risk to marine mammals during HRG surveys. While adoption of this measure would decrease risk to marine mammals under the Proposed Action, it would not alter the impact determination for HRG activities.
Alternative monitoring plan for pile driving	BOEM would require Ocean Wind to submit an alternative monitoring plan for nighttime pile driving at least 6 months prior to initiating nighttime impact pile-driving activities. The purpose of the plan is to demonstrate that Ocean Wind can meet the visual monitoring criteria with the technologies Ocean Wind is proposing to use for monitoring during nighttime impact pile driving. This plan may include deploying additional observers; alternative monitoring technologies such as night vision, thermal, and infrared technologies; or use of passive acoustic monitoring and must demonstrate the ability and effectiveness to maintain all clearance and shutdown zones during daytime and nighttime to BOEM's and NMFS's satisfaction.	Adoption of this measure would reduce the uncertainty in the ability of the nighttime monitoring techniques being proposed by Ocean Wind to detect marine mammals in the Level A monitoring zones. This would decrease the potential for PTS impacts to occur during nighttime impact pile-driving operations. However, it could still result in PTS effects on some marine mammal species (LFC, HFC, and phocid pinnipeds in water). In addition, the impact determination for underwater noise effects is made on all underwater noise sources and, therefore, implementation of the plan would not alter the impact determination of moderate for the underwater noise IPF for LFC, MFC, HFC, and phocid pinnipeds in water.
Periodic Underwater Surveys, Reporting of Monofilament and Other Fishing Gear Around WTG Foundations	The Lessee must monitor impacts associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least 10 of the WTGs located closest to shore in the Ocean Wind 1 Lease Area (OCS-A 0498) annually and report the results of the surveys to BOEM and BSEE in an annual report.	Periodic underwater surveys and reporting of monofilament and other fishing gear around WTG foundations would reduce the risk of entanglement associated with the presence of structures. While adoption of this measure would reduce risk to marine mammals under the Proposed Action, it would not alter the impact determination associated with the presence of structures, which would range from minor beneficial to minor adverse.

Measure	Description	Effect
PDC Minimize Vessel Interactions with Listed Species	All vessels associated with survey activities (transiting [i.e., travelling between a port and the survey site] or actively surveying) must comply with the vessel strike avoidance measures. If any ESA-listed marine mammal is sighted within 500 meters of the forward path of a vessel, the vessel operator must steer a course away from the whale at <10 knots (18.5 km/hr) until the minimum separation distance has been established. If any ESA-listed marine mammal is sighted within 200 meters of the forward path of a vessel, the vessel operator must reduce speed and shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 500 meters. If stationary, the vessel must not engage engines until the large whale has moved beyond 500 meters.	Ocean Wind has committed to implementing a vessel strike avoidance policy, vessel separation distances, and vessel speed restrictions as part of the Proposed Action and as described in Table H-1. These measures include maintaining a separation distance of greater than 500 meters from NARW and unidentified large marine mammals, greater than 100 meters from other large whales, and greater than 50 meters for dolphins, porpoises, seals, and sea turtles. Ocean Wind's vessel strike avoidance policy directs that if an animal is sighted in the vessel's path, the vessel will divert or reduce speed and shift gears to neutral (see Table H-1). Project design criteria to minimize vessel interactions with listed species would further clarify the distance at which vessels would divert their path and the distance at which vessels would reduce speed and shift to neutral. Adoption of these measures would further clarify requirements for vessel strike avoidance under the Proposed Action but would not alter the impact determinations for vessel traffic that would be minor for pinnipeds and odontocetes, minor to moderate for non-listed mysticetes, and moderate to major for NARW.
Operational Sound Field Verification Plan	BOEM would require the Lessee to develop an operational sound field verification plan to determine the operational noises emitted from the Offshore Wind Area. The plan would be reviewed and approved by BOEM and NMFS.	The development of an operational sound field verification plan would allow BOEM to confirm that impacts of operating WTG noise do not exceed predicted impacts based on existing monitoring data and modeling efforts. While adoption of this measure would improve accountability of WTG operational noise under the Proposed Action, it would not alter the impact determination for WTG noise.

Measure	Description	Effect
Biological Opinion Reasonable and Prudent Measures and Terms and Conditions	Reasonable and Prudent Measures and Terms and Conditions to minimize the impact of incidental take of ESA-listed species were documented in the NMFS Biological Opinion dated April 3, 2023. These measures include adherence to mitigation measures specified in the final MMPA ITA to minimize impacts during pile driving and UXO detonation; compliance with requirements for vessel operations within the Delaware River and Delaware Bay included in the Incidental Take Statements provided with the Paulsboro Marine Terminal Biological Opinion (dated July 19, 2022) and the New Jersey Wind Port Biological Opinion (dated February 25, 2022); reporting requirements related to effects to, or interactions with, ESA-listed species; submittal of required plans (e.g., PSO Training Plan for Trawl Surveys, Passive Acoustic Monitoring Plan, Marine Mammal and Sea Turtle Monitoring Plan, Cofferdam Installation and Removal Monitoring Plan, Alternative Monitoring Plan/Night Time Pile Driving Monitoring Plan, Sound Field Verification Plan, North Atlantic Right Whale Vessel Strike Avoidance Plan) to NMFS GARFO with sufficient time for review, comment and approval; and conducting on-site observation and inspection to gather information on the effectiveness and implementation of measures to minimize and monitor incidental take.	These RPMs and Terms and Conditions would minimize the exposure of ESA-listed species to pile-driving noise and the effects of UXO detonation. These RPMs and Terms and Conditions would also ensure that all incidental take that occurs is documented and reported to NMFS in a timely manner and that any incidentally taken individual specimens are properly handled, resuscitated if necessary, transported for additional care or reporting, or returned to the sea. Reporting requirements to document take would improve accountability for documenting take associated with the Proposed Action. In some cases, these RPMs and Terms and Conditions provide additional detail or clarification of measures that are included as part of the Proposed Action. Implementation of these RPMs and Terms and Conditions would provide incremental reductions in impacts on marine mammals and would improve accountability, but would not alter the overall impact determination of the Proposed Action.

DOI = Department of the Interior; GARFO = Greater Atlantic Regional Fisheries Office; ITA = incidental take authorization; km/hr = kilometers per hour; LOA = Letter of Authorization; m = meters; PAM = passive acoustic monitoring; PDC = project design criteria; PSO = protected species observer; RPM = Reasonable and Prudent Measure

Table 3.15-20 Additional Proposed Measures (Also Identified in Appendix H, Table H-3): Marine Mammals

Measure	Description	Effect
Vessel speed restrictions	A separate measure would stipulate that all vessels, regardless of size, would comply with a 10-knot speed restriction in any SMA, DMA, or Slow Zone.	Ocean Wind has committed to implementing vessel speed restrictions, including requirements that all vessels 65 feet or longer comply with a 10-knot speed restriction in any SMA during NARW migratory and calving periods and that vessels of all sizes would operate port to port (from ports in New Jersey, New York, Maryland, Delaware, and Virginia), within the offshore wind area, and in DMAs at 10 knots or less (Table H-1). Agency-proposed mitigation regarding vessel speed restrictions would further stipulate that all vessels regardless of size would comply with a 10-knot speed restriction in any SMA, DMA, or Slow Zone. While adoption of this measure would reduce risk to marine mammals under the Proposed Action, it would not alter the impact determinations for vessel traffic that would be minor for pinnipeds and odontocetes, minor to moderate for non-listed mysticetes, and moderate to major for NARW, given due to the current status of this ESA species a single loss of an individual would have major impacts to the population.

DMA = Dynamic Management Area; SMA = Seasonal Management Area

3.15.9.1. Measures Incorporated in the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.15-19 and Table H-2 in Appendix H, *Mitigation and Monitoring*, are incorporated in the Preferred Alternative. BOEM has identified the following additional measures in Table 3.15-20 as incorporated in the Preferred Alternative: vessel speed restrictions. These measures, if adopted, would further define how the effectiveness and enforcement of APMs would be ensured and improve accountability for compliance with APMs by requiring the submittal of plans for approval by the enforcing agency(ies) and by defining reporting requirements. Because these measures ensure the effectiveness of and compliance with APMs that are already analyzed as part of the Proposed Action, implementation of these measures would not further reduce the impact level of the Proposed Action from what is described in Section 3.15.2, *Environmental Consequences*. Agency-proposed measures related to vessel speed restrictions would expand upon Ocean Wind's APMs to require that all vessels regardless of size would comply with a 10-

knot speed restriction in any Seasonal Management Area, Dynamic Management Area, or Slow Zone. While adoption of this measure would reduce risk to marine mammals under the Proposed Action, it would not alter the impact determinations for vessel traffic that would be minor for pinnipeds and odontocetes, minor to moderate for non-listed mysticetes, and moderate to major for NARW.

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3.16. Navigation and Vessel Traffic

This section discusses navigation and vessel traffic characteristics and potential impacts on waterways and water approaches from the proposed Project, alternatives, and ongoing and planned activities in the navigation and vessel traffic geographic analysis area. The navigation and vessel traffic geographic analysis area, as shown on Figure 3.16-1, includes coastal and marine waters within a 10-mile (16.1-kilometer) buffer of the Offshore Project area and adjacent Lease Areas OCS-A 0499, OCS-A 0532, and OCS-A 0549, as well as waterways leading to ports that may be used by the Project. These areas encompass locations where BOEM anticipates direct and indirect impacts associated with Project construction, O&M, and conceptual decommissioning. Information presented in this section draws primarily upon the NSRA[1] (COP Volume III, Appendix M; Ocean Wind 2023), which was conducted per the guidelines in USCG *Navigation and Vessel Inspection Circular 01-19* (USCG 2019).

Marine risk modeling was used to estimate the increase in the number of accidents that could occur because of the Project. One year of AIS data was the primary marine traffic input into the model. The quantified assessment of the navigation risk for the Project according to the NSRA concludes that the risk increase due to the Project lies within the Project area and between the Project area and the coast. In this assessment, the modeled risk increase is 0.40 accident per year, 72 percent of which are groundings, primarily of pleasure vessels. The NSRA did not identify any major areas of concern regarding the impact on marine navigation. Additional information about the NSRA is in Section 3.16.5. Details about the NSRA development and conformance with USCG guidelines for key areas of inquiry such as vessel traffic and assessment of navigation within or close to Project structures is in Appendix F of the NSRA.

3.16.1 Description of the Affected Environment for Navigation and Vessel Traffic

Regional Setting

Proposed Project facilities would be approximately 13 nm (24 kilometers) southeast of Atlantic City, New Jersey under a Commercial Lease for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0498). The entrance to Delaware Bay is approximately 25 nm (46 kilometers) southeast of the Lease Area, marked by a line drawn between Cape May Light and Harbor of Refuge Light. Figure 3.16-1 shows the location of the Lease Area and the waterways leading to ports that may be used by the Project. Figure 2-3 in the NSRA presents regional vessel traffic in the vicinity of the Lease Area (COP Volume III, Appendix M, NSRA; Ocean Wind 2023).

There are several routing measures[2] that regulate vessel traffic to help ships avoid navigational hazards in the vicinity of the Lease Area. Vessel traffic in and out of Delaware Bay is regulated by a Traffic

[1] The NSRA analyzed vessel traffic within a Marine Traffic Study Area, which is inclusive of the Lease Area, the remainder of the Lease Area, and offshore waters for more than 40 nm (74 kilometers) in any direction. The study area considers current traffic patterns, density, and vessel numbers as well as anticipated changes in traffic from the Project within the areas between the ports, to and from the Offshore Project area, and inclusive of the Offshore Project area. The navigation and vessel traffic geographic analysis area is generally consistent with the Marine Traffic Study Area but also includes more distant ports that may be used by the Project. Where this EIS references vessel data and risk analysis from the NSRA, they are specific to the geographic scope of the Marine Traffic Study Area.

[2] The term *routing* measure originates from the International Maritime Organization. The International Convention for the Safety of Life at Sea, Chapter V, recognizes the International Maritime Organization as the only international body for establishing routing measures (https://www.imo.org/en/OurWork/Safety/Pages/ShipsRouteing.aspx). USCG submits and obtains approval for routing measures within U.S. navigable waters to the International Maritime Organization. Areas to Be Avoided, Inshore Traffic Zones, No Anchoring Areas, Precautionary Areas, Roundabouts, and Traffic Separation Schemes are all routing measures (USCG 2020a, Appendix B).

Separation Scheme (TSS), which is 15 nm from the Lease Area (Figure 3.16-2). The TSS within the approach to Delaware Bay consists of four parts: an Eastern Approach, a Southwestern Approach, a Two-Way Traffic Route, and a Precautionary Area (33 CFR 167.170). The Inbound Five Fathom Bank to Cape Henlopen Traffic Lane, the Eastern Approach of the TSS, is 18 nm (33 kilometers) to the south of the Lease Area and is primarily a shipping route for deep-draft vessels. The Two-Way Traffic Route (15 nm, 28 kilometers from the Lease Area) is used primarily by tug and barge vessels entering and exiting Delaware Bay (COP Volume III, Appendix M, NSRA, Table 2-4; Ocean Wind 2023).

Farther to the north of the Lease Area (approximately 40 nm [74 kilometers]) is a TSS that regulates vessel traffic in the approach to New York Harbor (NOAA 2023:349). There is a speed-restricted area for NARW seasonal management 14 nm (26 kilometers) from the Lease Area (50 CFR 224.105).

Figure 3.16-2 shows vessel traffic in the vicinity of the Lease Area based on AIS data and nearby routing measures (traffic separation zones, precautionary areas).

Commercial fishing vessel traffic using 2014–2019 VMS data is further described in Section 3.9. A polar histogram (Figure 3.9-3), developed by BOEM using VMS data, shows that 377 VMS-enabled commercial fishing vessels (Figure 3.9-3) use the lease area with a predominant orientation of travel from the southwest to the northeast and a secondary operating pattern of northwest to southeast.

The primary traffic patterns in the Lease Area are in the north-northeast/south-southwest and northwest/ southeast directions (COP Volume II, Section 2.3.6.1, p. 342; Ocean Wind 2023). Traffic patterns, traffic density, and statistics were developed from 1 year of AIS data for the period from March 1, 2019, through February 29, 2020; data from the Mid-Atlantic Ocean Data Portal (MARCO 2020) for commercial fishing transits; and ongoing dialogue with organizations representing or serving different types of waterborne traffic in the area (such as recreational boating, fishing, and towing industry organizations and pilot organizations). These data and information were analyzed in the NSRA for the Proposed Action. Subsequent to the preparation of the NSRA, USCG published the Draft *Port Access Route Study: Seacoast of New Jersey Including Offshore Approaches to the Delaware Bay, Delaware* (USCG 2021a). Using 3 years (January 1, 2017, to December 31, 2019) of traffic data, this analysis offers an in-depth look at the traffic patterns and traffic composition along the New Jersey seacoast from year to year. The Port Access Route Study was finalized in March 2022 and is available through USCG docket number USCG 2020-0172 (USCG 2022a).

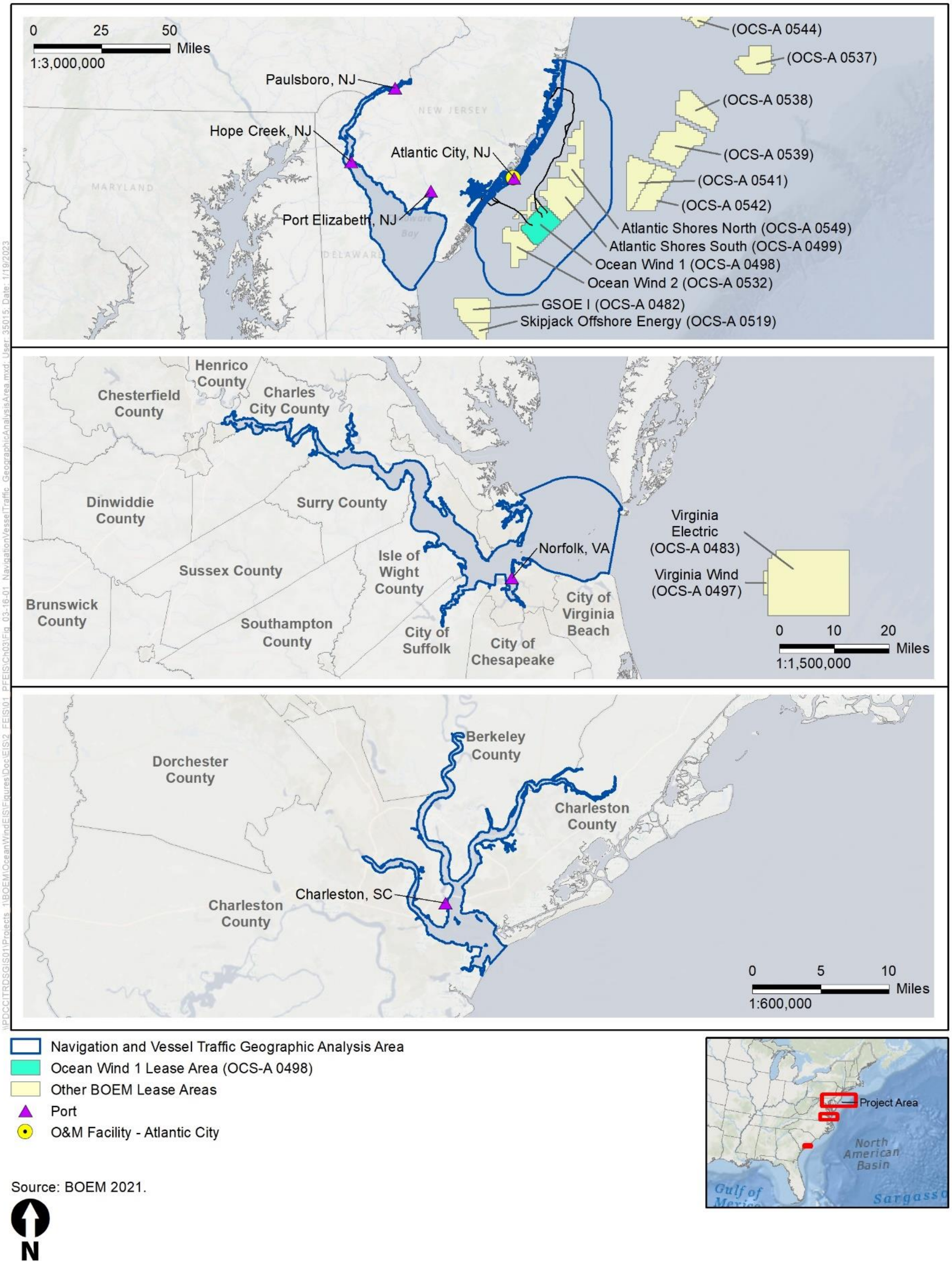
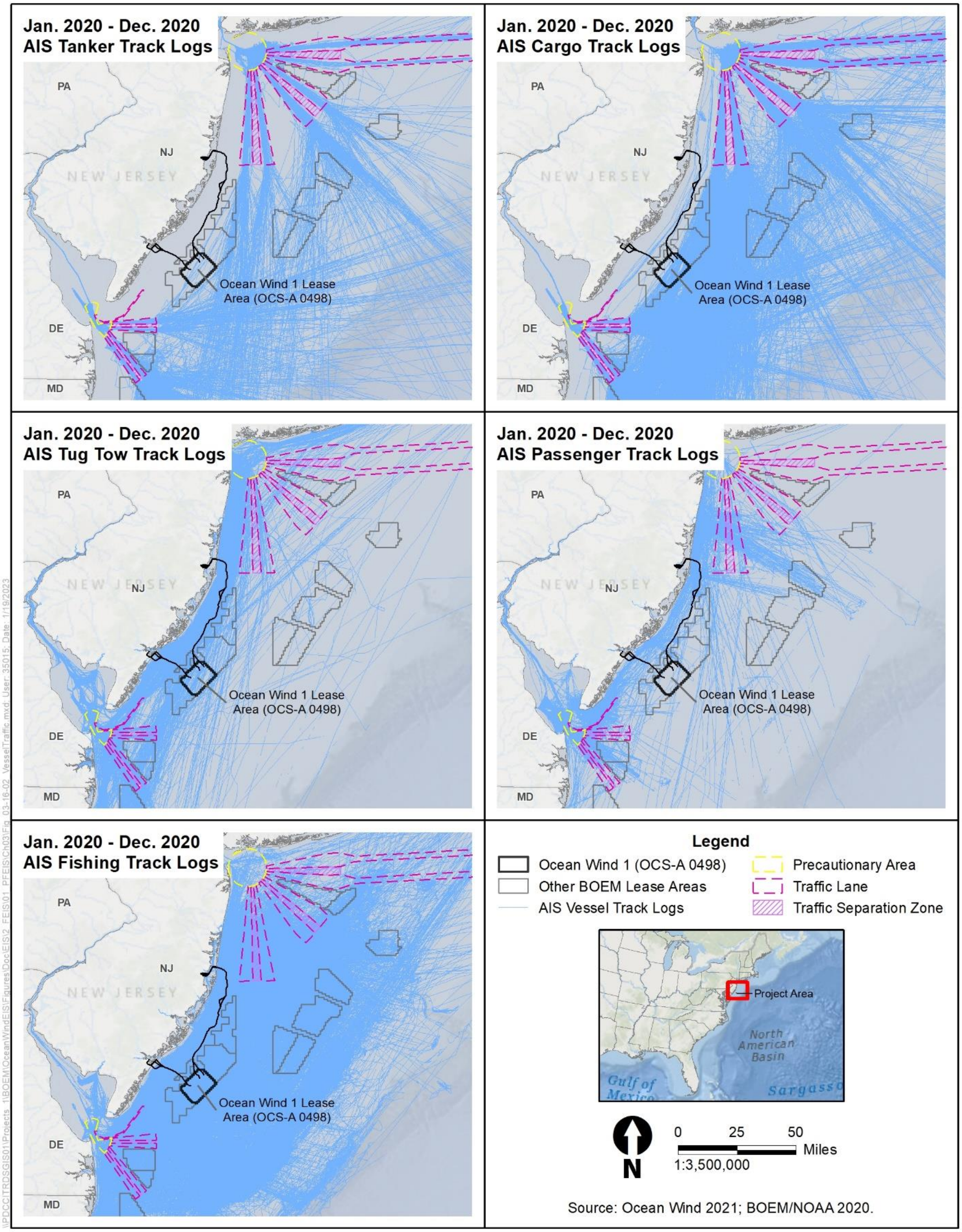


Figure 3.16-1 Navigation and Vessel Traffic Geographic Analysis Area



Note: AIS track counts for fishing and pleasure vessels underrepresent these vessel types, as not all of these vessel types are required to have AIS on board per USCG regulations.

Figure 3.16-2 Vessel Traffic in the Vicinity of the Lease Area

In June 2020 (USCG 2020a), USCG sought comments regarding the possible establishment of shipping safety fairways ("fairways") along the Atlantic Coast identified in the *Atlantic Coast Port Access Route Study* (USCG 2016) and related port access route studies such as the *Port Access Route Study: Seacoast of New Jersey Including Offshore Approaches to the Delaware Bay, Delaware* (draft, USCG 2021a; final, USCG 2022a).[3] Figure 2.3.6-4 (p. 347) in the COP, Volume II (Ocean Wind 2023), shows these fairways, which avoid the Ocean Wind 1 Lease Area OCS-A 0498 and a significant portion of the offshore wind lease areas OCS-A 0532, OCS-A 0499, and OCS-A 0549. On April 5, 2017, USCG announced the completion of the *Atlantic Coast Port Access Route Study*. The *Atlantic Coast Port Access Route Study* analyzed predominantly north/south vessel transit routes along the Atlantic Coast. USCG announced new studies focused on port approaches and international entry and departure areas along the Atlantic Coast to supplement the *Atlantic Coast Port Access Route Study* on March 15, 2019. While these supplemental PARS were ongoing, USCG published the Advanced Notice of Proposed Rulemaking on June 19, 2020. On September 9, 2022, USCG published on the federal notice (87 *Federal Register* 55449) the availability of the *Consolidated Port Approaches and International Entry and Departure Transit Areas Port Access Route Studies*. The *Consolidated Port Approaches and International Entry and Departure Transit Areas Port Access Route Studies* summarizes the findings of four regional port access route studies, two of which provide approved recommendations and alternatives. These approved recommendations and alternatives will be included in a subsequent rulemaking proposal.

Existing lease areas (Garden State, Skipjack, and Empire) and recent lease sales (New York Bight Lease Areas: Mid-Atlantic, Ocean Winds East, Attentive Energy, Bight Wind Holdings, Atlantic Shores, and Invenergy), although outside of the navigation and vessel traffic geographic analysis area, could contribute to increased vessel traffic within the navigable waterways and approaches to New Jersey ports within the geographic analysis area (i.e., Paulsboro, Hope Creek, Port Elizabeth, and Atlantic City).

Lease Area

Vessel Traffic

Table 3.16-1 summarizes the distribution (represented by vessel tracks), type of vessel, average length, average width (beam), and average deadweight tonnage of vessels recorded within 5 miles (8 kilometers) of the Lease Area from March 1, 2019, through February 29, 2020.

The NSRA reported data on vessels using AIS, which is only required on commercial vessels with a length of 65 feet (19.8 meters) or longer. As shown in Table 3.16-1, some smaller recreational and fishing vessels carry AIS; however, the NSRA data likely exclude most vessels less than 65 feet (19.8 meters) long that traverse the Lease Area (COP Volume III, Appendix M, NSRA, pp. 8–9; Ocean Wind 2023). Therefore, AIS tracks for fishing and pleasure vessels in Table 3.16-1 are underrepresented. Section 3.9 discusses commercial fisheries and for-hire recreational fishing and Section 3.18 discusses recreation and tourism. "Other/undefined" vessel types include research, military, law enforcement, and unspecified vessels (COP Volume III, Appendix M, NSRA, Section 2.1.1.6, p. 37; Ocean Wind 2023).

[3] Although the *Port Access Route Study: Seacoast of New Jersey Including Offshore Approaches to the Delaware Bay, Delaware*, Final Report was released to the public in March 2022, the study began in May 2020 and, along with other port access route studies under development for ports along the Atlantic Coast, informed the recommendations within the *Atlantic Coast Port Access Route Study*. This analysis and preparation of recommendations for proposed Atlantic Coast Routing Measures continues with the *Consolidated Port Approaches and International Entry and Departure Transit Areas Port Access Route Studies* described in this same paragraph.

Table 3.16-1 Vessels within 5 Miles (8 Kilometers) of Lease Area[1]

Vessel Type	Count of AIS Tracks	Average Length	Average Width (Beam)	Average Deadweight Tonnage
Cruise Ships and Large Ferries	33	968 ft (295 m)	132 ft (40 m)	9,141 metric tons
Cargo/Carrier	639	789 ft (241 m)	113 ft (34 m)	51,138 metric tons
Tanker/Tanker-Oil	65	573 ft (175 m)	94 ft (29 m)	38,589 metric tons
Other/Undefined	2,169	205 ft (63 m)	43 ft (13 m)	1,033 metric tons
Tug	324	123 ft (38 m)	37 ft (11 m)	495 metric tons
Tug with Towline	8	121 ft (37 m)	37 ft (11 m)	538 metric tons
Fishing	901	102 ft (31 m)	29 ft (9 m)	Insufficient data
Pleasure	262	69 ft (21 m)	18 ft (6 m)	154 metric tons

Source: Table 2-2, NSRA, Ocean Wind 2023 citing MarineTraffic 2020
[1] AIS track counts for fishing and pleasure vessels underrepresent these vessel types, as not all of these vessel types are required to have AIS on board per USCG regulations.
ft = feet; m = meters

The NSRA analyzed vessel traffic activity as transit counts per transect (COP Volume III, Appendix M, NSRA, pp. 40–45; Ocean Wind 2023). Transect locations were selected to evaluate the areas of heaviest vessel traffic in the vicinity of the Lease Area. Only three transects have more than 10 transits per day, according to the AIS data (3,650 transits per year):

- The entrance to Delaware Bay with an average of about 18 transits per day
- Barnegat Inlet with an average of 16 transits per day
- The eastern end of Delaware Bay with an average of 11 transits per day

The coastal traffic west of the Lease Area is predominantly tug transits,[4] while the coastal traffic farther south is predominantly pleasure and fishing vessels (COP Volume III, Appendix M, NSRA, p. 41; Ocean Wind 2023). Some deep-draft vessel traffic (cruise ships, cargo and carrier ships, and tankers) occurs within the Lease Area but most of the deep-draft vessels in the vicinity of the Lease Area pass to the east (COP Volume III, Appendix M, NSRA, p. 12; Ocean Wind 2023).[5] No ferry routes are identified within the Lease Area. The closest ferry route (Cape May to Lewes) is 29 nm (54 kilometers) from the Lease Area (COP Volume III, Appendix M, NSRA, p. 65; Ocean Wind 2023). Additional information and datasets, tables, and figures related to vessel traffic can be found in COP Volume II, Section 2.3.6, and COP Volume III, Appendix M, NSRA (Ocean Wind 2023).

Aids to Navigation

The closest federal aid to navigation is Avalon Shoal Lighted Buoy 2, which is 9.1 nm (17 kilometers) from the Project. There is one private buoy (PATON) within the Lease Area and another 3.8 nm from the Lease Area. USCG administers the permits for PATONs on structures positioned in or near navigable waters of the United States.

[4] Less than 1 percent of the tracks are from tugs self-identified as “Pusher tug.” Tug data include tug-with-tow, Articulated Tug Barges, and Integrated Tug/Barges (COP Volume III, Appendix M, NSRA p. 35; Ocean Wind 2023).
[5] AIS data for March 2019 to February 2020 (Ocean Wind 2023 citing MarineTraffic 2020) show that about five transits per day enter the Wind Farm Area, 1,632 per year in total, including some minor double-counting (COP, Volume II, p. 344; Ocean Wind 2023).

Ports, Harbors, and Navigation Channels

The major navigable waterway within the analysis area is Delaware Bay and River. Delaware Bay and River offer access to several ports of call (such as Wilmington, Philadelphia, and Trenton) for large commercial deep-draft ships and tug/barge units as well as smaller commercial and non-commercial shallower-draft vessels. Most of the traffic to or from other ocean access ports in the vicinity of the Lease Area consists of transits of fishing and pleasure vessels (COP Volume III, Appendix M, NSRA, p. 42; Ocean Wind 2023). North of the Lease Area is the outer portion of the approach to New York Harbor, Ambrose Channel, and the AIS data show a large distribution of deep-draft ships within this passage. Although most of the deep-draft vessels in the vicinity of the Lease Area pass to the east, a fraction of them pass through the Lease Area while transiting between the Ambrose to Barnegat Traffic Lane and the Five Fathom Bank to Cape Henlopen Traffic Lane (COP Volume III, Appendix M, NSRA, p. 12; Ocean Wind 2023). Other ports within the geographic analysis area include Atlantic City, Paulsboro, Hope Creek, and Port Elizabeth, New Jersey; Norfolk, Virginia; and Charleston, South Carolina (COP Volume I, Section 4.1.1, p. 53; Ocean Wind 2023).

The NSRA analyzed vessel incidents using AIS data from March 1, 2019, through February 29, 2020, plus additional transits for commercial fishing vessels[6] (COP Volume III, Appendix M, NSRA, pp. E-20–E-21; Ocean Wind 2023). Accident frequencies in the Lease Area for allision and grounding are zero (currently, there are no wind turbines and no grounding locations in the Lease Area that present a risk for allisions and groundings). The accident frequency for collisions in the Lease Area is 0.0004, or four accidents in 10,000 years; the vessel types that contributed to collisions are cargo, fishing, and pleasure. The accident frequency for other ship types, including tug, tug-with-tow, passenger, and tanker, is zero. Over an 11-year period (2008 through 2018), USCG executed five missions in the Lease Area, all of which were search and rescue (SAR) missions (COP Volume III, Appendix M, NSRA, p. 148; Ocean Wind 2023).

3.16.2 Environmental Consequences

3.16.2.1. Impact Level Definitions for Navigation and Vessel Traffic

Definitions of impact levels are provided in Table 3.16-2. There are no beneficial impacts on navigation and vessel traffic.

Table 3.16-2 Impact Level Definitions for Navigation and Vessel Traffic

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts would be so small as to be unmeasurable.
Minor	Adverse	Impacts would be avoided. Normal or routine functions associated with vessel navigation would not be disrupted.
Moderate	Adverse	Impacts would be unavoidable. Vessel traffic would have to adjust somewhat to account for disruptions due to impacts of the Project.
Major	Adverse	Vessel traffic would experience unavoidable disruptions to a degree beyond what is normally acceptable, including potential loss of vessels and life.

[6] To account for commercial fishing vessel activity not fully captured in the AIS data, 344 additional commercial fishing vessel transits from ports to or through the Lease Area and 344 return trips were included in the base case for modeling (COP Volume III, Appendix M, NSRA, p. 15 and Section E.2.5; Ocean Wind 2023).

3.16.3 Impacts of the No Action Alternative on Navigation and Vessel Traffic

Section 3.1 of the Final EIS explains the approach to predicting impacts related to the No Action Alternative. When analyzing the impacts of the No Action Alternative on navigation and vessel traffic, BOEM considered the impacts of past and ongoing trends and activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for navigation and vessel traffic. BOEM separately analyzes how resource conditions will be affected over time as reasonably foreseeable activities are implemented. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*. Separate impact conclusions are presented for both scenarios.

3.16.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for navigation and vessel traffic described in Section 3.16.1, *Description of the Affected Environment for Navigation and Vessel Traffic*, would continue to follow regional current trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities.

There are no ongoing offshore wind activities within the geographic analysis area for navigation and vessel traffic.

Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on navigation and vessel traffic are generally associated with marine transportation, military use, NMFS activities and scientific research, and fisheries use and management. Impacts from these activities increase vessel traffic in the area, adding to congestion in waterways and increasing the potential for maritime accidents. Impacts associated with global climate change have the potential to require modifications to existing port infrastructure and aids to navigation, with the former adding to port congestion and limited berths during construction activities.

3.16.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with other planned non-offshore wind activities and planned offshore wind activities (without the Proposed Action).

Planned non-offshore wind activities that may affect navigation and vessel traffic in the geographic analysis area include port improvement projects, dredging projects, and installation of new structures on the OCS (see Section F.2 in Appendix F for a description of ongoing and planned activities). These activities may result in a moderate increase in port maintenance activities, port upgrades to accommodate larger deep-draft vessels, and temporary increases in vessel traffic for offshore cable emplacement and maintenance. Planned offshore wind projects include Ocean Wind 2, Atlantic Shores South, and Atlantic Shores North. In addition, USCG is planning to establish shipping safety fairways or other vessel-routing measures along the Atlantic Coast of the United States as referenced in Section 3.16.1. The purpose of the fairways is to protect maritime commerce and safe navigation amidst the non-offshore wind activities described in this section. See Table F1-14 for a summary of potential impacts associated with ongoing and planned non-offshore wind activities by IPF for navigation and vessel traffic.

BOEM expects planned offshore wind activities to affect navigation and vessel traffic through the following primary IPFs.

Anchoring: Offshore wind developers are expected to coordinate with the maritime community and USCG to avoid laying export cables through any traditional or designated lightering/anchorage areas, meaning that any risk for deep-draft vessels would come from anchoring in an emergency scenario, specifically near the Delaware Bay TSS or in the approach to New York Harbor. Generally, larger vessels accidentally dropping anchor on top of an export cable (buried or mattress protected) to prevent drifting in the event of vessel power failure would result in damage to the export cable, damage to the vessel anchor or anchor chain, and risks associated with an anchor contacting an electrified cable (see the *Anchoring* IPF in Section 3.16.5 for additional information).

Smaller commercial or recreational vessels anchoring in the offshore wind lease areas may have issues with anchors failing to hold near foundations and any scour protection. Considering the small size of the geographic analysis area compared to the remaining area of open ocean, as well as the low likelihood that any anchoring risk would occur in an emergency scenario, it is unlikely that offshore wind activities would affect vessel-anchoring activities. Impacts on navigation and vessel traffic would likely be minor because impacts would be temporary and localized, and navigation and vessel traffic would be expected to fully recover following the disturbance.

Port utilization: As described in Appendix F, Section F.2.13, offshore wind development would support planned expansions and modifications at ports in the geographic analysis area for navigation and vessel traffic, including the ports of Hope Creek and Paulsboro, New Jersey and Norfolk, Virginia. Simultaneous construction or decommissioning (and, to a lesser degree, operation) activities for multiple offshore wind projects in the geographic analysis area could stress port capacity and resources and could concentrate vessel traffic in port areas. Such concentrated activities could lead to increased risk of allision, collision, and vessel delay.

Under the No Action Alternative, three offshore wind projects in the analysis area, Ocean Wind 2, Atlantic Shores South, and Atlantic Shores North, would generate vessel traffic during construction. Only one of these projects, Atlantic Shores South, has a published COP with estimated vessel trip numbers. The Atlantic Shores South project may generate a maximum of 51 vessels at any given time during construction (Atlantic Shores 2021). For the other two projects, BOEM assumed vessel traffic would be similar to that of the Proposed Action: between 20 and 65 vessels operating simultaneously during construction, depending upon the activity (COP, Volume I, Section 6.1, pp. 110–111 and 115–117; Ocean Wind 2023). Atlantic Shores South is estimated to be under construction between 2025 and 2027, and Ocean Wind 2 and Atlantic Shores North are estimated to be under construction between 2026 and 2030. In 2026–2027, when all three projects would be under construction at the same time, a maximum of 181 vessels could be operating simultaneously.

The increase in port utilization due to this vessel activity would vary across ports and would depend on the specific port or ports supporting each offshore wind project. It is unlikely that all projects would use the same ports; therefore, the total increase in vessel traffic would be distributed across multiple ports in the region. Port utilization in the geographic analysis area would occur primarily during construction. As discussed in Section 3.11, offshore wind construction activities may result in competition for scarce berthing space and port services, potentially causing short- to medium-term adverse impacts on commercial shipping. During peak activity, impacts on port utilization would be moderate, short term, and continuous at the ports and their maritime approaches.

After offshore wind projects are constructed, related port utilization would decrease. During operations, project-related port utilization would have minor, long-term, intermittent, localized impacts on overall vessel traffic and navigation. Port utilization would increase again during decommissioning at the end of the operating period of each project, which BOEM anticipates to be approximately 35 years, with magnitudes and impacts similar to those described for construction.

Presence of structures: Under the No Action Alternative, approximately 468 WTGs and 15 OSS would be constructed in the geographic analysis area. Structures in this area would pose navigational hazards to vessels transiting within and around areas leased for offshore wind projects. Offshore wind projects would increase navigational complexity and ocean space use conflicts, including the presence of WTG and OSS structures in areas where no such structures currently exist, potential compression of vessel traffic both outside and within offshore wind lease areas, and potential difficulty seeing other vessels due to a cluttered view field. Another potential impact of offshore wind structures is interference with marine vessel radars. USCG noted in its final *Areas Offshore of Massachusetts and Rhode Island Port Access Route Study* (USCG 2020b) that various factors play a role in potential marine radar interference by offshore wind infrastructure, stating that "the potential for interference with marine radar is site specific and depends on many factors including, but not limited to, turbine size, array layouts, number of turbines, construction material(s), and the vessel types." In the event of radar interference, other navigational tools are available to ship captains. See the *Presence of Structures* IPF in Section 3.16.5 for additional information drawn from *Wind Turbine Generator Impacts to Marine Vessel Radar* (National Academies of Science 2022).

The fish aggregation and reef effects of offshore wind structures would also provide new opportunities for recreational fishing. The additional recreational vessel activity focused on aggregation and reef effects would incrementally increase vessel congestion and the risk of allision, collision, and spills near WTGs. Overall, the impacts of this IPF on navigation and vessel traffic would be moderate, long term (as long as structures remain, approximately 35 years), regional (throughout the entire geographic analysis area for navigation and vessel traffic), and continuous.

Cable emplacement and maintenance: Based on the assumptions in Table F2-2 in Appendix F, the 483 foundations (468 WTGs and 15 OSS) would require about 1,567 miles (2,510.6 kilometers) of inter-array and offshore export cables. Emplacement and maintenance of cables for these offshore wind projects would generate vessel traffic and would specifically add slower-moving vessel traffic above cable routes. Vessels not involved in cable emplacement or maintenance would need to take additional care when crossing cable routes during installation and maintenance activities. BOEM anticipates that there would likely be simultaneous cable-laying activities from multiple projects based on the estimated construction timeline. While simultaneous cable-laying activities may disrupt vessel traffic over a larger area than if activities occurred sequentially, the total time of disruption would be less than if each project were to conduct cable-laying activities sequentially. The impacts of this IPF on vessel traffic and navigation under the No Action Alternative would be minor to moderate because impacts would be short term, localized, and most disruptive during peak construction activity of the offshore wind projects from 2026 through 2027.

Traffic: Offshore wind projects would generate vessel traffic during construction, operation, and decommissioning within the navigation and vessel traffic geographic analysis area. Other vessel traffic in the region (e.g., from commercial fishing, for-hire and individual recreational use, shipping activities, military uses) would overlap with offshore wind-related vessel activity in the open ocean and near ports supporting the offshore wind projects. BOEM anticipates that the total increase in vessel traffic would be distributed across multiple ports in the region.

As shown in Table F2-1 in Appendix F, the increase in vessel traffic and navigation risk due to offshore wind projects would be at its peak in 2026 to 2027, when 468 WTGs and 15 OSS associated with three offshore wind projects other than the Proposed Action (Ocean Wind 2, Atlantic Shores South, and Atlantic Shores North) would be under simultaneous construction. During this peak construction period for the three planned offshore wind projects, a maximum of 181 vessels could be operating simultaneously in the geographic analysis area at any given time. The presence of offshore wind project vessels would add to the Atlantic Coast vessel traffic levels as each offshore wind farm area is developed, leading to increased congestion and navigational complexity, which could result in crew fatigue, damage to vessels, injuries to crews, engagement of USCG SAR, and vessel fuel spills. Increased offshore wind-related vessel traffic during construction would have moderate, short-term, constant, localized impacts on overall (wind and non-wind) vessel traffic and navigation.

After offshore wind projects are constructed, related vessel activity would decrease. Vessel activity related to the operation of offshore wind facilities would consist of scheduled inspection and maintenance activities with corrective maintenance as needed. As noted above under *Port Utilization*, only the Atlantic Shores South project in the geographic analysis area has a published COP with estimated vessel numbers. The Atlantic Shores South project would have up to 11 vessels in operation at any given time during normal O&M activities (Atlantic Shores 2021). For Ocean Wind 2 and Atlantic Shores North, BOEM assumed operations-related vessel traffic would be the same as the Proposed Action estimates of 10 vessels per day. Combined, the three offshore wind projects in the geographic analysis area would generate 31 vessels at any given time during normal O&M. During operations, project-related vessel traffic would have minor, long-term, intermittent, localized impacts on overall vessel traffic and navigation. Vessel activity would increase again during decommissioning at the end of the operating period of each project, which BOEM anticipates to be approximately 35 years, with magnitudes and impacts similar to those described for construction.

3.16.3.3. Conclusions

Impacts of the No Action Alternative. BOEM expects ongoing activities, including other offshore wind activities, to have continuing short- and long-term impacts on navigation and vessel traffic, primarily through the presence of structures, port utilization, and vessel traffic. BOEM anticipates that the impacts of ongoing activities, especially port utilization and vessel traffic, would be moderate. The No Action Alternative would result in **moderate** impacts on navigation and vessel traffic.

Cumulative Impacts of the No Action Alternative. Under the No Action Alternative, existing environmental trends and activities would continue, and navigation and vessel traffic would continue to be affected by natural and human-caused IPFs. Planned activities other than offshore wind such as oil and gas activities, dredging projects, offshore cable emplacement and maintenance, and onshore development activities would contribute to impacts on navigation and vessel traffic. BOEM anticipates that the impacts of planned activities other than offshore wind would be minor because while impacts would be measurable, they would not disrupt navigation and vessel traffic. Other offshore wind projects would increase vessel activity, which could lead to congestion at affected ports, the possible need for port upgrades beyond those currently envisioned, and an increased likelihood of collisions and allisions, with resultant increased risk of accidental releases. In addition, the offshore wind projects other than the Proposed Action would lead to the construction of approximately 468 WTGs and 14 OSS in areas where no such structures currently exist, also increasing the risk for collisions, allisions, and resultant accidental releases and threats to human health and safety. While non-routine events such as collisions and allisions (and resulting spills or personal injury) have the potential to occur during construction, O&M, and decommissioning of offshore wind projects, BOEM anticipates that these events would be unlikely to occur given requirements for lighting and marking, vessel speed restrictions, and inclusion of project components on navigation charts as outlined in Section 2.2. BOEM expects other offshore wind projects to result in long-term, regional, and moderate impact on navigation and vessel traffic. BOEM anticipates that cumulative impacts of the No Action Alternative in the geographic analysis area would be **moderate** primarily due to the presence of structures.

3.16.4 Relevant Design Parameters & Potential Variances in Impacts for the Action Alternative

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than described in the sections below. The following proposed PDE parameters (Appendix E) would influence the magnitude of the impacts on navigation and vessel traffic characteristics:

- The Project layout including the number, type, and placement of the WTGs and OSS including the location, width, and orientation of the Wind Farm Area rows and columns;
- The number of vessels utilized for construction and installation;
- The offshore electric cable corridor routes/locations;
- Time of year of construction;
- Ports selected to support construction and installation; and
- Ports selected to support O&M.

Variability of the proposed Project design within the PDE that could affect navigation and vessel traffic includes the number of vessels that would be used during construction; the ports used to support Project construction, installation, and decommissioning; the exact placement and number of WTGs; and the construction schedule, as outlined in Appendix E. Variances in these factors could affect vessel traffic and navigation choices. This section has assessed the maximum-case scenario, so variances from this scenario should lead to similar or reduced impacts.

Ocean Wind has committed to measures to minimize impacts on navigation and vessel traffic, such as equipping select structures within the Wind Farm Area with strategically located AIS transponders (NAV-03) and arranging WTGs in equally spaced rows in a northwest to southeast orientation to aid safe navigation (NAV-04) (COP Volume II, Table 1.1-2; Ocean Wind 2023). Ocean Wind is also developing a Navigational Safety and Training program. The program would provide eligible commercial, charter, and for-hire fishing vessels operating in and near the Ocean Wind 1 wind farm with reimbursement for new radar equipment and training courses. Ocean Wind will finance the program and provide grants (vouchers) to eligible applicants to provide navigation equipment including pulse compression radar systems/AIS transceivers and professional training and experiential learning for fishers, which can include a captain course, license upgrade, radar course, or rules-of-the-road refresher. The program would be implemented during the construction phase of the Project. A similar program is being developed for other Ørsted-sponsored projects in New England, which has included strong input from New Jersey fisheries groups. To implement the program specifically focused on Ocean Wind 1, feedback is being sought from stakeholder groups, including the New Jersey Offshore Wind Environmental Resources Working Group, to reach a consensus on the issues of (1) fisheries eligibility, (2) program timing, and (3) program roll-out (including the potential for third-party administrative involvement).

3.16.5 Impacts of the Proposed Action on Navigation and Vessel Traffic

3.16.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.16.8, *Impacts of Alternative E on Navigation and Vessel Traffic*.

Impacts from the Proposed Action alone would include increased vessel traffic in and near the Wind Farm Area and on the approach to ports used by the Proposed Action, as well as obstructions to navigation caused by Proposed Action activities. COP Volume I, Section 6.1, Tables 6.1.2-1 to 6.1.2-5 (Ocean Wind 2023) summarize the anticipated Project-related vessel traffic during Proposed Action construction. Construction vessel trips could originate or terminate at Atlantic City, Paulsboro, Hope Creek, and Port Elizabeth, New Jersey; Norfolk, Virginia; and Charleston, South Carolina.

Anticipated changes in traffic from the Project were estimated to include:

1. Project-related vessel traffic related to construction, O&M, and decommissioning activities
2. Additional non-Project traffic that might be generated by the presence of the wind farm, for example, pleasure vessel trips for sight-seeing or recreational fishing
3. The modification of usual traffic routes for some ship types due to the presence of wind farm structures

Impacts on navigation and vessel traffic would also include changes to navigational patterns and the effectiveness of marine radar and other navigation tools. This could result in delays within or approaching ports, increased navigational complexity, detours to offshore travel or port approaches, or increased risk of incidents such as collision and allision, which could result in personal injury or loss of life from a marine casualty, damage to boats or turbines, and oil spills. Section 3.18 addresses the Proposed Action's impacts on recreation, while Section 3.9 addresses the Proposed Action's impacts on commercial fisheries and for-hire recreational fishing.

The NSRA marine risk analysis modeled the frequency of non-Project vessel accidents that could result from installation of the Proposed Action wind farm structures.[7] The model estimates frequencies for marine accidents accounting for Project- and location-specific environmental, traffic, and operational parameters. Baseline vessel traffic data used in the model are described in Section 3.16.1. Detailed information about the risk analysis is included in COP Volume III, Appendix M, NSRA (Ocean Wind 2023). The risk analysis calculated the frequency of accidents due to the following navigation hazards:

- Collision between two ships underway
- Powered grounding, where a ship grounds due to human error (steering and propulsion not impaired)
- Drift grounding, where a ship strikes the ground line due to mechanical failure (steering or propulsion failed)
- Powered allision, where a ship strikes a human-made structure (e.g., WTG) due to human error (steering and propulsion not impaired)
- Drift allision, where a ship strikes a human-made structure (e.g., WTG) due to mechanical failure (steering or propulsion failed)

Results of the NSRA risk modeling are described below under the IPF headings for *Presence of Structures* and *Traffic*.

Anchoring: The nearest established anchorage is Big Stone Beach Anchorage Ground, 38 nm (70 kilometers) from the Project. USCG has proposed the establishment of three new anchorage areas in the vicinity of the Cape Henlopen to Delaware Traffic Lane to provide additional usable grounds to support port demands and enhance navigational safety in the area (84 *Federal Register* 65727[8]). If established, proposed anchorage areas notionally referred to as Anchorage B – Breakwater Anchorage and Anchorage C – Cape Henlopen would be slightly closer to the Project area than Big Stone Beach Anchorage Ground. The Project is not anticipated to affect routine vessel anchorage operations within the existing anchorage areas or the additional proposed anchorage grounds (COP Volume III, Appendix M, NSRA, p. 96; Ocean Wind 2023). Smaller vessels anchoring in the Wind Farm Area may have issues with anchors failing to hold near foundations and any associated scour protection, or, alternately, where the anchors may become

[7] Project traffic is not explicitly included in the NSRA risk model; however, it appears to be more than offset in the AIS data by Project-related vessel traffic performing site surveys and other site characterization studies (COP, Volume III, Appendix M, NSRA, p. 72; Ocean Wind 2023).
[8] https://www.govinfo.gov/content/pkg/FR-2019-11-29/pdf/2019-25854.pdf.

snagged and potentially lost. During construction, installation, and decommissioning operations, smaller recreational and fishing vessels would most likely not transit the Wind Farm Area and therefore not anchor within the Project area. Consequently, any potential impacts from smaller vessels anchoring within the Wind Farm Area would primarily occur during the O&M phase. These impacts would be minor, localized, and temporary to short term.

Deviations from "normal" anchorage activities, such as vessels anchoring in an emergency scenario, pose a potential hazard to subsea cables. Depending upon the anchor weight, vessels with a tonnage greater than 10,000 deadweight tonnage would be the most likely to carry anchors that could penetrate to the Project cable burial depth if anchoring in an emergency scenario in the vicinity of the export cable corridor (Sharples 2011:96). However, anchor penetration is dependent upon factors other than ship size and anchor weight such as the type of soil on the seabed and whether the anchor is dragged after the initial drop (Sharples 2011:94–97). If BOEM approves the COP, Ocean Wind would be required to develop a CBRA (refer to COP Volume I, Section 6.1.1.5; Ocean Wind 2023) that will incorporate relevant information including seabed conditions and risks associated with fishing gear and vessel anchors to determine target burial depth.[9]

If sufficient burial depth cannot be achieved, armoring or other cable protection would be used to protect cables from external damage. Cable protection methods may include rock placement, concrete mattresses, frond mattresses, rock bags, and seabed spacers (COP Volume I, pp. 89–96; Ocean Wind 2023).[10] In the event an anchor does make contact with a buried export cable, impacts could include damage to the export cable and potential damage to the vessel anchor or anchor chain. Depending upon the extent of the damage to the export cable, the risks associated with an anchor contacting an electrified cable can pose issues to Project equipment (an overload and shut-down of converter or transformer stations) but is not anticipated to cause electrical shock to the ship involved because seawater is a good conductor of electricity (Sharples 2011:111). If the export cable is damaged to the point of requiring repair, there could be impacts associated with additional vessel activity to conduct damage assessment and repair. Secondary impacts would be repercussions on the vessel operator's liability and insurance. Combined with the low likelihood that any anchoring risk would occur in an emergency scenario, impacts on navigation and vessel traffic would be minor, localized, and temporary to short term.

Port utilization: The Proposed Action would generate vessel traffic at the Port of Atlantic City, New Jersey (the construction management base) during construction as well as potentially at Norfolk, Virginia; Paulsboro, Hope Creek, and Port Elizabeth, New Jersey; and Port Charleston, South Carolina. An onshore O&M facility in or near Atlantic City, New Jersey (COP, Volume I, p. 117; Ocean Wind 2023) would be used to support O&M activities. The construction phase of the Proposed Action would generate trips by jack-up vessels to provide a stable platform on site. In addition, support vessels such as crew transport vessels, hotel vessels, tugs, and miscellaneous vessels (such as for security) would be used. Vessels would transport components from Europe either directly to the Wind Farm Area or first to a U.S. port for staging before being transported to the Wind Farm Area. For example, monopiles and transition pieces are expected to be manufactured in Europe and transported across the Atlantic Ocean to a U.S. port where their assembly would be completed (COP, Volume I, p. 100; Ocean Wind 2023). The construction phase

[9] According to the historical (2017, 2018, and 2019) vessel traffic patterns presented in the New Jersey Port Access Route Study and tow track logs for the Project analysis (Table 3.16-1), tug traffic has generally followed a coastwise traffic path. This same coastwise pattern is expected to continue during Project operations (COP Volume III, NSRA, pp. E-13 and E-14; Ocean Wind 2023). Therefore, the most likely large commercial vessel to be transiting over proposed export cable corridors would be tugs or tugs with tows.

[10] According to survey participants drawn from the New York state maritime community, marine mattresses are not a desirable cable protection strategy in areas where vessel anchoring could potentially take place because the marine mattress creates an obstruction that vessel anchors could grab onto, potentially causing breaking the anchor cable/ line, damaging the vessel, or damaging the cable (New York Department of State 2020:23).

of the Proposed Action would generate 20 to 65 vessels operating in the Wind Farm Area or over the offshore export cable corridor route at any given time (COP Volume I, Section 6.1.2.6.5; Volume III, NSRA, Section 5; Ocean Wind 2023). In total, the Proposed Action would generate approximately 3,847 vessel trips during the construction and installation phase (COP Volume I, Section 6.1, Tables 6.1.2-1 through 6.1.2-5; Ocean Wind 2023). On average, the Proposed Action would generate approximately 10 vessel trips per day during regular operations. The presence of these vessels could cause delays for non-Proposed Action vessels and could cause some fishing or recreational vessel operators to change routes or use an alternative port. The Proposed Action's impacts on vessel traffic due to port utilization would be moderate, short term, and continuous through construction and installation. During O&M, impacts would be minor, long term, and intermittent. Impacts would increase to moderate for decommissioning, comparable to construction and installation impacts.

Presence of structures: The Proposed Action would include up to 98 WTGs and 3 OSS, operating for approximately 35 years, within the Wind Farm Area where no such structures currently exist. Presently there are no formal routing measures within the proposed Project area that would be altered by the presence of structures (NAV-02, which states that Project facilities will be placed to avoid unreasonable interference with major ports and USCG-designated TSS). Predominant vessel traffic patterns within the Lease Area for commercial fishing vessels (as shown with polar histograms in Section 3.9) and other vessel types, as discussed in Section 3.16.1 (and in greater detail in the NSRA), informed the Proposed Action structure orientation (southeast-northwest). Proposed Action structures would increase the risk of allision as well as collision with other vessels navigating through WTGs and could interfere with marine radars (although other navigational tools are available to ship captains). The increased risk of allisions and collisions would, in turn, increase the risk of spills (refer to Section 3.21, *Water Quality*, for a discussion of the likelihood of spills), vessel foundering, engagement of USCG SAR activities, injuries, and loss of life.

Nearly all vessels that travel through the Wind Farm Area where no structures currently exist would need to navigate with greater caution under the Proposed Action to avoid WTGs and OSS; however, there would be no restrictions on use or navigation in the Wind Farm Area. WTGs with lighting and marking (GEN-07, which cites lighting, marking, and signage requirements to aid navigation) could serve as additional aids to navigation. Many vessels that currently navigate that area would continue to be able to navigate through the Wind Farm Area between the WTGs and OSS. Vessels that exceed a height of 66 feet (20 meters) would be at risk of alliding with WTG blades at mean high water, and would need to navigate around the Wind Farm Area or navigate with caution through the Wind Farm Area to avoid the WTGs, although vessels of this size are unlikely to transit close enough to the WTGs to be affected by the blade sweep (COP Volume III, Appendix M, NSRA, p. 81; Ocean Wind 2023). Tug and tow vessels would also need to make relatively minor deviations farther west to avoid the turbine array (COP Volume III, Appendix M, NSRA, p. E-13; Ocean Wind 2023).

While some non-Project vessel traffic may navigate through the Wind Farm Area, many vessels would most likely choose not to pass through the area during construction (due to the presence of construction-related activities and the emergence of fixed structures), during the life of the Project (due to the presence of fixed structures), and during decommissioning. The NSRA modeled the frequency of marine accidents under the Proposed Action assuming there would be a rerouting of common vessel traffic routes around the Wind Farm Area for cargo, passenger, tankers, and tugs (see COP Volume III, Appendix M, NSRA, Figure E-7, p. E-14 [Ocean Wind 2023]), for an example of how one route was modified). Navigating around the Wind Farm Area would allow these vessels to avoid the navigational risks and delays of transiting through the WTGs and OSS in the Wind Farm Area.

The NSRA assumed that other vessel types, including fishing, pleasure and other vessels, would not reroute around the Wind Farm Area. The primary increase in marine accidents (derived by comparing future-case with base-case vessel traffic conditions) related to the presence of Proposed Action structures for all vessel types would be due to powered allision, resulting in an increase of 0.066 accident per year, and drift allision, resulting in an increase in 0.019 accident per year (COP Volume III, Appendix M, NSRA, Table 11-4, p. 132, and Table E-38, p. E-35; Ocean Wind 2023). The estimated increase in powered allision accident frequency is attributed to those vessel types that would not reroute around the Project (fishing, other, and pleasure). Pleasure ships would dominate the increase in total powered allision frequency. This is largely because the NSRA assumed there would be an increase in the number of recreational and pleasure vessels that would visit the Wind Farm Area under the Proposed Action, such as for sightseeing of the wind farm and recreational fishing, compared to baseline conditions without the Project. Tugs would experience a minor increase in drift allision frequency (COP Volume III, Appendix M, NSRA, Table E-38, p. E-35; Ocean Wind 2023).[11]

Smaller static and mobile gear fishing vessels, like all vessels, would not be prohibited from transiting or fishing within the array; however, vessel operators would need to take the WTGs and OSS into account as they set their courses through the Wind Farm Area and would need to take care when fishing near the WTGs and OSS to avoid snagging fishing equipment on underwater WTG components (COP Volume III, Appendix M, NSRA, Section 2.3.6.1.2; Ocean Wind 2023). Vessels that could continue to navigate within the Wind Farm Area would still need to navigate with more caution than is currently necessary to avoid WTGs and OSS, as well as other vessel traffic, especially during inclement weather. Increased navigational awareness while navigating through WTGs could lead to increased crew fatigue, which could also increase the risk of allision or collision and resultant injury or loss of life.

O&M of the Proposed Action would likely affect marine vessel radar performance near or within the Wind Farm Area. The National Academy of Sciences report titled *Wind Turbine Generator Impacts to Marine Vessel Radar* notes that WTG interference decreases the effectiveness of marine vessel radar mounted on all vessel classes (National Academies of Science 2022:5). Larger vessels may have more experienced bridge personnel; however, there is no requirement, domestic or international, for training to include specifics on WTGs and there is currently no standard system of active radar tailored to a WTG environment (National Academies of Science 2022:21–25, 66). Smaller vessels operating in the vicinity of the Project may experience the same challenges as larger vessels if equipped with marine vessel radar, such as clutter due to the WTGs or ambiguous detections, and may also be harder to identify as distinct targets or become lost contacts by larger vessels while in the proximity of WTGs (National Academies of Science 2022:38–48). The purchase of more sophisticated radar equipment and additional training (GEN-16, which states that equipment upgrades and training will be available for eligible commercial, charter, and for-hire fishing vessels operating in or near the Wind Farm Area) would mitigate this impact. While radar is one of several navigational tools available to vessel captains, including navigational charts, global positioning system, and navigation lights mounted on the WTGs (COP Volume III, Appendix M, NSRA, Section 11.3; Ocean Wind 2023), radar is the main tool used to help locate other nearby vessels that are not otherwise visible, particularly in adverse weather when visibility is limited. The navigational complexity of transiting through the Wind Farm Area, including the potential effects of WTGs and OSS on marine radars, would increase risk of collision with other vessels (including non-Project vessels and Proposed Action vessels).

Furthermore, the presence of the WTGs could complicate offshore SAR operations. USCG SAR activities could be hindered within the Wind Farm Area due to navigational complexity and safety concerns of operating among WTGs. Changing navigational patterns could also concentrate vessels within and around the outsides of the Project area, potentially causing space-use conflicts in these locations or reducing the efficiency of SAR operations, resulting in moderate, adverse impacts on SAR operations. USCG may

[11] The NSRA also modeled a future case (case 3) that was like case 2, but 50 percent of the coastal tugs were modeled as tugs-with-tows. The comparative results were mostly similar to Table E-38 but drift allision results were higher by a factor of 2.2 due to the tug-with-tow analysis (COP Volume III, NSRA, Table E-39, p. E-36; Ocean Wind 2023).

need to adjust its SAR planning and search patterns to accommodate the WTG layout, leading to a less optimized search pattern and a lower probability of success. This could lead to increased loss of life due to maritime incidents (see Section 3.17.5).

When adjacent offshore wind projects share borders, USCG recommends a common WTG spacing and layout across the projects to provide a consistent straight-line orientation through the adjoining areas. A common WTG spacing and layout facilitates predictable navigation patterns, navigational safety, consistent and continuous marking and lighting, SAR, and other uses such as commercial fishing. In the absence of a common spacing and orientation between adjacent wind projects, USCG recommends setbacks from the shared border to create a separation between projects. A change in orientation or spacing without this separation will increase risk for surface and aerial navigation through the wind farms and could make it more difficult for SAR aircraft to perform operations in the geographic analysis area, leading to a less optimized search pattern and a lower probability of success. The space between projects should be greater than the WTG spacing within either wind farm to provide a clear visual reference to easily distinguish separate projects (USCG 2021b).

Unique structure orientation patterns are planned within Atlantic Shores South and the Proposed Action to accommodate different traffic patterns in each lease area and, although BOEM lease agreements for Atlantic Shores South and Ocean Wind 1 do not require setbacks from adjoining borders, the Proposed Action WTG layout does include an agreed-upon separation of a minimum distance of 1,500 meters (0.8 nm) from any WTGs within the adjacent Atlantic Shores South Lease Area. With Ocean Wind 1's adoption of an agreed-upon separation with Atlantic Shores South, impacts on navigation and vessel traffic under the Proposed Action would be reduced from major to moderate.

APM GEN-07 (and NAV-01, continued engagement with FAA and the Department of Defense [DOD] with regard to potential effects on aviation) will implement ADLS on WTGs to mitigate this risk. Nevertheless, this added complexity to SAR operations could lead to increased possibility for loss of life due to maritime incidents. The proposed setback area defining a minimum spacing distance between the Ocean Wind 1 and Atlantic Shores South WTGs will facilitate navigation safety and improve the likelihood of effective SAR operations.

Cable emplacement and maintenance: The Proposed Action would require the installation of offshore export cables and inter-array and substation interconnector cables. The presence of slow-moving (or stationary) installation or maintenance vessels would increase the risk of collisions and spills. Offshore export cable installation activities include site preparation such as sand wave and boulder clearance. In areas where sand waves are present, multiple passes may be required. Vessels engaged in cable emplacement are, by definition, restricted in their ability to maneuver and other power-driven vessels must give way.[12] Cable-laying vessels would display lights at nighttime or day shapes during the daytime to communicate to other vessels that they are restricted in their ability to maneuver. USCG's local notice to mariners may also include information affecting local waterways such as cable emplacement activity. Vessels not involved in cable emplacement or maintenance would need to take additional care when crossing cable routes or avoid installation or maintenance areas entirely during installation and maintenance activities. The presence of installation or maintenance vessels would have minor to moderate, localized, short-term, intermittent impacts on navigation and vessel traffic.

Traffic: Construction of the Proposed Action would generate between 20 and 65 vessels operating in the Wind Farm Area or over the offshore export cable route at any given time (COP Volume I, Section 6.1; Ocean Wind 2023). Various vessel types (scour protection, installation, cable-laying, support, transport/feeder, and crew vessels) would be deployed throughout the Offshore Project area during the construction and installation phase (COP Volume I, Section 6.1, Tables 6.1.2-1 through 6.1-2-5; Ocean

[12] International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS), rules 3, 18, and 27.

Wind 2023). The presence of these vessels would increase the risk of allisions, collisions, and spills (refer to Section 3.21, *Water Quality*, for a discussion of the likelihood of spills). During offshore export cable route construction, non-Project vessels required to travel a more restricted (narrow) lane could potentially experience greater delays waiting for cable-laying vessels to pass. Proposed Action vessel traffic in ports could result in vessel traffic congestion, limited maneuvering space in navigation channels, and delays in ports and could also increase the risk of collision, allision, and resultant spills in or near ports. Non-Project vessels transiting between the Proposed Action ports and the Wind Farm Area would be able to avoid Proposed Action vessels, components, and any safety zones (where USCG is authorized and elects to establish such zones)[13] through routine adjustments to navigation. The Proposed Action's construction and installation vessel traffic would have moderate, localized, short-term impacts on overall navigation and vessel traffic in open waters and near ports (including but not limited to the Port of Atlantic City, New Jersey).

Operation of the Proposed Action would generate approximately 10 trips per day from ports used for O&M and the Wind Farm Area. Annually, the Proposed Action would generate a maximum of 3,392 total vessel trips consisting of service operation vessels, jack-up, crew, and supply vessel trips, with a majority of the trips consisting of service operation vessels or crew transfer vessels (COP Volume I, Table 6.1.2-11; Ocean Wind 2023). Vessel traffic generated by Proposed Action could restrict maneuvering room and cause delays accessing the port. Although vessel traffic within the Lease Area is expected to decrease once the WTGs and OSS are in place, O&M of the Proposed Action would result in the same types of vessel traffic and navigation impacts as those described during construction (COP, Volume II, Section 2.3.6.2.1, p. 348; Ocean Wind 2023). Operation of the Proposed Action would have minor, long-term, intermittent, and localized impacts on overall navigation and vessel traffic near ports and in open waters.

The NSRA risk modeling suggests that under the Proposed Action, accident frequency would increase by 0.403 accident per year (Table 3.16-3). The greatest increase in accident frequency would be as a result of groundings (a modeled increase of 0.148 powered grounding and 0.144 drift grounding per year) followed by powered allisions (an increase of 0.066 accident per year).[14] The increased risk of vessel grounding is to the northwest of the Project area and not within the Project area whereas the increase in frequency of powered allisions, the striking of a stationary object such as a WTG by a vessel transiting at cruising speed within the WTG array, is identified exclusively within the Project area. Collision frequencies are also anticipated to increase (increase of 0.027 accident per year), which would be largely a result of the 23-percent increase in ship-miles due to vessels transiting around the Project Wind Farm Area and the adjacent Atlantic Shores Wind Farm Lease Areas (OCS-A-0499 and OCS-A-0549). Although the risk of drift allisions may increase slightly (increase of 0.019 accident per year within the Project area) with the Proposed Action, drift allisions are typically of low consequence (COP Volume III, Appendix M, NSRA, p. 89 and Table 11-3, p. 129; Ocean Wind 2023).

Table 3.16-3 NSRA Modeled Change in Accident Frequencies from the Proposed Action

Accident Type	Increase in Frequency (number per year)	Percentage of Total (%)
Powered Grounding	0.148	36.8
Drift Grounding	0.144	35.6
Powered Allision	0.066	16.3
Drift Allision	0.019	4.6

[13] Under the current captain of the Port authority, USCG does not regulate the safety and security risks associated with the construction and operation of Offshore Renewable Energy Installations beyond 12 nm (USCG 2021c).
[14] An assessment within the NSRA focusing on a powered allision accident concludes that it is unlikely that smaller vessels transiting or operating within the Project area would damage a structure to the extent that it may collapse (COP Volume III, Appendix M, NSRA, Section 3.5; Ocean Wind 2023).

Accident Type	Increase in Frequency (number per year)	Percentage of Total (%)
Collision	0.027	6.7
Total	**0.403**	**100**

Source: COP Volume III, Appendix M, NSRA, Table 11-3, p. 129; Ocean Wind 2023

Chapter 2 describes the non-routine activities associated with Proposed Action. Examples of such activities or events that could affect navigation and vessel traffic include non-routine corrective maintenance activities, collisions or allisions between vessels or vessels and WTGs or OSS, cable displacement or damage by anchors or fishing gear, chemical spills or releases, and severe weather and other natural events. These activities, if they were to occur, would generally require intense, temporary activity to address emergency conditions. The occasional increased vessel activity in offshore locations near the offshore export cable route or within the Wind Farm Area working on individual WTGs or OSS could temporarily prevent or deter navigation and vessel traffic near the site of a given non-routine event. In addition, severe weather could temporarily prevent or deter vessel operators from approaching or crossing the Wind Farm Area. Impacts on navigation and vessel traffic would be temporary, lasting only as long as severe storms or repair or remediation activities necessary to address these non-routine events.

3.16.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned activities.

Anchoring: The Proposed Action would contribute an undetectable increment to the cumulative anchoring impacts, which would be short term and minor due to the small size of the offshore wind lease areas in the geographic analysis area compared to the remaining area of open ocean, as well as the low likelihood that any anchoring risk would occur in an emergency scenario. In addition, the establishment of the anchorage areas described above would limit the potential impacts on routine anchorage operations across the geographic analysis area.

Port utilization: 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. Within the geographic analysis area, the Proposed Action is anticipated to overlap in construction with the Atlantic Shores South project for 1 year in 2025. The increase in port utilization due to other offshore wind project vessel activity would be limited during construction and installation of the Proposed Action. The total increase in vessel traffic would likely be distributed across multiple ports in the region; however, there could be delays for vessels using those ports if two or more projects are under construction at the same time. Accordingly, the Proposed Action would contribute a noticeable increment to the cumulative port utilization impacts on navigation and vessel traffic, which would be continuous and moderate.

Presence of structures: The Proposed Action would contribute an appreciable increment to the cumulative impacts from the presence of structures. Structures from other offshore wind activities would generate comparable types of impacts as under the Proposed Action across the entire geographic analysis area. A total of 566 WTGs and 18 OSS would be constructed under the Proposed Action and the other offshore wind projects in the geographic analysis area. The presence of structures from all offshore wind projects in the geographic analysis area would further increase the navigational complexity in the region, resulting in an increased risk of collisions and allisions, which would result in impacts, potentially including personal injury or loss of life from a marine casualty, damage to boats or turbines, and oil spills. The presence of neighboring offshore wind projects could also affect demand for and resources associated with USCG SAR operations by changing vessel traffic patterns and densities.

Cable emplacement and maintenance: The Proposed Action would contribute a noticeable increment to the cumulative impacts from cable emplacement and maintenance, which would be localized, intermittent, and minor to moderate. Cable installation and maintenance for other offshore wind activities would generate comparable types of impacts to those of the Proposed Action for each offshore export cable route and inter-array and interconnector cable system. As shown in Table F2-1 in Appendix F, offshore export cable and inter-array/interconnector cables for up to three other offshore wind projects could be under construction simultaneously while the Proposed Action is in operation. Simultaneous construction of inter-array and interconnector cables for adjacent projects could have a combined effect, although it is assumed that installation vessels would only be present above a portion of a project's inter-array/interconnector system at any given time. Substantial areas of open ocean are likely to separate simultaneous offshore export cable and inter-array/interconnector installation activities for other offshore wind projects.

Traffic: The three other offshore wind projects in the geographic analysis area would generate amounts of vessel traffic comparable to that of the Proposed Action. One of the three projects, Atlantic Shores South, is anticipated to overlap construction with the Proposed Action for 1 year in 2025. During that year, the two projects may generate up to 116 vessel trips at any given time within the geographic analysis area. The three other wind projects would be under construction between 2025 and 2030, and construction on all three would occur simultaneously in 2026 to 2027. Following construction, all four offshore wind projects would be operating simultaneously and could generate up to 41 vessel trips to support O&M activities at any given time. Because the ports to be used by other offshore wind projects have not been determined, the overlap of vessel activity at any single port cannot be predicted. Traffic from these projects would likely be spread among multiple ports within and outside the geographic analysis area for navigation and vessel traffic, thus potentially moderating the effect of offshore wind-related vessel traffic at any single location. The Proposed Action would contribute a noticeable increment to cumulative vessel traffic impacts during peak construction and installation activity, which would be moderate, localized, short term, and intermittent.

3.16.5.3. Conclusions

Impacts of the Proposed Action. In summary, construction and installation, O&M, and conceptual decommissioning of the Proposed Action would have adverse impacts on navigation and vessel traffic. The impacts of the Proposed Action on navigation and vessel traffic would be **moderate**. Impacts on non-Project vessels would include changes in navigation routes, delays in ports, degraded communication and radar signals, and increased difficulty of offshore SAR or surveillance missions within the Wind Farm Area, all of which would increase navigational safety risks. Some commercial fishing, recreational, and other vessels would choose to avoid the Wind Farm Area altogether, leading to some potential congestion of vessel traffic along the Wind Farm Area borders. In addition, the increase in potential for marine accidents, which may result in injury, loss of life, and property damage, could produce disruptions for ocean users in the geographic analysis area. While non-routine events such as collisions and allisions (and resulting spills or personal injury) have the potential to occur during Project construction, O&M, and decommissioning, BOEM anticipates that these events would be unlikely to occur given requirements for lighting and marking, vessel speed restrictions, and inclusion of Project components on navigation charts as outlined in Section 2.2.

Cumulative Impacts of the Proposed Action. The incremental impacts contributed by the Proposed Action to the cumulative impacts on navigation and vessel traffic would be appreciable. The main IPF from which impacts are contributed is the presence of structures, which increase the risk of collision/allision and navigational complexity, particularly when adjoining offshore wind projects do not share a common WTG layout or spacing and do not include a separation between adjoining lease areas. Considering all the IPFs together, BOEM anticipates that the cumulative impacts associated with the

Proposed Action would be **moderate**, due primarily to the increased navigational complexity, which could produce disruptions for ocean users in the geographic analysis area.

3.16.6 Impacts of Alternatives B and D on Navigation and Vessel Traffic

Impacts of Alternatives B and D. The impacts on navigation and vessel traffic from Alternatives B-1, B-2, and D would be similar but slightly less than the impacts from the Proposed Action. These action alternatives would also not address USCG's recommendation to include a common WTG spacing and layout across adjoining projects or include a separation between adjoining projects to facilitate safe navigation (USCG 2021b). Alternatives B-1 and B-2 would exclude up to 9 WTG positions or up to 19 WTG positions, respectively, in the rows nearest to coastal communities. The WTG locations in Alternatives B-1 or B-2 would incrementally decrease impacts on vessel traffic compared to the Proposed Action by providing additional space closer to coastal areas more frequently used by recreational vessels. It would also produce a greater buffer between the Wind Farm Area and the USCG-proposed fairways for towing vessel traffic discussed in Section 3.16.3.2 and, in the case of Alternative B-2, a slight reduction in the shared border with the Atlantic Shores South lease area. These changes notwithstanding, the overall impacts of Alternatives B-1 or B-2 on navigation and vessel traffic would be substantially similar, but not identical, to those of the Proposed Action.

Alternative D would exclude up to 15 WTG positions in the northeast corner of the proposed Wind Farm Area. As discussed in Section 3.16.1, deep-draft vessel traffic generally maintains a course well to the east of the Lease Area, although a small fraction passes through the Project area. Alternative D would provide additional area between the easternmost portion of the WTG array and the usual deep-draft vessel transit routes. Also, the exclusion of the three WTG positions (A07, A08, and A09) closest to the Atlantic Shores South Lease Area would result in a reduced shared border between the two wind farm areas. Both of these outcomes of Alternative D would incrementally decrease impacts on navigation and vessel traffic safety, compared to the Proposed Action, but would not change the overall impact magnitudes described for the Proposed Action.

Cumulative Impacts of Alternatives B and D. Incremental impacts contributed by Alternatives B-1, B-2, and D to cumulative impacts would be similar to those of the Proposed Action.

3.16.6.1. Conclusions

Impacts of Alternatives B and D. Construction of Alternatives B-1, B-2, and D alone would have the same **moderate** impact on navigation and vessel traffic as described under the Proposed Action. While Alternatives B-1, B-2, and D may slightly reduce impacts due to the reduction in WTG positions, the magnitude of impacts would not be materially different from that of the Proposed Action.

Cumulative Impacts of Alternatives B and D. The incremental impacts contributed by Alternatives B-1, B-2, and D to the cumulative impacts on navigation and vessel traffic would be appreciable. Considering all the IPFs together, BOEM anticipates that the cumulative impacts associated with Alternatives B-1, B-2, and D would be similar to those of the Proposed Action: **moderate**.

3.16.7 Impacts of Alternative C on Navigation and Vessel Traffic

Impacts of Alternative C. Alternative C was developed in response to public scoping comments to address concerns regarding the different layouts between the Ocean Wind 1 and Atlantic Shores South projects and the need for a buffer for each of the two projects in the adjacent lease areas (refer to Section 2.1.3). USCG recommends that, when multiple lease areas share borders, there is a common WTG spacing and layout throughout all adjoining wind projects; additionally, in the absence of the common spacing and orientation between adjacent wind projects, a setback from the shared border is recommended (USCG 2021b). Alternatives C-1 and C-2 encompass wind turbine layout modifications that would result in an 0.81- to 1.08-nm buffer between WTGs in the Ocean Wind 1 Lease Area (OCS-A 0498) and WTGs in the Atlantic Shores South Lease Area (OCS-A 0499) (BOEM 2022). Alternative C-1 would accomplish the buffer with the removal of eight WTG positions from Row A of the WTG layout and Alternative C-2 would retain all 98 WTG positions but compress the WTG layout from 1 nm between rows to no less than 0.99 nm between rows to achieve up to an 0.81- to 1.08-nm buffer between WTGs in the Lease Area and WTGs in the Atlantic Shores South Lease Area.

The proposed buffer (0.81 to 1.08 nm) would be an improvement to vessel navigation and SAR considerations over no separation between lease areas, particularly as there is a lack of common WTG spacing and layout throughout. The separation would provide a clear visual reference for each project to mariners within the area and to USCG aviators on SAR missions that the operators will need to adjust their course, as well as provide the sea and air space to conduct that course adjustment. Under both Alternatives C-1 and C-2, an 0.81- to 1.08-nm separation width between bordering WTGs (taking into account the Atlantic Shores South buffer distance) would allow for the transit of larger fishing vessels or survey vessels between the Ocean Wind 1 and Atlantic Shores South WTG arrays when vessel captains do not want to transit directly through the WTG array due to maneuverability concerns or operate within the array due to fishing equipment integrity concerns.

The compression of the WTG layout (Alternative C-2) could have an impact on the sea room for a vessel actively fishing within the WTG array depending upon the type of gear used and the turning circle of the vessel. Using a generic evaluation of turning radius, the NSRA established that the Project layout with a minimum of 0.8 nm between offshore structures "is estimated to provide sufficient sea room for safe navigation of vessels engaged in fishing within the Wind Farm Area; however, depending upon the exact gear length and the type that is utilized, the distances between the structures may limit safe fishing patterns" within the Wind Farm Area (COP Volume III, Appendix M, NSRA, p. 80; Ocean Wind 2023). USCG has preliminarily reviewed the reduced spacing between WTG rows (from 1 nm to no less than 0.99 nm between rows) under Alternative C-2 and has informed BOEM this spacing for WTGs would still be within the 0.80- to 1.1-nm preferred range for the safe navigation of vessels less than 200 feet in length (West pers. comm. 2022).

Overall, Alternatives C-1 and C-2 would have slightly reduced impacts on navigation and vessel traffic compared to the Proposed Action.

Cumulative Impacts of Alternative C. The incremental impacts contributed by Alternative C on navigation and vessel traffic to the combined impacts from ongoing and planned activities including offshore wind would be less than those described under the Proposed Action.

3.16.7.1. Conclusions

Impacts of Alternative C. With Ocean Wind 1's adoption of an agreed-upon separation with Atlantic Shores South, impacts on navigation and vessel traffic under Alternatives C-1 and C-2 would be the same as those of the Proposed Action: **moderate**. The proposed distance between WTGs of each project (from 0.81 to 1.08 nm) would improve vessel navigation and SAR by providing additional space for transiting between the two adjacent wind projects, as well as the visual reference and sea space to adjust course when moving from one project to another. While Alternative C-2 would compress the WTG layout, the spacing between structures would be within USCG's preferred range for safe navigation of vessels less than 200 feet in length, and would not have a substantive change in impacts on navigation and vessel traffic. As with the Proposed Action, impacts from Alternatives C-1 and C-2 would either be measurable but would not disrupt navigation and vessel traffic, or would be notable but vessels would be able to adjust to account for disruptions. With consideration of Alternatives C-1 and C-2 alone, the magnitude of impacts would not be materially different than that of the Proposed Action.

Cumulative Impacts of Alternative C. The incremental impacts contributed by Alternatives C-1 and C-2 to the cumulative impacts on navigation and vessel traffic would be appreciable. The incremental impacts would be reduced compared to the Proposed Action due to WTG layout modifications to address navigational safety concerns as recommended by USCG. Considering all the IPFs together, BOEM anticipates that the cumulative impact of Alternative C-1 or C-2 in combination with other ongoing and planned activities including offshore wind would be **moderate**, primarily due to the presence of structures, which increases the likelihood of allisions and complicates SAR activities.

3.16.8 Impacts of Alternative E on Navigation and Vessel Traffic

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. Under Alternative E, the Oyster Creek export cable route would be modified to avoid impacts on SAV. Because the Proposed Action’s PDE also includes the route proposed under Alternative E, there would be no meaningful differences in impacts. The rerouting of the Oyster Creek export cable for Alternative E would relocate a 4-mile section of the buried cable in Barnegat Bay north of the route under the Proposed Action, but this would not result in a discernable difference in impacts on any smaller vessel emergency anchoring activities Barnegat Bay.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to cumulative impacts would be similar to those described under the Proposed Action.

3.16.8.1. Conclusions

Impacts of Alternative E. Construction of Alternative E alone would likely have the same **moderate** impact on navigation and vessel traffic as under the Proposed Action. The rerouting of the Oyster Creek export cable in Barnegat Bay would not result in a discernable difference in impacts on navigation and vessel traffic.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts on navigation and vessel traffic would be the same as under the Proposed Action—appreciable. BOEM anticipates that the cumulative impact associated with Alternative E would be **moderate**, due primarily to the increased possibility for marine accidents, which could produce significant disruptions for ocean users in the geographic analysis area.

3.16.9 Potential Mitigation Measures

Several measures are proposed to minimize impacts on navigation and vessel traffic (Appendix H, Table H-2). If the measures analyzed below are adopted by BOEM or cooperating agencies, some adverse impacts could be further reduced.

Table 3.16-4 Additional Proposed Measures Identified in Appendix H, Table H-3: Navigation and Vessel Traffic

<table>
<tr><th>Measure</th><th>Description</th><th>Effect</th></tr>
<tr><td>Navigation safety plan</td><td>BOEM would ensure that Ocean Wind coordinates with USCG in advance of export cable installation to develop a navigation safety plan, which may include establishing a safety zone around the cable-laying vessel(s), a monitoring plan, a mitigation plan, a schedule, PATONs, and a local notice to mariners.</td><td rowspan="2">The presence of a navigation safety plan would ensure that USCG has advance notice of Project vessel activities. Although the measures within a navigation safety plan, if implemented, would potentially reduce the risk of vessel collisions and resultant oil spills, vessel traffic would still have to adjust by giving a wide berth for slow-moving or stationary Project vessels conducting cable emplacement. Therefore, impacts would remain minor to moderate for the Proposed Action and other action alternatives.</td></tr>
<tr><td>Safety zones</td><td>Establishing safety zones should not be used as the key mitigating factor when considering risks and impacts. Commander, USCG Fifth District, may consider safety zones in the lease area, but safety zones will not be granted for the sole purpose of keeping project construction on track.</td></tr>
<tr><td>Cable maintenance and monitoring plan</td><td>BOEM would ensure that Ocean Wind develops a cable maintenance and monitoring plan that outlines a process for identifying when cable burial depths reach unacceptable risks, requires prompt remediation of exposed and shallow-buried cable segments, and includes review to address repeat exposures. The cable maintenance and monitoring plan would also describe methods for providing an accessible graphic/geo-referenced repository of locations where target burial depths were not achieved and/or cable protection was installed, and mariner notification for monitoring and remedial burial activities.</td><td>The presence of a cable maintenance and monitoring plan would ensure that a methodology is outlined for monitoring cables and identifying appropriate remediation, and that timeframes for monitoring and remediation are determined so that risks to transiting vessels are minimized to the extent possible. BOEM's requirement for the development of a cable maintenance and monitoring plan would help ensure that Ocean Wind adheres to commitments; however, impacts would remain minor to moderate for the Proposed Action and other action alternatives.</td></tr>
</table>

3.16.9.1. Measures Incorporated in the Preferred Alternative

BOEM has identified the additional measures in Table 3.16-4 as incorporated in the preferred alternative: navigation safety plan, safety zones, and cable maintenance and monitoring plan. These measures, if adopted, would reduce the potential for conflicts with other transiting vessels during export cable installation by establishing a navigation safety plan and cable maintenance and monitoring plan. However, overall impacts on navigation and vessel traffic would remain minor to moderate.

3.17. Other Uses (Marine Minerals, Military Use, Aviation)

This section discusses potential impacts on other uses not addressed in other portions of the EIS, including marine minerals, military use, aviation, cables and pipelines, radar systems, and scientific research and surveys, that would result from the proposed Project, alternatives, and ongoing and planned activities in the geographic analysis area. The geographic analysis areas for these topics are described below and shown on Figure 3.17-1.

- Aviation and air traffic, military and national security, and radar systems: Areas within 10 miles (16.1 kilometers) of the export cable route corridor and Wind Farm Area and the Ocean Wind 1 and Atlantic Shores South Lease Areas as well as Atlantic City International Airport, Ocean City Municipal Airport, Woodbine Municipal Airport, Cape May County Airport, and Warren Grove Range Airport (Figure 3.17-1)
- Cables and pipelines: Areas within 1 mile (1.6 kilometers) of the export cable route corridor and Wind Farm Area that could affect future siting or operation of cables and pipelines (Figure 3.17-1)
- Scientific research and surveys: Same analysis area as finfish, invertebrates, and EFH (Figure 3.13-1)
- Marine minerals: Areas within 0.25 mile (0.4 kilometer) of the export cable route corridor and Wind Farm Area that could affect marine minerals extraction (Figure 3.17-1)

These areas encompass locations where BOEM anticipates direct and indirect impacts associated with Project construction, O&M, and conceptual decommissioning.

3.17.1 Description of the Affected Environment for Other Uses (Marine Minerals, Military Use, Aviation)

Marine Mineral Extraction

BOEM's Marine Mineral Program manages non-energy minerals (primarily sand and gravel) on the OCS and leases access to these resources to target shoreline erosion, beach renourishment, and restoration projects. At this time, there are no active or requested BOEM leases in the geographic analysis area. The closest previous lease in BOEM's Marine Minerals Program is known as the D2 borrow area, offshore New Jersey near Harvey Cedars, Surf City, Long Beach Township, Ship Bottom, and Beach Haven (Lease Number OCS-A-0505; executed 7/1/2014), which was approved through September 30, 2018, for the use of up to 10,000,000 cubic yards of material. Periodic nourishment for this project has been authorized in a 7-year cycle, with an estimated final nourishment year of 2055 (Cresitello 2020).

Due to the depletion of sand sources in state waters, it is highly likely that OCS material will be sought for future nourishment cycles on Long Beach Island, for projects to the south on Absecon Island, along beaches stretching from Great Egg Harbor Inlet to Townsends Inlet, and to the north along beaches stretching from Barnet Inlet to Sandy Hook (Cresitello 2020).

Several sand and gravel borrow areas and ocean disposal sites designated by USACE in partnership with NJDEP are mapped in the vicinity of the Wind Farm Area and offshore export cable corridors. However, none of these sites is within the geographic analysis area.

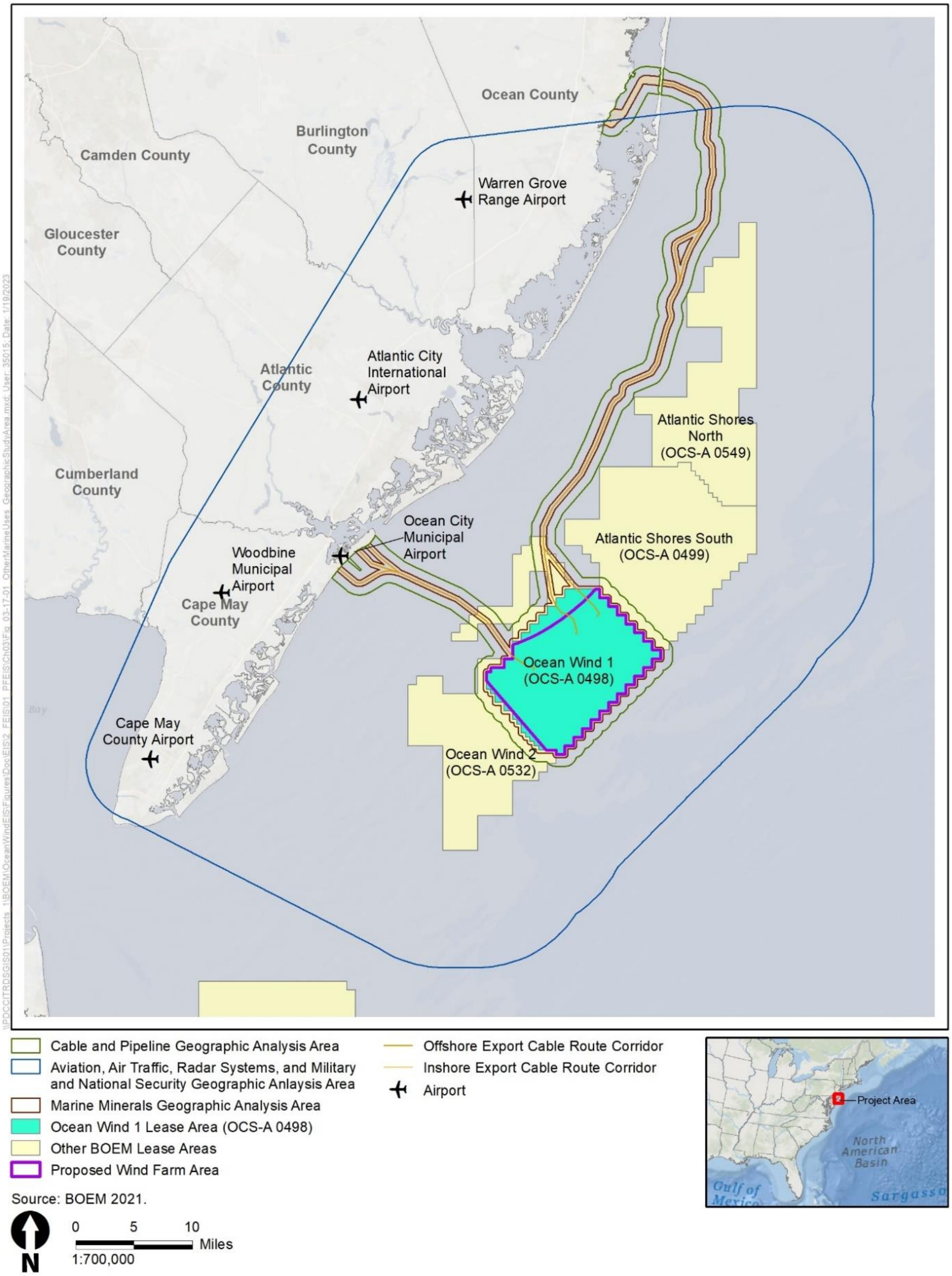


Figure 3.17-1 Other Uses Geographic Analysis Area

National Security and Military Uses

DOD operates in the airspace over and adjacent to the Wind Farm Area. Portions of the Wind Farm Area are within or in the vicinity of the Atlantic City Range Complex and the Atlantic City at-sea operating area (OPAREA), which extends from the shoreline seaward and is approximately 100 nm from land at its farthest point (Ocean Wind 2023). The range complex and Atlantic City OPAREA are primarily used by the U.S. Atlantic Fleet and the U.S. Air Force for test and training exercises. Warning Area W-107 is the block of special-use airspace over the Atlantic City OPAREA. It is designated for aircraft activity that may be hazardous for nonparticipating aircraft and is typically used for surface and surface-to-air exercises (Ocean Wind 2023). Additionally, the U.S. Marine Corps uses a military flight route (VR-1709) that crosses the western portion of the Wind Farm Area.

Major onshore regional military facilities include Naval Weapons Station Earle, Joint Base McGuire-Dix-Lakehurst, and the Manasquan Inlet USCG station (Ocean Wind 2023). Naval Weapons Station Earle in Colts Neck, New Jersey provides all the ordnance for the Atlantic Fleet Carrier and Expeditionary Strike Groups and supports strategic ordnance requirements. Joint Base McGuire-Dix-Lakehurst is a military installation approximately 18 miles south of Trenton, New Jersey. The Manasquan Inlet USCG station is approximately 60 miles north of Oyster Creek in Point Pleasant. Military activities at the Manasquan Inlet Station could include various vessel training exercises, submarine and antisubmarine training, and U.S. Air Force exercises. Even though this installation is north of the Lease Area, vessel training exercises may be conducted closer to the Project (Ocean Wind 2023). DOD also operates the North American Aerospace Defense Command national defense radar in the Project vicinity.

Military activities are anticipated to continue to use onshore and offshore areas in the vicinity of the Project area into the future and may involve routine and non-routine activities.

Aviation and Air Traffic

Multiple public and private-use airports serve the region surrounding the Project area including Atlantic City International Airport, Ocean City Municipal Airport, Woodbine Municipal Airport, Cape May County Airport, and Warren Grove Range Airport. Atlantic City International Airport is also the base for the New Jersey Air National Guard's 177th Fighter Wind and the USCG Air Station Atlantic City (Ocean Wind 2023).

Air traffic is expected to continue at current levels in and around the Wind Farm Area.

Cable and Pipelines

The onshore export cable corridors for BL England and Oyster Creek are within developed areas of New Jersey that overlap multiple utilities including electric and gas distribution and transmission lines, communications cables, and water and sewer pipelines. Additionally, there are a number of sewer and stormwater pipelines and intake structures along the coast of New Jersey that begin onshore and extend offshore in the vicinity of the Project area.

Offshore, there are no pipelines within the Wind Farm Area; however, there is a submarine pipeline present within the BL England offshore export cable corridor. There are at least four in-service submarine telecommunications cables and six out-of-service cables in the vicinity of the Wind Farm Area that would cross the Oyster Creek export cable corridor. There are no sewer or stormwater outfalls in navigable waters near Oyster Creek or BL England (Ocean Wind 2023).

BOEM has not identified any publicly noticed plans for additional submarine cables or pipelines in the geographic analysis area.

Radar Systems

Commercial air traffic control, national defense, and weather radar systems currently operate in the region. Four DOD national defense and FAA air traffic control radar sites are in the vicinity of the Project area:

- Atlantic City Airport Surveillance Radar-9 (ASR-9) and co-located Air Traffic Control Beacon Interrogator-5
- Dover Air Force Base (AFB) Digital Airport Surveillance Radar (DASR) and co-located Monopulse Surveillance Secondary Surveillance Radar
- Gibbsboro Air Route Surveillance Radar-4 (ARSR-4) and co-located Air Traffic Control Beacon Interrogator-6
- McGuire AFB DASR and co-located Monopulse Surveillance Secondary Surveillance Radar

One DOD and one National Weather Service weather radar sites are in the vicinity of the Project area:

- Weather Surveillance Radar-1988 Doppler (WSR-88D)
- National Weather Service Philadelphia WSR-88D

In addition to onshore facilities, several high-frequency radar stations are along the New Jersey Continental Shelf as part of regional and local high-frequency radar networks to make coastal observations (Ocean Wind 2023). The high-frequency radars are used by the NOAA Integrated Ocean Observing System as part of its Surface Currents Program. Surface current data collected are used by USCG's Search and Rescue Optimal Planning System, a decision-support tool that uses ocean observations to narrow search areas. These offshore high-frequency radar stations provide coverage from Cape Cod to Cape Hatteras:

- Seaside Park SeaSonde Oceanographic High-Frequency Radar
- Brant Beach SeaSonde Oceanographic High-Frequency Radar
- Holgate SeaSonde Oceanographic High-Frequency Radar
- Strathmere SeaSonde Oceanographic High-Frequency Radar
- North Wildwood SeaSonde Oceanographic High-Frequency Radar
- Hempstead SeaSonde Oceanographic High-Frequency Radar
- Loveladies SeaSonde Oceanographic High-Frequency Radar
- Brigantine SeaSonde Oceanographic High-Frequency Radar
- Wildwood SeaSonde Oceanographic High-Frequency Radar

Existing radar systems will continue to provide weather, navigational, and national security support to the region. The number of radars and their coverage area are anticipated to remain at current levels for the foreseeable future.

Scientific Research and Surveys

Research in the geographic analysis area includes oceanographic, biological, geophysical, and archaeological surveys focused on the OCS and nearshore environments, and resources that may be affected by offshore wind development. Federal and state agencies, educational institutions, and environmental non-governmental organizations participate in ongoing offshore research in the Wind Farm Area and surrounding waters.

Current fisheries management and ecosystem monitoring surveys conducted by or in coordination with the NMFS NEFSC would overlap with offshore wind lease areas in the Mid-Atlantic and Southern New England region. Surveys include (1) the NEFSC Bottom Trawl Survey, a more than 50-year multispecies stock assessment tool using a bottom trawl; (2) the NEFSC Sea Scallop/Integrated Habitat Survey, a sea scallop stock assessment and habitat characterization tool, using a bottom dredge and camera tow; (3) the NEFSC Surfclam/Ocean Quahog Survey, a stock assessment tool for both species using a bottom dredge; (4) the NEFSC Ecosystem Monitoring Program, a more than 40-year shelf ecosystem monitoring program using plankton tows and conductivity, temperature, and depth units; (5) AMAPPS shipboard and aerial surveys; (6) NARW aerial surveys; and (7) the large coastal shark long-line survey. These surveys support management of more than 40 fisheries in the region, more than 30 marine mammal species, and 14 threatened and endangered species (Hare et al. 2022). Additionally, these surveys support numerous other science products produced by NOAA Fisheries, including ecosystem and climate assessments. Additionally, NJDEP has conducted the New Jersey Ocean Trawl Program annually for over 30 years to document the occurrence, distribution, and relative abundance of marine recreational and non-recreational fish species in New Jersey coastal waters. Similarly, the NJDEP surfclam surveys were performed annually from 1988–2019 to document the occurrence, distribution, and abundance of surfclams in New Jersey coastal waters. Nearshore survey activities associated with the NEAMAP overlap with the western edge of the Project area. As offshore wind development continues, alternative platforms, sampling designs, and sampling methodologies would be needed to maintain surveys conducted in or near the Project.

BOEM is committed to working with NOAA toward a long-term regional solution to account for changes in survey methodologies because of offshore wind farms. On December 4, 2022, NOAA Fisheries and BOEM published a Federal Survey Mitigation Strategy for the Northeast U.S. Region to address anticipated impacts of offshore wind energy development on NOAA Fisheries' scientific surveys (Hare et al. 2022). This implementation strategy also defines stakeholders, partners, and other ocean users that will be engaged throughout the process and identifies potential resources for successful implementation. Activities described in the implementation strategy are designed to mitigate the effect of offshore wind energy development on NOAA surveys and is referred to as the Federal Survey Mitigation Program. The mitigation program will include survey-specific mitigation plans for each affected survey including both vessel and aerial surveys. The implementation strategy is intended to guide the implementation of the mitigation program through the duration of wind energy development in the Northeast U.S. region.

3.17.2 Environmental Consequences

3.17.2.1. Impact Level Definitions for Other Uses (Marine Minerals, Military Use, Aviation)

Definitions of impact levels are provided in Table 3.17-1. There are no beneficial impacts on other uses.

Table 3.17-1 Impact Level Definitions for Other Uses (Marine Minerals, Military Use, Aviation)

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts would be so small as to be unmeasurable.
Minor	Adverse	Impacts on the affected activity would be avoided, and impacts would not disrupt the normal or routine functions of the affected activity. Once the Project is decommissioned, the affected activity would return to a condition with no measurable effects.

Impact Level	Impact Type	Definition
Moderate	Adverse	Impacts on the affected activity would be unavoidable. The affected activity would have to adjust to account for disruptions due to impacts of the Project, or, once the Project is decommissioned, the affected activity could return to a condition with no measurable effects if proper remedial action is taken.
Major	Adverse	The affected activity would experience unavoidable disruptions to a degree beyond what is normally acceptable, and, once the Project is decommissioned, the affected activity could retain measurable effects indefinitely, even if remedial action is taken.

3.17.3 Impacts of the No Action Alternative on Other Uses (Marine Minerals, Military Use, Aviation)

Section 3.1 of the Final EIS explains the approach to predicting impacts related to the No Action Alternative. When analyzing the impacts of the No Action Alternative on other uses, BOEM considered the impacts of past and ongoing trends and activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for other uses. BOEM separately analyzes how resource conditions will be affected over time as reasonably foreseeable activities are implemented. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix F, *Planned Activities Scenario*. Separate impact conclusions are presented for both scenarios.

3.17.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, marine minerals, military and national security uses, aviation and air traffic, offshore cables and pipelines, radar systems, and scientific research and surveys described in Section 3.17.1, *Description of the Affected Environment for Other Uses (Marine Minerals, Military Use, Aviation)*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities.

There are no ongoing offshore wind activities within the geographic analysis area for marine mineral extraction, military and national security uses, aviation and air traffic, cables and pipelines, or radar systems. Within the geographic analysis area for scientific research and surveys, the following offshore wind activities are ongoing: Block Island Wind Farm offshore Rhode Island, the Coastal Virginia Offshore Wind pilot project offshore Virginia, Vineyard Wind 1 offshore Massachusetts, and South Fork Wind Farm offshore Rhode Island.

Ongoing activities within the geographic analysis area that would contribute to impacts on other uses would generally be associated with offshore developments and climate change. Impacts on the marine environment associated with ongoing offshore wind activity have the potential to affect ongoing research and surveys within the geographic analysis area.

3.17.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with other planned activities (without the Proposed Action). No planned activities related to other uses in the offshore environment, such as the installation of new structures on the OCS outside of planned offshore wind projects, were identified (see Section F.2 in Appendix F for a complete description of ongoing and planned activities). See Tables F1-15 through F1-19 for a summary of potential impacts associated with ongoing and planned non-offshore wind activities by IPF for other uses. BOEM expects planned offshore wind development to primarily affect other uses through the following IPFs.

Marine Mineral Extraction

Presence of structures: The demand for sand and gravel resources is expected to grow with increasing trends in coastal erosion, storm events, and sea level rise. Within the geographic analysis area, there are no mineral leases, borrow sites, or ocean disposal sites. Offshore wind project infrastructure, including WTGs and transmission cables, could prevent future marine mineral extraction activities where the project footprint overlaps with the extraction area. Marine mineral extraction typically occurs within 8 miles of the shoreline, limiting adverse impacts on the offshore export cable routes. Additionally, other offshore wind projects would be able to avoid existing and proposed borrow areas through consultation with the BOEM Marine Minerals Program, USACE, and relevant state agencies before an offshore wind cable route is approved. The adverse impacts on sand and marine mineral extraction of offshore wind activities are anticipated to be negligible.

National Security and Military Uses

The offshore wind lease area geographic boundaries were developed through coordination with stakeholders to address concerns surrounding overlapping military and security uses. BOEM continues to coordinate with stakeholders to minimize these concerns, as needed.

Presence of structures: Existing stationary facilities within the geographic analysis area are limited to meteorological buoys operated for offshore wind farm site assessment. Dock facilities and other structures are concentrated along the coastline. Installation of up 468 WTGs as part of other offshore wind projects in the geographic analysis area would affect military and national security, including USCG SAR operations, primarily through increased risk of allision with foundations and other stationary structures. Generally, deep-draft military vessels are not anticipated to transit outside of navigation channels unless necessary for SAR operations or other non-typical activities. Smaller-draft vessels moving within or near the wind installation have a higher risk of allision with offshore wind structures. Wind energy facility structures would be lighted according to USCG and BOEM requirements at sea level to decrease allision risk. Allision risk would be further mitigated through coordination with stakeholders on WTG layouts to allow for safe navigation through the offshore wind lease areas in the analysis area.

The construction of offshore wind projects in the geographic analysis area would incrementally change navigational patterns and would increase navigational complexity for vessels and military aircraft operating in the region around the wind energy projects. The structures associated with offshore wind energy may necessitate route changes to navigate around the offshore wind lease areas and vessels associated with the construction of a project. Military and national security aircraft would be affected by the presence of tall equipment necessary for offshore wind facility construction, such as stationary lift vessels and cranes, which would increase navigational complexity in the area. Additionally, military and security operations conducted within Warning Area W-107 would be affected during the construction and operation periods of offshore wind activities. It is assumed, however, that all offshore wind energy projects would coordinate with relevant agencies during the COP development process to identify and minimize conflicts with military and national security operations. Refer to Section 3.16, *Navigation and Vessel Traffic*, for additional discussion of navigation impacts in the offshore wind lease areas.

Once the WTGs are operational, the artificial reef effect created by the offshore structures could attract commercial and recreational fishing vessels farther offshore than currently, possibly leading to use conflicts. An increase in commercial and recreational vessels in and around offshore wind projects could increase the risk of vessel collisions with military and national security vessels and may lead to an increased demand for USCG SAR operations.

Potential measures mitigating risks that offshore wind projects could implement include operational protocols to stop WTG rotation during SAR aircraft operations and implementation of FAA- and BOEM-recommended navigational lighting and marking to reduce the risk of aircraft collisions. Wind energy structures would be visible on military and national security vessel and aircraft radar. Even if these mitigation measures were implemented, the presence and layout of large numbers of WTGs could make it more difficult for SAR aircraft to perform operations, leading to less effective search patterns or earlier abandonment of searches. This could result in otherwise avoidable loss of life due to maritime incidents.

Navigational hazards would be eliminated as structures are removed during decommissioning. Due to anticipated coordination with agencies and the mitigation measures described above, the overall impacts on military and national security uses from offshore wind energy activities are anticipated to be minor, except for USCG SAR operations, which would have moderate adverse impacts.

Traffic: Impacts on military operations from vessel traffic related to the construction and operation of offshore wind activities on the OCS are expected to be short term, localized, and minor. Vessel traffic is expected to increase during construction. While construction periods of various offshore wind energy projects are expected to be staggered, there would be an overlap in construction between the three offshore wind projects in the geographic analysis area (Ocean Wind 2, Atlantic Shores South, and Atlantic Shores North) in 2026–2027, which would result in a cumulative impact on traffic volumes. Military and national security vessels may experience congestion and delays in ports due to the increase in offshore wind facility vessels.

Aviation and Air Traffic

Presence of structures: Other offshore wind development could add up to 468 WTGs to the offshore environment in the nearby OCS. WTGs could have a maximum blade tip height of 1,049 feet (320 meters) AMSL. As these structures are built, aircraft navigational patterns and complexity would incrementally increase in the region around the offshore wind lease areas, along transit routes between ports and construction sites, and locally around ports. These changes could compress lower-altitude aviation activity into more limited airspace in these areas, leading to airspace conflicts or congestion and increasing collision risks for low-flying aircraft. After all foreseeable offshore wind energy projects are built, there would still be open airspace available over the open ocean. Navigational hazards and collision risks in transit routes would be reduced as construction is completed, and would be gradually eliminated during decommissioning as offshore WTGs are removed.

All stationary structures would have aviation and navigational marking and lighting in accordance with FAA, USCG, and BOEM requirements and guidelines to minimize and mitigate impacts on air traffic. BOEM assumes that offshore wind projects would coordinate with aviation interests through the planning, construction, operations, and conceptual decommissioning processes to avoid or minimize impacts on aviation activities and air traffic. For this reason, the adverse impacts on aviation and airports are anticipated to be minor.

Cables and Pipelines

Presence of structures: At least four in-service submarine telecommunications cables, six abandoned cables, and one near-shore submarine pipeline are present within the geographic analysis area. Installed WTGs and OSS, and the stationary lift vessels used during construction of offshore wind energy project infrastructure, may pose allision/collision risks and navigational hazards to vessels conducting maintenance activities on these existing cables and pipelines. Risk to cable maintenance vessels during construction and operations of nearby offshore wind projects would be limited due to the infrequent submarine cable maintenance required at any single location along existing cable routes. Allision risks would be mitigated by navigational hazard markings per FAA, BOEM, and USCG requirements and guidelines. Risk of allision by cable maintenance vessels would decrease to zero after project decommissioning as structures are removed.

Up to 1,560 miles of submarine cables are expected to be installed for the Ocean Wind 2, Atlantic Shores South, and Atlantic Shores North projects. The installation of WTGs and OSS could preclude future submarine cable placement within the foundation footprint, which would cause future cables to route around these areas. However, the presence of existing submarine cables would not prohibit the placement of additional cables and pipelines. Following standard industry procedures, cables and pipelines can be crossed without adverse impact. Impacts on submarine cables would be eliminated during decommissioning of offshore wind farms when foundations are removed and if the export and inter-array cables associated with those projects are removed. Minor adverse impacts on existing cables and pipelines due to anticipated offshore wind projects are expected.

Radar Systems

Presence of structures: WTGs that are near to or in the direct line of sight of land-based radar systems can interfere with the radar signal, causing shadows or clutter in the received signal. Construction of other wind energy projects would add up to 468 WTGs with a maximum blade tip height of up to 1,049 feet (320 meters) AMSL in the geographic analysis area. The presence of these wind energy structures could lead to localized, long-term, moderate impacts on radar systems. Development of offshore wind projects could incrementally decrease the effectiveness of individual radar systems if the field of WTGs expands within the radar system’s coverage area. In addition, large areas of installed WTGs could create a large geographic area of degraded radar coverage that could affect multiple radars. Most offshore wind structures would be sited at such a distance from existing and proposed land-based radar systems to minimize interference to most radar systems, but some impacts are anticipated.

For radar structures with a co-located secondary surveillance radar (including the Dover AFB DASR and McGuire AFB DASR), the secondary surveillance radar is the main source of aircraft identification and positional data for air traffic control. A Department of Homeland Security–funded study found that secondary radar tracks were rarely affected by wind turbines (Ocean Wind 2023). Additional flight trials by the Department of Energy, Department of Homeland Security, DOD, and FAA found that while primary surveillance radars were affected by wind turbines, beacon transponder-based secondary surveillance radars were not affected (Ocean Wind 2023).

BOEM assumes that project proponents would conduct an independent radar analysis and coordinate with FAA to identify potential impacts and any mitigation measures specific to aeronautical, military, and weather radar systems. BOEM would continue to coordinate with the Military Aviation and Installation Assurance Siting Clearinghouse to review each proposed offshore wind project on a project-by-project basis, and would attempt to resolve project concerns identified through such consultation related to military and national security radar systems with COP approval conditions. Refer to Section 3.16, *Navigation and Vessel Traffic*, for discussion of impacts on marine vessel radar.

Scientific Research and Surveys

Presence of structures: Construction of other wind energy projects between 2023 and 2030 in the geographic analysis area would add up to 2,946 WTGs, associated cable systems, and associated vessel activity that would present additional navigational obstructions for sea- and air-based scientific studies. Collectively, these developments would prevent NOAA from continuing scientific research surveys or protected species surveys under current vessel capacities, would affect monitoring protocols in the geographic analysis area, could conflict with state and nearshore surveys, and may reduce opportunities for other NOAA scientific research studies in the area. This EIS incorporates by reference the detailed summary of and potential impacts on NOAA's scientific research provided in the Vineyard Wind 1 Final EIS in Section 3.12.2.5, *Scientific Research and Surveys* (BOEM 2021a). In summary, offshore wind facilities actuate impacts on scientific surveys and advice by preclusion of NOAA survey vessels and aircraft from sampling in survey strata; impacts on the random-stratified statistical design that is the basis for assessments, advice, and analyses; alteration of benthic and pelagic habitats and airspace in and around the wind energy development, which would require new designs and methods to sample new habitats; and reduced sampling productivity through navigation impacts of wind energy infrastructure on aerial and vessel surveys. NOAA has determined that survey activities within offshore wind facilities are outside of safety and operational limits. Survey vessels would be required to navigate around offshore wind projects to access survey locations, leading to a decrease in survey precision and operational efficiency. The height of turbines would affect aerial survey design and protocols, requiring flight altitudes and transects to change. Scientific survey and protected species survey operations would therefore be reduced or eliminated as offshore wind facilities are constructed. If stock or population changes, biomass estimates, or other environmental parameters differ within the offshore wind lease areas but cannot be observed as part of surveys, resulting survey indices could be biased and unsuitable for monitoring stock status. Offshore wind facilities will disrupt survey sampling statistical designs, such as random stratified sampling. Impacts on the statistical design of region-wide surveys violate the assumptions of probabilistic sampling methods. Development of new survey technologies, changes in survey methodologies, and required calibrations could help to mitigate losses in accuracy and precision of current practices caused by the impacts of wind development on survey strata.

Other offshore wind projects could also require implementation of mitigation and monitoring measures identified in records of decision. Identification and analysis of specific measures are speculative at this time; however, these measures could further affect NOAA's ongoing scientific research surveys or protected-species surveys because of increased vessel activity or in-water structures from these other projects. BOEM is committed to working with NOAA toward a long-term regional solution to account for changes in survey methodologies as a result of offshore wind farms.

Overall, reasonably foreseeable offshore wind energy projects in the area would have major effects on NOAA's scientific research and protected-species surveys, potentially leading to impacts on fishery participants and communities; as well as potential major impacts on monitoring and assessment activities associated with recovery and conservation programs for protected species.

3.17.3.3. Conclusions

Impacts of the No Action Alternative. Ongoing activities in the geographic analysis area would likely result in negligible impacts for marine mineral extraction, marine and national security uses, aviation and air traffic, cables and pipelines, and radar systems. Currently, offshore structures in the geographic analysis area are limited to meteorological buoys associated with planned offshore wind activities. Military and national security use, aviation and air traffic, vessel traffic, commercial fishing, and scientific research and surveys are expected to continue in the geographic analysis area. Ongoing activities would likely result in major impacts on scientific research and surveys due to the impacts from ongoing offshore wind activity including the Block Island Wind Farm, the Coastal Virginia Offshore Wind pilot project, Vineyard Wind 1, and the South Fork Wind Farm. The No Action Alternative would result in **negligible** impacts for marine mineral extraction, marine and national security uses, aviation and air traffic, cables and pipelines, and radar systems and **moderate** impacts on scientific research and surveys.

Cumulative Impacts of the No Action Alternative. Under the No Action Alternative, existing environmental trends and activities would continue, and other uses would continue to be affected by natural and human-caused IPFs. Planned activities expected to occur in the geographic analysis area include increasing vessel traffic; continued residential, commercial, and industrial development onshore and along the shoreline; and continued development of FAA-regulated structures including cell towers and onshore wind turbines. BOEM anticipates that any issues with aviation routes or radar systems would be resolved through coordination with DOD or FAA, as well as through implementation of aviation and navigational marking and lighting of structures according to FAA, USCG, and BOEM requirements and guidelines. There are no planned non-offshore activities anticipated to affect marine mineral extraction or cable and pipeline infrastructure.

BOEM anticipates that offshore wind activities in the geographic analysis area would result in negligible to minor impacts for marine mineral extraction, aviation and air traffic, and cables and pipelines; moderate for radar systems due to WTG interference; minor for military and national security uses except for USCG SAR operations, which would have moderate adverse impacts; and major for scientific research and surveys. The presence of stationary structures associated with offshore wind energy projects could prevent or impede continued NOAA scientific research surveys using current vessel capacities and monitoring protocols or reduce opportunities for other NOAA scientific research studies in the area. Coordinators of large-vessel survey operations or operations deploying mobile survey gear have determined that activities within offshore wind facilities would not be within current safety and operational limits. In addition, changes in required flight altitudes due to the proposed WTG height would affect aerial survey design and protocols.

BOEM anticipates that the cumulative impacts of the No Action Alternative in the geographic analysis area would be **negligible** to **minor** for marine mineral extraction, aviation and air traffic, and cables and pipelines; **moderate** for radar systems due to WTG interference; **minor** for military and national security uses except for USCG SAR operations, which would be **moderate**; and **major** for scientific research and surveys.

3.17.4 Relevant Design Parameters & Potential Variances in Impacts for the Action Alternatives

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than those described in the sections below. The following PDE parameters (Appendix E) would influence the magnitude of the impacts on other uses:

- The number, size, location, and spacing of WTGs;
- Timing of offshore construction and installation activities; and
- Location and route of offshore export cable corridor.

Variability of the proposed Project design exists as outlined in Appendix E. Below is a summary of potential variances in impacts:

- WTG size and location: larger turbines closer to shore could increase impacts on land-based radar systems, movements of civilian and military aircraft, and military vessels.
- WTG spacing: Removal of groups of WTGs, creating spacing of greater than 1 nm, could allow for scientific research and surveys in those areas, decreasing the impact.
- Timing of construction: Construction could affect submarine or surface military vessel activity during typical operations and training exercises.
- Offshore cable route options: The route chosen (including variants within the general route) could conflict with marine mineral extraction or cables and pipelines.

Ocean Wind has committed to avoiding other marine uses to the extent practicable and to coordinating with other users where avoidance is not practicable (OUSE-01) (COP Volume II, Table 1.1-2; Ocean Wind 2023).

3.17.5 Impacts of the Proposed Action on Other Uses (Marine Minerals, Military Use, Aviation)

3.17.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.17.8, *Impacts of Alternative E on Other Uses (Marine Minerals, Military Use, Aviation).*

Marine Mineral Extraction

Presence of structures: While there are several borrow areas and ocean disposal sites in the vicinity of the Project, none of these areas occur within the geographic analysis area for marine mineral extraction. Offshore wind project infrastructure, including WTGs and transmission cables, has the potential to prevent future marine mineral extraction activities where the footprint of the structures and cable corridors overlaps with the extraction area.

Beach replenishment activities routinely occur within the geographic analysis area to replace sediment lost due to erosion. There are multiple planned or proposed beach replenishment projects within Berkeley and Upper Townships (Press of Atlantic City 2022; Patch 2022). Depending on the landfall locations selected and location of the proposed beach replenishment projects, the proposed offshore export cable landfall locations for the Oyster Creek and BL England cable corridors may be near or overlapping with these activities. As more information on these planned beach replenishment activities is made available, Ocean Wind will coordinate with USACE, non-federal sponsor, and local owner as necessary to avoid conflicts.

Because the Project would avoid mineral leases, sand and gravel leases and borrow areas, and ocean disposal areas, negligible impacts associated with construction, O&M, and decommissioning are anticipated.

National Security and Military Uses

Presence of structures: The addition of up to 98 WTGs and up to 3 OSS would increase the risk of allisions for military vessels during Project operations, particularly in bad weather or low visibility, resulting in minor impacts on most military and national security uses. The presence of structures could also change navigational patterns and add to the navigational complexity for military vessels and aircraft operating in the Project area during construction and operation of the Proposed Action. Project structures would be marked as a navigational hazard per FAA, BOEM, and USCG guidelines and WTGs would be visible on military and national security vessel and aircraft radar, minimizing the potential for allision and increased navigational complexity. Additional navigational complexity would increase the risk of collision and allisions for military and national security vessels or aircraft within the Project area.

The U.S. Marine Corps uses a military flight route (VR-1709) that crosses the western portion of the Wind Farm Area. Ocean Wind has coordinated with the Marine Corps, which indicated that, while its primary interest is in keeping VR-1709 as free from obstruction as possible, it is not seeking to impose any requirements on the Project (Ocean Wind 2023). Ocean Wind has agreed to continue to coordinate with the Marine Corps as design progresses. In addition, Ocean Wind is coordinating with DOD regarding military exercises within the special-use airspace Warning Area 107 to inform turbine layout and design (Ocean Wind 2023). These coordination activities would ensure the Project is designed and operated in a manner that would minimize impacts on military use in the Project area to the extent feasible. Potential impacts on military operations from the permanent placement of structures within the water column and above the sea surface within the Wind Farm Area are expected to be long term and localized.

The Military Aviation and Installation Assurance Siting Clearinghouse coordinated a review of the COP within the DOD and this review identified minimal impacts on DOD's mission. The Department of the Navy requested that BOEM include a provision for distributed fiber-optic sensing technology that could be used as part of the wind energy project or associated transmission cables as terms of COP approval. The provision language is being developed by the Department of the Navy in coordination with BOEM and aims to mitigate potential impacts on the Department of the Navy's operations in the area (Sample 2021).

USCG SAR activities could be hindered within the Wind Farm Area due to navigational complexity and safety concerns of operating among WTGs. Changing navigational patterns could also concentrate vessels within and around the outsides of the Project area, potentially causing space use conflicts in these locations or reducing the efficiency of SAR operations, resulting in moderate, adverse impacts on SAR operations. USCG may need to adjust its SAR planning and search patterns to accommodate the WTG layout, leading to a less optimized search pattern and a lower probability of success. This could lead to increased loss of life due to maritime incidents.

Construction of the Proposed Action would add up to 98 WTGs and up to 3 OSS that could create an artificial reef effect, attracting species of interest to recreational fishing or sightseeing, which would attract additional recreational vessels in addition to existing vessel traffic in the area. The presence of additional recreational vessels would add to the space use conflict and collision risks for military and national security vessels.

Traffic: Increased vessel traffic in the Project area during construction, operations, and decommissioning could result in an increased risk of vessel collisions with military and national security vessels, cause military and national security vessels to change routes, and result in congestion and delays in ports. Impacts are anticipated to be minor and would be greatest during construction when vessel traffic is greatest and would be reduced during operations. Vessel traffic and navigation impacts are summarized in Section 3.16, *Navigation and Vessel Traffic*.

Aviation and Air Traffic

Presence of structures: The Proposed Action would install up to 98 WTGs with maximum blade tip heights of up to 906 feet (276 meters) above MLLW in the Wind Farm Area. The addition of these structures would increase navigational complexity and change aircraft navigational patterns around the Wind Farm Area. WTGs would be constructed under the listed FAA flight level ceiling designated within the Wind Farm Area and, therefore, would not affect commercial or military flight operations; however, low-level flights would be affected throughout the duration of the Proposed Action's operational timeframe (Ocean Wind 2023).

WTGs and OSS would comply with lighting and marking regulations and be marked per FAA and USCG rules to minimize and mitigate impacts on air traffic. Due to their size, WTGs would also be visible on aircraft radars. Navigational hazards and collision risks in transit routes would be reduced as construction is completed, and would be gradually eliminated during decommissioning as offshore WTGs are removed. Adverse impacts on air traffic are anticipated to be localized, long term, and minor.

Cables and Pipelines

Presence of structures: Several in-service and abandoned submarine telecommunication cables are present in the offshore export cable corridor and in the vicinity of the Lease Area.

Installation of the offshore export cables to Oyster Creek would cross four active and six inactive undersea telecommunication cables. Ocean Wind would follow standard industry procedures for crossing utility lines and avoid adverse impacts on these existing lines. The presence of future offshore wind energy structures could preclude future submarine cable placement within any given development footprint, requiring future cables to route around these areas. However, the placement and presence of the Proposed Action's offshore export cables would not prohibit the placement of additional cables and pipelines because these could be crossed following standard industry protection techniques. Impacts on submarine cables and pipelines are anticipated to be negligible and would be eliminated during decommissioning of the Project as the export and inter-array cables are removed.

Project structures including WTGs and OSS, and the stationary lift vessels used during Project construction and installation, may pose allision risks and navigational hazards to vessels conducting maintenance activities on existing submarine telecommunication cables. However, FAA, USCG, and BOEM navigational hazard marking as well as the relative infrequency of maintenance activities would minimize the risk of allision. Risk of vessel collision between cable maintenance vessels and vessels associated with the Project would be limited to the construction and installation phase and during planned maintenance activities during the operational phase.

Radar Systems

Presence of structures: Air traffic control and national defense radar within the line of sight of the offshore infrastructure associated with the Proposed Action may be affected by the O&M phase of the Project. Ocean Wind conducted an analysis of the impact on radar systems from the Proposed Action and found that either portions or the entire Project Area are within the line of sight of and would affect the following radar systems: Atlantic City ASR-9, Dover AFB DASR, Gibbsboro ARSR-4, and the following SeaSonde High-Frequency Radar systems: Seaside Park, Brant Beach, Strathmere, North Wildwood, Hempstead, Loveladies, Brigantine, and Wildwood (Ocean Wind 2023 citing Westlope Consulting 2019; BOEM 2020). The entire Proposed Action is within the line of sight of the Atlantic City ASR-9, which is expected to affect the radar system's ability to identify aircraft within the 40- to 60-kilometer range from Atlantic City (BOEM 2020). For Gibbsboro ARSR-4, only the tips of a small number of WTGs are within the line of sight, resulting in minimal interference (BOEM 2020). Impacts on the McGuire AFB DASR, Dover AFB WSR-88D, and National Weather Service Philadelphia WSR-88D are not expected, as the WTGs in the Project area would not be within the line of sight.

Potential impacts for radar operations over and in the immediate vicinity of the Project area include unwanted radar returns (clutter) resulting in a partial loss of primary target detection and a number of false primary targets, and partial loss of weather detection including false weather indications (Ocean Wind 2023). Based on review of the COP, the North American Aerospace Defense Command identified minor but acceptable impacts on their radar operations (Sample 2021).

Several options are available to minimize and mitigate impacts. Ocean Wind's radar line-of-sight study recommended a Clear Day Map update to reduce false weather indications at Atlantic City ASR-9. For impacts on the Dover AFB DASR, the study noted that the Range-Azimuth Gate mapping should remove false primary targets in the small area affected. Geocensoring in the Gibbsboro ARSR-4 should remove false primary targets. The Ocean Wind 1 COP, Volume II, Section 2.3.7 provides additional information on the radar line-of-sight study (Ocean Wind 2023). Ocean Wind has committed to continued coordination with FAA, DOD, and NOAA to assess and mitigate impacts on radar operations.

Scientific Research and Surveys

Presence of structures: Scientific research and surveys, particularly for NOAA surveys supporting commercial fisheries and protected-species research programs, could be affected during the construction and operations of the Proposed Action; however, research activities may continue within the proposed Project area, as permissible by survey operators. The Proposed Action would affect survey operations by excluding certain portions of the Lease Area occupied by Project components from sampling, affecting the statistical design of surveys, reducing survey efficiency, and causing habitat alteration within the Wind Farm Area that cannot be monitored. This Final EIS incorporates by reference the detailed analysis of potential impacts on scientific research and surveys provided in the Vineyard Wind 1 Final EIS (BOEM 2021a). The analysis in the Vineyard Wind 1 Final EIS is summarized above under the discussion of the No Action Alternative in Section 3.17.3.2, *Future Offshore Wind Activities (without Proposed Action)*.

The Proposed Action would install up to 98 WTGs with a maximum blade tip of 906 feet (276 meters) above MLLW. Aerial survey track lines for cetacean and sea turtle abundance surveys could not continue at the current altitude (600 feet AMSL) within the Project area because the planned maximum-case scenario for WTG blade tip height would exceed the survey altitude. The increased altitude necessary for safe survey operations could result in lower chances of detecting marine mammals and sea turtles, especially smaller species. Agencies would need to expend resources to update scientific survey methodologies due to construction and operation of the Proposed Action, as well as to evaluate these changes on stock assessments and fisheries management, resulting in major impacts for scientific research and surveys.

3.17.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned activities.

Marine Mineral Extraction

Presence of structures: The Proposed Action would contribute an undetectable increment to the cumulative impacts on marine mineral extraction, which would be negligible. BOEM anticipates that other offshore wind projects would be designed to avoid existing and proposed mineral extraction areas through consultation with BOEM, USACE, and relevant state and local agencies; therefore, there would be negligible impacts on future mineral extraction activity.

National Security and Military Uses

Presence of structures and traffic: Ongoing and planned activities, including the Proposed Action, would create navigational complexity within the geographic analysis area through the construction and operation of offshore structures. While potential impacts on most military and national security uses are anticipated to be minor, installation of WTGs throughout the geographic analysis area would hinder USCG SAR operations across a larger area, resulting in a moderate impact on SAR operations, potentially leading to increased loss of life. Additionally, the Proposed Action would contribute a noticeable increment to the cumulative vessel traffic impacts, which are most likely to occur during the construction and decommissioning timeframes. This would result in localized, temporary, and minor impacts on military and national security uses.

Aviation and Air Traffic

Presence of structures: Open airspace around the offshore wind lease areas in the geographic analysis area would still exist after all reasonably foreseeable future offshore wind energy projects are built.

BOEM assumes that offshore wind project operators would coordinate with aviation interests throughout the planning, construction, operations, and conceptual decommissioning processes to avoid or minimize impacts on aviation activities and air traffic. The Proposed Action would contribute a noticeable increment to the minor cumulative impacts.

Cables and Pipelines

Presence of structures: The Proposed Action would contribute an undetectable increment to the cumulative impacts from cables and pipelines, which would be localized and long term. However, these impacts would be negligible because they can be avoided by standard protection techniques.

Radar Systems

Presence of structures: Development of offshore wind projects could incrementally decrease the effectiveness of individual radar systems if the field of WTGs expands within the radar system's coverage area. In addition, large areas of installed WTGs could create a large geographic area of degraded radar coverage that could affect multiple radars. Cumulative impacts of the Proposed Action would be moderate, primarily due to the presence of WTGs within the line of sight causing interference with radar systems.

Scientific Research and Surveys

Presence of structures: Cumulative impacts of the Proposed Action would be long term and major on scientific research and surveys, particularly for NOAA surveys that support commercial fisheries and protected-species research programs. The entities conducting scientific research and surveys would have to make significant investments to change methodologies to account for areas occupied by offshore energy components, such as WTGs and cable routes, that are no longer able to be sampled.

3.17.5.3. Conclusions

Impacts of the Proposed Action. Under the Proposed Action, up to 98 WTGs with a maximum blade tip of 906 feet (276 meters) above MLLW would be installed, operate, and eventually be decommissioned within the Project area. The presence of these structures would introduce navigational complexity and increased vessel traffic in the area that would continue to have temporary to long-term impacts that range from **negligible** to **major** on marine mineral extraction, military and national security uses, aviation and air traffic, cables and pipelines, radar systems, and scientific research and surveys.

- Marine Mineral Extraction: The Wind Farm Area and offshore export cable routes for the Proposed Action would avoid sand, gravel borrow, and ocean disposal areas, resulting in **negligible** potential impacts.
- Military and National Security Uses: The installation of WTGs in the Project area would result in increased navigational complexity and increased allision risk, creating potential **moderate** adverse impacts on USCG SAR operations and potential **minor** impacts on all other military and national security uses.
- Aviation and Air Traffic: Potential **minor** impacts on low-level flights would occur, primarily due to the installation of WTGs in the Project area and changes in navigation patterns. Potential impacts on commercial and military flight operations are not anticipated, as WTGs would be constructed under the listed FAA flight level ceiling.
- Cables and Pipelines: Potential impacts on cables and pipelines would be **negligible** due to the use of standard protection techniques to avoid impacts.

- Radar: Potential **minor** adverse impacts on radar systems would primarily be caused by the presence of WTGs within the line of sight causing interference with radar systems. Options are available to minimize or mitigate impacts and Ocean Wind would continue to coordinate with the FAA, DOD, and NOAA on impacts.
- Scientific Research and Surveys: Potential impacts on scientific research and surveys would be **major**, particularly for NOAA surveys supporting commercial fisheries and protected-species research programs. The presence of structures would exclude certain areas within the Project area occupied by Project components (e.g., WTG foundations, cable routes) from potential vessel and aerial sampling, and by affecting survey gear performance, efficiency, and availability.

Cumulative Impacts of the Proposed Action. The incremental impacts contributed by the Proposed Action to the cumulative impacts on other uses would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts associated with the Proposed Action would range from **negligible** to **minor** for aviation and air traffic, cables and pipelines, marine mineral extraction, and most military and national security uses; **moderate** for radar systems and USCG SAR operations; and **major** for NOAA's scientific research and surveys. The presence of structures associated with the Proposed Action and increased risk of allisions are the primary drivers for impacts on other marine uses. Impacts on NOAA scientific research and surveys would qualify as major because entities conducting surveys and scientific research would have to make significant investments to change methodologies to account for unsampleable areas, with potential long-term and irreversible impacts on fisheries and protected-species research as a whole, as well as on the commercial fisheries community.

3.17.6 Impacts of Alternative B, C-1, and D on Other Uses (Marine Minerals, Military Use, Aviation)

Impacts of Alternative B, C-1, and D. The impacts resulting from individual IPFs associated with the construction and installation, O&M, and conceptual decommissioning under Alternatives B-1, B-2, C-1, and D would be similar to those described under the Proposed Action. Construction of Alternatives B and D would install fewer WTGs (9 fewer WTGs for B-1; up to 19 fewer WTGs for B-2; up to 15 fewer for D) and associated inter-array cables, which would slightly reduce the construction impact footprint and installation period. Alternative C-1 would exclude 8 WTGs along the northeastern boundary of the Lease Area or relocate them to the northern portion of the Lease Area. All other design parameters and potential variability in the design would be the same as under the Proposed Action.

Impacts of Alternatives B-1 and B-2 would be similar to those of the Proposed Action for marine mineral extraction, military and national security uses, aviation and air traffic, cables and pipelines, and scientific research and surveys. Alternatives B-1 and B-2 could potentially decrease impacts on radar systems by removing the WTGs closest to the shore, which would possibly reduce line-of-sight impacts; however, localized, long-term impacts on radar systems are still anticipated.

Impacts of Alternative C-1 would be similar to those of the Proposed Action for marine mineral extraction, military and national security uses, aviation and air traffic, cables and pipelines, and scientific research and surveys. Alternative C-1 could potentially increase adverse impacts on radar systems by adding an additional 8 WTGs to the northern portion of the Lease Area closest to the shore, which would possibly increase line-of-sight impacts; however, localized, long-term impacts on radar systems are still anticipated.

Impacts of Alternative D would be similar to the Proposed Action for cables and pipelines, marine mineral extraction, military and national security uses, radar, aviation and air traffic. Alternative D could potentially reduce localized impacts on scientific research and surveys by avoiding placing structures in sand ridges and troughs; however, the structures present throughout the remainder of the Lease Area would exclude certain portions of the Project area from potential vessel and aerial sampling.

Cumulative Impacts of Alternative B, C-1, and D. The incremental impacts contributed by Alternatives B, C-1, and D to the combined impacts from ongoing and planned activities including offshore wind would be similar to those of the Proposed Action.

3.17.6.1. Conclusions

Impacts of Alternative B, C-1, and D. Implementation of Alternatives B, C-1, and D would not result in meaningfully different types or magnitudes of impacts on other uses as compared to the Proposed Action. The overall level of impact would remain similar to that of the Proposed Action, and the impacts of each alternative alone resulting from individual IPFs associated with these alternatives would be **negligible** for marine mineral extraction, cables and pipelines; **minor** for aviation and air traffic and for radar systems; **minor** for most military and national security uses, but **moderate** for USCG SAR operations; and **major** for scientific research and surveys.

Cumulative Impacts of Alternative B, C-1, and D. The incremental impacts contributed by Alternatives B, C-1, and D to the cumulative impacts on other uses would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts associated with Alternatives B, C-1, and D would range from **negligible** to **minor** for aviation and air traffic, cables and pipelines, marine mineral extraction, and most military and national security uses; **moderate** for radar systems and for USCG SAR operations; and **major** for scientific research and surveys. These impact ratings are primarily driven by the presence of offshore structures such as WTGs in the offshore wind lease areas.

3.17.7 Impacts of Alternative C-2 on Other Uses (Marine Minerals, Military Use, Aviation)

Impacts of Alternative C-2. Construction of Alternative C-2 would create an 0.81-nm to 1.08-nm buffer from WTS in the Ocean Wind 1 Lease Area and WTGs in the Atlantic Shores South Lease Area by compressing the WTG array layout to allow for a full build of up to 98 WTGs. All other design parameters and potential variability in the design would be the same as under the Proposed Action.

Impacts of Alternative C-2 would be similar to those of the Proposed Action for marine mineral extraction, aviation and air traffic, cables and pipelines, and radar. The reduction of the Project’s WTG array spacing to no less than 0.92 nm between rows is not expected to increase impacts on military and national security uses, as deep-draft military vessels are not anticipated to transit outside of navigation channels unless necessary for SAR operations and the separation would still be wide enough for safe navigation for smaller-draft military vessels moving within the WTG array (see Section 3.16, *Navigation and Vessel Traffic*). Although Alternative C-2 would reduce the array spacing to no less than 0.92 nm between rows, the overall magnitude of impacts on scientific research and surveys would remain similar to those described for the Proposed Action, as the area would still likely be excluded from survey operations because the spacing between WTGs would be less than 1 nm.

Cumulative Impacts of Alternative C-2. The incremental impacts contributed by Alternative C-2 to cumulative impacts would be similar to those of the Proposed Action.

3.17.7.1. Conclusions

Impacts of Alternative C-2. The overall level of impact from Alternative C-2 would remain similar to that of the Proposed Action. The impacts of Alternative C-2 alone resulting from individual IPFs would be **negligible** for marine mineral extraction and cables and pipelines; **minor** for aviation and air traffic;

and for radar systems; **minor** for most military and national security uses, but **moderate** for USCG SAR operations; and **major** for scientific research and surveys.

Cumulative Impacts of Alternative C-2. The incremental impacts contributed by Alternative C-2 to the cumulative impacts on other uses would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts associated with Alternative C-2 would range from **negligible** to **minor** for aviation and air traffic, cables and pipelines, and marine mineral extraction; **minor** for most military and national security uses; **moderate** for radar systems and USCG SAR operations; and **major** for scientific research and surveys. These impact ratings are primarily driven by the presence of offshore structures such as WTGs in the offshore wind lease areas.

3.17.8 Impacts of Alternative E on Other Uses (Marine Minerals, Military Use, Aviation)

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. Alternative E would modify the Oyster Creek export cable route to minimize impacts on SAV in Barnegat Bay. Impacts of Alternative E would be similar to those of the Proposed Action for marine mineral extraction, military and national security uses, aviation and air traffic, cables and pipelines, radar, and scientific research and surveys. While Alternative E would slightly increase the length of the export cable, there are no mapped mineral extraction areas or pipelines reasonably close to the offshore export cable route that could be affected by this alternative. Because Alternative E would not result in a change to the WTG array compared to the Proposed Action, there would be no change in impacts for military and national security uses, aviation and air traffic, radar, and scientific research and surveys.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts would be similar to those of the Proposed Action.

3.17.8.1. Conclusions

Impacts of Alternative E. Implementation of Alternative E would not result in meaningfully different types or magnitudes of impacts on other uses as compared to the Proposed Action. The overall level of impact would remain similar to that of the Proposed Action. The impacts of Alternative E alone resulting from individual IPFs would be **negligible** for marine mineral extraction and cables and pipelines; **minor** for aviation and air traffic and for radar systems; **minor** for most military and national security uses, but **moderate** for USCG SAR operations; and **major** for scientific research and surveys.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts on other uses would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts from Alternative E would range from **negligible** to **minor** for aviation and air traffic, cables and pipelines, marine mineral extraction, and most military and national security uses; **moderate** for radar systems and USCG SAR operations; and **major** scientific research and surveys. These impact ratings are primarily driven by the presence of offshore structures such as WTGs in the offshore wind lease areas.

3.17.9 Proposed Mitigation Measures

In the Draft EIS, BOEM analyzed general radar systems mitigations as outlined in the BOEM OCS Study 202-039. After publication of the Draft EIS, BOEM coordinated with radar system operating agencies to identify Ocean Wind 1-specific proposed mitigation measures, which are analyzed below and in

Appendix H, Table H-2 and Table H-3. Several measures proposed to minimize impacts on scientific research and surveys and military and national security uses are also analyzed below. If these measures are adopted by BOEM or cooperating agencies, some adverse impacts could be further reduced.

Table 3.17-2 Measures Resulting from Consultations (Also Identified in Appendix H, Table H-2): Other Uses

Measure	Description	Effect
Fiber-optic sensing technology	Distributed fiber-optic sensing (DOFS) technology proposed for the wind energy project or associated transmission cables would be reviewed by the DOD to ensure that DOFS is not used to detect sensitive data from DOD activities, conduct any other type of surveillance of U.S. Government operations, or to otherwise pose a threat to national security.	The mitigation measure would ensure that DOD activities could continue within the Lease Area, as possible while avoiding structures, without the risk of DOFS inadvertently capturing sensitive information from DOD activities. However, the overall Project impact on military and national security uses would remain minor, as the primary cause of the impact level is the presence of WTG structures within the Lease Area.

Table 3.17-3 Additional Proposed Measures (Also Identified in Appendix H, Table H-3): Other Uses

Measure	Description	Effect
Mitigation for oceanographic high frequency radars	BOEM will require that Ocean Wind coordinates with the radar operators and the Surface Currents Program of NOAA Integrated Ocean Observing System (IOOS) Office to assess if the Project causes radar interference to the degree that radar performance is no longer within the specified radar system's operation parameters or fails to meet mission objectives. If either is the case, the lessee must notify BOEM, make publicly available via NOAA IOOS the near real-time accurate numerical telemetry of surface current velocity, wave height, wave period, wave direction, and other oceanographic data measured at Project locations selected by the Lessee in coordination with the affected radar operators and the NOAA IOOS Surface Currents Program; and, if requested by the affected radar operators or the NOAA IOOS Surface Currents Program, share with them accurate numerical time-series data of blade rotation rates, nacelle bearing angles, and other information about the operational state of each turbine in the wind development area to aid interference mitigation.	The proposed mitigation measure would reduce some of the impacts of the Project on oceanographic high-frequency radars and would ensure that the Surface Currents Program could continue to meet its mission objectives. However, the overall impact rating would remain minor, as the mitigation measures are not able to fully eliminate the potential line-of-sight impacts of the WTGs on radar systems.

3.17.9.1. Measures Incorporated in the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.17-2 and Table H-2 in Appendix H, *Mitigation and Monitoring*, are incorporated in the Preferred Alternative. BOEM has identified the following additional measures in Table 3.17-3 as incorporated in the Preferred Alternative: fiber-optic sensing technology and mitigation for oceanographic high-frequency radars. These measures, if adopted, would have the effect of reducing some of the impacts on radar systems and military and national security uses. Identified as a result of Military Aviation and Installation Assurance Siting Clearinghouse reviews, the fiber-optic sensing technology mitigation measure would enable DOD to review the distributed fiber-optic sensing technology proposed for the Project and associated transmission cables to ensure the DOFS are not being used to detect sensitive data from DOD activities. The mitigation measure would ensure that DOD activities could continue within the Lease Area without the risk of distributed fiber-optic sensing inadvertently capturing sensitive information from DOD activities, which could pose a risk to national security. However, the overall Project impact on military and national security uses would remain minor, as the primary cause of the impact level is the presence of WTG structures creating increased navigational complexity within the Lease Area. The mitigation measure for oceanographic high-frequency radars was developed through coordination with the NOAA Integrated Ocean Observing System Office. This mitigation measure would de-conflict Ocean Wind 1 development and the ability of this office to meet mission objectives and would reduce impacts; however, the overall Project impact on radar systems would remain minor.

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3.18. Recreation and Tourism

This section discusses potential impacts on recreation and tourism resources and activities from the proposed Project, alternatives, and ongoing and planned activities in the geographic analysis area. The geographic analysis area, as shown on Figure 3.18-1, includes the 40-mile (64.4-kilometer) visual analysis area measured from the borders of the Wind Farm Area. The geographic analysis area encompasses Cape May County entirely and parts of Atlantic, Burlington, Cumberland, and Ocean Counties. Other offshore wind activities in the recreation and tourism geographic analysis area includes Ocean Wind 1, Ocean Wind 2, Atlantic Shores South, Atlantic Shores North, Garden State Offshore Energy, Skipjack, Hudson South A, Hudson South E, and Hudson South F. Section 3.11, *Demographics, Employment, and Economics*, discusses the economic aspects of recreation and tourism in the Project area.

3.18.1 Description of the Affected Environment for Recreation and Tourism

Regional Setting

Proposed Project facilities would be within and off the coast of New Jersey. The coastal areas support ocean-based recreation and tourist activities that include boating, swimming, surfing, scuba diving, sailing, and paddle sports. As indicated in Section 3.11, *Demographics, Employment, and Economics*, recreation and tourism contribute substantially to the economies of New Jersey's coastal counties. More than 96 million people visited New Jersey in 2021, with $37.3 billion in visitor spending in the state (Tourism Economics 2021). Tourism in New Jersey's coastal communities is a multibillion-dollar industry. Approximately 42.9 million people visited Cape May, Atlantic, Burlington, and Ocean Counties in 2021, or 44 percent of the total visitors to the state (Tourism Economics 2021). More than 1.8 million people visited Island Beach, Barnegat Lighthouse, and Cape May Point state parks in 2016, while over 688,000 used the state's marinas (NJDEP 2018a).

Coastal New Jersey has a wide range of visual characteristics, with communities and landscapes ranging from large cities to small towns, suburbs, rural areas, and wildlife preserves. As a result of the proximity of the Atlantic Ocean, as well as the views associated with the shoreline, the New Jersey shore has been extensively developed for water-based recreation and tourism.

The scenic quality of the coastal environment is important to the identity, attraction, and economic health of many of the coastal communities. Additionally, the visual qualities of these historic coastal towns, which include marine activities within small-scale harbors, and the ability to view birds and marine life are important community characteristics.

Project Area

Recreational and tourist-oriented activities are concentrated in the coastal communities in Atlantic, Cape May, and Ocean Counties, which are some of the most densely populated coastal communities in the U.S. Coastal communities provide hospitality, entertainment, and recreation for hundreds of thousands of visitors each year. Although many of the coastal and ocean amenities, such as beaches, that attract visitors to these regions are accessible to the public for free and thus do not directly generate employment, these nonmarket features function as key drivers for recreation and tourism businesses.

Water-oriented recreational activities in the Project area include boating, visiting beaches, hiking, fishing, shellfishing, and bird and wildlife viewing. Boating covers a wide range of activities, from ocean-going vessels to small boats used by residents and tourists in sheltered waters, and includes sailing, sailboat races, fishing, shellfishing, kayaking, canoeing, and paddleboarding.

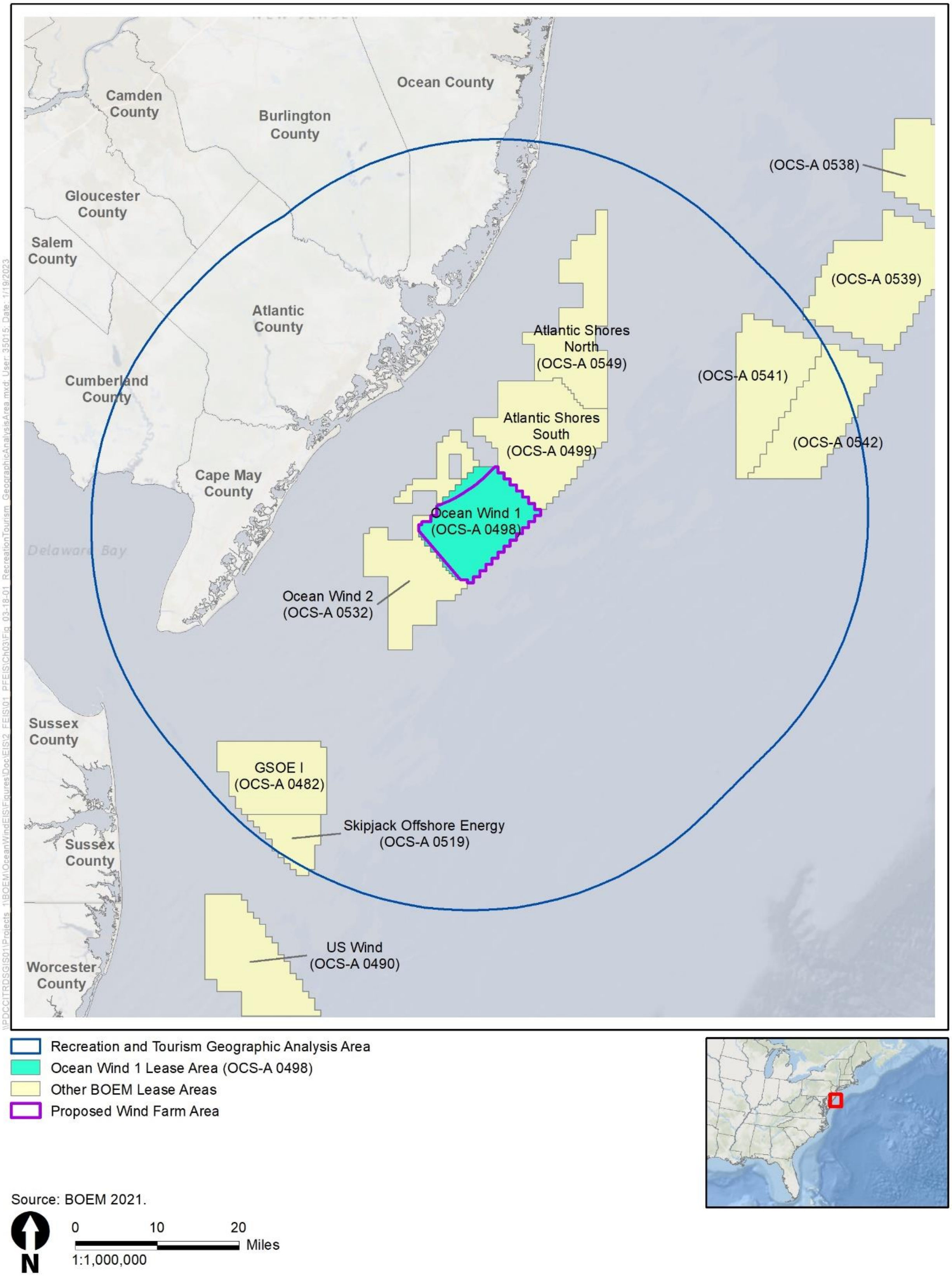

Figure 3.18-1 Recreation and Tourism Geographic Analysis Area

Commercial businesses offer boat rentals, private charter boats for fishing, whale watching and other wildlife viewing, and tours with canoes and kayaks. As discussed in Section 3.11 (*Demographics, Employment, and Economics*), recreation and hospitality are major sectors of the economy in Atlantic, Cape May, and Ocean Counties, supported by the ocean-based recreation uses.

Inland recreational facilities are also popular but bear less of a relationship to possible impacts of the Project; this section does not address them in detail. These include inland waters such as ponds and rivers, wildlife sanctuaries, golf courses, athletic facilities, parks, and picnic grounds.

Coastal and Offshore Recreation

Recreational boating activities occur along the coastline, especially during the summer months (MARCO 2018). Swimming is also popular during the summer months along the miles of white sand beaches in New Jersey (COP Volume II, Section 2.3.3; Ocean Wind 2023). Surfing can occur year-round, with the prime season in the fall. Surfers frequent several towns and cities along the coastline, including Ocean City and Atlantic City (New Jersey Department of State 2021a). Scuba diving and snorkeling are identified as dominant uses offshore from approximately Atlantic City south through the coastline of Cape May County (COP Volume II, Section 2.3.3; Ocean Wind 2023) with dive sites that include shipwrecks, artificial reefs, beach dives, and various inland sites. The sailing season typically runs from May to October in New Jersey (New Jersey Department of State 2021b) and primarily occurs in relatively small areas within the bays and inlets and just along the coastline (COP Volume II, Section 2.3.3; Ocean Wind 2023).

There is a large and robust recreational fishing industry in New Jersey. The *Fisheries Economics of the United States Report of 2019* estimates that recreational fishing had a $3.88 million impact on New Jersey's economy in 2019 (NOAA 2022c). Collectively, there were over 117 million recreational angler trips (i.e., party boats, rental/private boats, and shore) made in New Jersey from 2012 to 2019 (NOAA 2022c). There are several areas classified as Prime Fishing Areas by NJDEP, which are areas that have a history of supporting a significant local quantity of recreational and commercial fishing activity (see Section 3.9, *Commercial Fisheries and For-Hire Recreational Fishing*). The popular recreational saltwater species in New Jersey are primarily caught from May to October. There are also annual recreational fishing tournaments held in coastal towns in New Jersey. Saltwater fishing tournaments target a variety of fish including stripers, fluke, bluefish, black drum, weakfish, northern kingfish, sea bass, tautog, tuna, and shark (COP Volume II; Ocean Wind 2023). According to NOAA Fisheries One Stop Shop database, recreational anglers off the coast of New Jersey caught 27,884,119 pounds of fish in 2015; 36,790,649 pounds in 2016; 36,002,306 pounds in 2017; 27,819,980 pounds in 2018; and 21,344,901 pounds in 2019 (NOAA n.d.).

NOAA's social indicator mapping (NOAA 2022b) identifies the importance or level of dependence of recreational fishing to coastal communities. Several communities in the geographic analysis area have a high recreational fishing reliance, which measures the presence of recreational fishing in relation to the population size of a community, and high recreational fishing engagement, which measures the presence of recreational fishing through fishing activity estimates. The communities with the highest reliance on recreational fishing are Cape May and Barnegat Light; Atlantic City has a low reliance on recreational fishing. Communities with the highest recreational fishing engagement are Cape May, Atlantic City, Barnegat Light, and Ocean City; the rest of the New Jersey coast within the geographic analysis area has a low or medium recreational fishing engagement. The communities with the highest recreational fishing reliance and recreational fishing engagement would be most affected by impacts on recreational fishing from offshore wind development.

Recreational crabbing is important to the region and occurs primarily along the bays and creeks on the Jersey Shore, especially in the upper portion of Barnegat Bay, Little Egg Harbor, and the Maurice River estuary, which contribute 65 to 86 percent of the total recreational harvest (NJDEP 2018b). The peak crabbing season occurs from mid-June until early October and is especially good in August.

Atlantic County

Atlantic County lies in the southern peninsula of New Jersey and encompasses approximately 671 square miles (BOEM 2012a). There are nine harbors, 12 marinas/boatyards, and one yacht club (BOEM 2012a). The county is best known for its boardwalk along the beach of Atlantic City, which is the largest casino resort area on the East Coast, composed of twelve 24-hour/7-day-a-week casinos with restaurants, nightclubs, and game rooms. It has approximately 20 miles of shoreline with four public beaches, which collectively total over 14 miles (BOEM 2012a). There are several boat launches and marinas in the county, which have small recreational boat rentals. Recreational fishing is permitted on the beaches, outside of guarded areas, and from the jetties. There are also multiple fishing piers available to the public. The seawall is a popular area for fishing and crabbing (COP Volume II, Section 2.3.3; Ocean Wind 2023).

Cape May County

Cape May is New Jersey's southernmost county and encompasses 620 square miles, receiving millions of visitors annually. It has 30 miles of shoreline and is considered one of the premiere remote beach destinations along the Mid-Atlantic coast. The county has 14 beaches, six harbors, 32 marinas/boatyards, and six yacht clubs. It has two boardwalk beaches but the majority of oceanfront property is undeveloped, with few stores, beachside amenities, and amusement rides (BOEM 2012a). Popular activities at the boardwalks include shopping, dining, rides, and walking along the boardwalk. The more remote beaches are utilized for sunbathing, swimming, and beachcombing. Surfing, sailing, boating, fishing, diving, and kayaking are also popular offshore activities. Recreational fishing occurs along the back bays and from the surf, piers, and boats along the Jersey Cape (COP Volume II, Section 2.3.3; Ocean Wind 2023).

Cumberland County

Cumberland County's shore is along the Delaware Bay, which offers miles of undisturbed bay shore. Coastal recreation in Cumberland County includes boating, fishing, and bird watching. Cumberland County dining options for tourists feature local delicacies such as the sweet oysters found in the Delaware Bay (Cumberland County 2021).

Ocean County

Ocean County is in the center of the Jersey Shore region and is approximately 916 square miles. The county provides an array of recreational beaches, boardwalks, and wildlife areas. There are 19 beaches, six harbors, nearly 50 marinas/boatyards, and 25 yacht clubs (BOEM 2012a). The majority of tourism in Ocean County is focused on barrier beaches, such as Island Beach State Park, as well as the natural, shoreline areas. Island Beach State Park is a narrow barrier island stretching for 10 miles between the Atlantic Ocean and Barnegat Bay (COP Volume II, Section 2.3.3; Ocean Wind 2023). Island Beach State Park has received Land and Water Conservation Fund funding through the State and Local Assistance Program. The State and Local Assistance Program is administered by the National Park Service and provides matching grants to state, local, and tribal governments to create and expand their parks, develop recreational facilities, and further the local recreation (NPS 2021). The National Park Service will need to analyze potential conversion per 36 CFR 59.3, Conversion Requirements. Popular activities include sunbathing, swimming, and beachcombing. The shoreline is also popular for recreational fishing, with multiple bait and tackle shops, marinas, boat rentals, and public fishing piers (COP Volume II, Section 2.3.3; Ocean Wind 2023).

Onshore Recreation

Atlantic County

A majority of the Tuckahoe-Corbin City Fish and Wildlife Management Area is within the county and consists of approximately 17,500 acres of tidal marsh, woodlands, fields, and impoundments (NJDEP 2018c; COP Volume II, Figure 2.3.3-2; Ocean Wind 2023). Eight wildlife management areas totaling 35,613 acres also fall within Atlantic County: Absecon (3,946 acres), Great Egg Harbor River (6,825 acres), Hammonton Creek (5,720 acres), Makepeace Lake (11,737 acres), Malibu Beach (257 acres), Maple Lake (4,789 acres), Pork Island (867 acres), and Port Republic (1,471 acres) (NJDEP 2021a).

There were 827 accommodation and food service establishments in the county in 2019. Together, these generated over $1.2 billion in annual payroll. There were 113 arts, entertainment, and recreation establishments in Atlantic County, which bring in approximately $41 million in annual payroll. Approximately 13.4 percent of all housing units in Atlantic County are for seasonal, occupational, or occasional use (U.S. Census Bureau 2021a, 2021b).

Burlington County

Burlington County boarders Atlantic and Ocean Counties at the mouth of the Mullica River and stretches northwest to the Delaware River, which is the state border with Pennsylvania. The portion of Burlington County in the geographic analysis area is primarily state land, including parts of Wharton State Forest, Penn State Forest, Bass River State Forest, and Swan Bay Wildlife Management Area (NJDEP 2021b). Recreation activities in the area include hiking and biking (Burlington County n.d.).

Cape May County

There are many parks, state forests, and wildlife management areas in Cape May County. The Cape May National Wildlife Refuge encompasses 11,500 acres of grasslands, saltmarshes, and beachfront (BOEM 2012a; COP Volume II, Figure 2.3.3-2; Ocean Wind 2023). The Cape May Coastal Wetlands Wildlife Management Area extends along the coast of Cape May County and occupies approximately 17,800 acres (COP Volume II, Section 2.3.3; Ocean Wind 2023).

There were 917 accommodation and food service establishments in the county in 2019. Together, these generated over $240 million in annual payroll. There were 143 arts, entertainment, and recreation establishments in Cape May County, which bring in approximately $50 million in annual payroll. Approximately 50.9 percent of all housing units in Cape May County are for seasonal, occupational, or occasional use (U.S. Census Bureau 2021a, 2021b).

Cumberland County

Inland Cumberland County is home to wild and scenic rivers, which offer opportunities for boating, fishing, and birdwatching. Cumberland County also has golf courses, historic sites and tours, a performing arts center, a downtown arts district, museums, and a zoo (Cumberland County 2021).

Thirteen wildlife management areas totaling at least 50,872 acres fall within Cumberland County: Buckshutem (4,222 acres), Cedarville Ponds (42 acres), Clarks Pond (196 acres), Cohansey River (1,474 acres), Dix (5,408 acres), Egg Island (8,992 acres), Fortescue (1,951 acres), Heislerville (7,695 acres), Menantico Ponds (474 acres), Milville (16,403 acres), Nantuxent (1,144 acres), and New Sweden (2,871 acres). The 34,153-acre Peaslee Wildlife Management Area resides in both Cumberland and Cape May Counties (NJDEP 2021a).

Ocean County

Ocean County has 27 parks and conservation areas with over 40,000 acres of wildlife management areas. Twelve wildlife management areas fall within Ocean County: Butterfly Bogs (166 acres), Colliers Mills (12,968 acres), Forked River Mountain (2,121 acres), Great Bay Boulevard (5,982 acres), Manahawkin (1,791 acres), Manchester (3,802 acres), Oyster Creek Access (14 acres), Point Pleasant Fishing Access (7 acres), Sedge Islands (193 acres), Stafford Forge (12,592 acres), Upper Barnegat Bay (427 acres), and Whiting (1,212 acres) (NJDEP 2021a). The Edwin B. Forsythe National Wildlife Refuge consists of more than 47,000 acres of coastal habitats and provides wildlife viewing and nature trails (New Jersey Department of State 2021c). The Barnegat Lighthouse State Park is on the northern tip of Long Beach Island, includes provides panoramic views of Barnegat Inlet, and provides trails through maritime forests, birding sites for waterfowl, fishing sites, and nature walks (New Jersey Department of State 2021d). Other popular activities in the county include hiking, biking, kayaking, golfing, and sightseeing (Ocean County 2021).

There were 1,292 accommodation and food service establishments in the county in 2019. Together, these generated over $342 million in annual payroll. There were 272 arts, entertainment, and recreation establishments in Ocean County, which bring in approximately $116 million in annual payroll. Approximately 6.4 percent of all housing units in Ocean County are for seasonal, occupational, or occasional use (U.S. Census Bureau 2021a, 2021b).

3.18.2 Environmental Consequences

3.18.2.1. Impact Level Definitions for Recreation and Tourism

Definitions of impact levels are provided in Table 3.18-1.

Table 3.18-1 Impact Level Definitions for Recreation and Tourism

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts on the recreation setting, recreation opportunities, or recreation experiences would be so small as to be unmeasurable.
	Beneficial	No effect or measurable impact.
Minor	Adverse	Impacts would not disrupt the normal functions of the affected activities and communities.
	Beneficial	A small and measurable improvement to infrastructure/facilities and community services, or benefit for tourism.
Moderate	Adverse	The affected activity or community would have to adjust somewhat to account for disruptions due to the Project.
	Beneficial	A notable and measurable improvement to infrastructure/facilities and community services, or benefit for tourism.
Major	Adverse	The affected activity or community would have to adjust to significant disruptions due to large local or notable regional adverse impacts of the Project.
	Beneficial	A large local, or notable regional improvement to infrastructure/facilities and community services, or benefit for tourism.

3.18.3 Impacts of the No Action Alternative on Recreation and Tourism

Section 3.1 of the Final EIS explains the approach to predicting impacts related to the No Action Alternative. When analyzing the impacts of the No Action Alternative on recreation and tourism, BOEM considered the impacts of past and ongoing trends and activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for recreation and tourism. BOEM separately analyzes how resource conditions will be affected over time as reasonably foreseeable activities are implemented. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*. Separate impact conclusions are presented for both scenarios.

3.18.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, recreation and tourism in the geographic analysis area described in Section 3.18.1, *Description of the Affected Environment for Recreation and Tourism*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities.

Recreation and tourism would continue to be affected by ongoing activities, especially ongoing vessel traffic; noise and trenching from periodic maintenance or installation of piers, pilings, seawalls, and offshore cables; and onshore development activities. These activities would contribute to periodic disruptions to recreational and tourism activities but are a typical part of daily life along the New Jersey coastline and would not substantially affect recreational enjoyment in the geographic analysis area. Visitors would continue to pursue activities that rely on the area's coastal and ocean environment, scenic qualities, natural resources, and establishments that provide services for tourism and recreation. The geographic analysis area has a strong tourism industry and abundant coastal and offshore recreational facilities, many of which are associated with scenic views. The beach, and by proxy the ocean, is a primary concern for the local jurisdictions' tourism industry (NJCRDA 2012, Cape May County n.d.). See Table F1-20 for a summary of potential impacts associated with ongoing non-offshore wind activities by IPF for recreation and tourism. There are no ongoing offshore wind activities within the geographic analysis area for recreation and tourism.

3.18.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with other planned activities (without the Proposed Action). Planned non-offshore wind activities that may affect recreation and tourism include emplacement of submarine cables and pipelines, dredging and port improvements, marine mineral use, and military use (see Section F.2 in Appendix F for a description of ongoing and planned activities). Like ongoing activities, other planned non-offshore wind activities may result in periodic disruptions to recreation and tourism activities along the coast. However, visitors are expected to be able to continue to pursue activities that rely on other coastal and ocean environments, scenic qualities, natural resources, and establishments that provide services to recreation and tourism. BOEM expects planned offshore wind activities to affect recreation and tourism through the following primary IPFs.

Anchoring: This IPF would potentially affect recreational boating through both the presence of an increased number of anchored vessels within the geographic analysis area and the creation of offshore areas with cable hardcover or scour protection where recreational vessels may experience limitations or difficulty in anchoring.

Increased vessel anchoring during offshore wind development between 2023 and 2030 would affect recreational boaters. The greatest volume of anchored vessels would occur in offshore work areas during construction. The COP estimated there would be a maximum of 65 daily vessel trips generated during peak construction periods of the Proposed Action (Section 3.16, *Navigation and Vessel Traffic*). Offshore wind projects may generate similar numbers of active and anchored vessels, depending on project size and construction schedule. Anchored construction-related vessels may be within temporary safety zones established in coordination with USCG for active construction areas (COP Volume II, Section 2.3.6.2.1; Ocean Wind 2023). Offshore wind development in the geographic analysis area is anticipated to result in increased survey activity and overlapping construction periods between 2023 and 2030.

Vessel anchoring would also occur during maintenance and monitoring activities during operations. Following construction of other offshore projects (if approved), the presence of operating offshore wind projects in the geographic analysis area would result in a long-term increase in the number of vessels anchored during periodic maintenance and monitoring. Vessel anchoring during maintenance and monitoring would have moderate impacts on recreation and tourism.

Anchored construction, survey, or service vessels would have localized, temporary impacts on recreational boating. Recreational vessels could navigate around anchored vessels with only brief inconvenience. The temporary turbidity from anchoring would briefly alter the behavior of species important to recreational fishing (Section 3.13, *Finfish, Invertebrates, and Essential Fish Habitat*) and sightseeing (primarily whales, but also dolphins and seals) (Section 3.15, *Marine Mammals*). Inconvenience and navigational complexity for recreational vessels would be localized, variable, and long term, with increased frequency of anchored vessels during surveying and construction and reduced frequency of anchored vessels during operations. Construction, survey, and service vessel anchoring would have moderate impacts on recreation and tourism.

Land disturbance: Other offshore wind development would require installation of onshore export cables and onshore substation infrastructure, which would cause temporary traffic delays and could temporarily affect access to adjacent properties, resulting in localized, temporary disturbances of recreational activity or tourism-based businesses near cable routes and construction sites for substations and other electrical infrastructure. These impacts would only last through construction and occasionally during maintenance events. The exact extent of impacts would depend on the locations of landfall and onshore transmission cable routes for offshore wind energy projects; however, the No Action Alternative would generally have localized, short-term minor impacts during construction or maintenance and no long-term impacts on recreation and tourism use.

Lighting: Construction-related nighttime vessel lighting would be used if offshore wind development projects include nighttime, dusk, or early morning construction or material transport. In a maximum-case scenario, lights could be active throughout nighttime hours for up to eight other offshore wind projects within the geographic analysis area simultaneously under active construction. Vessel lighting would enable recreational boaters to safely avoid nighttime construction areas. The impact on recreational boaters would be localized, sporadic, short term, and minimized by the limited offshore recreational activities that occur at night.

Permanent aviation warning lighting required on the WTGs would be visible from beaches and coastlines within the geographic analysis area and could have impacts on recreation and tourism in certain locations if the lighting influences visitor decisions in selecting coastal locations to visit. FAA hazard lighting systems would be in use for the duration of O&M for up to 761 WTGs. The amassing of these WTGs and associated synchronized flashing strobe lights affixed with a minimum of three red flashing lights at the mid-section of each tower and one at the top of each WTG nacelle within the offshore wind lease areas would have long-term minor to major impacts on sensitive onshore and offshore viewing locations, based on viewer distance and angle of view and assuming no obstructions. Atmospheric and environmental factors such as haze and fog would influence visibility and perception of hazard lighting from sensitive viewing locations (Section 3.20).

A University of Delaware study evaluating the impacts of visible offshore WTGs on beach use found that WTGs visible more than 15 miles from the viewer would have negligible impacts on businesses dependent on recreation and tourism activity (Parsons and Firestone 2018). The study participants viewed visual simulations of WTGs in clear, hazy, and nighttime conditions (without ADLS). A 2017 visual preference study conducted by North Carolina State University evaluated the impact of offshore wind facilities on vacation rental prices. The study found that nighttime views of aviation hazard lighting (without ADLS) for WTGs close to shore (5 to 8 miles [8 to 13 kilometers]) would adversely affect the rental price of properties with ocean views (Lutzeyer et al. 2017). It did not specifically address the relationship between lighting, nighttime views, and tourism for WTGs 15 or more miles (24.1 or more kilometers) from shore. More than 95 percent of the WTG positions likely to be present based on anticipated offshore wind lease area build-out in the geographic analysis area would be more than 15 miles (24.1 kilometers) from coastal locations with views of the WTGs.

The Jersey Shore is within the viewshed of the WTGs and has been extensively developed for recreation and tourism. Because of the high development density, existing nighttime lighting is prevalent. Elevated boardwalks, jetties, and seawalls afford greater visibility of offshore elements for viewers in tidal beach areas. Nighttime views toward the ocean from the beach and adjacent inland areas are diminished by ambient light levels and glare of shorefront developments. Visible aviation warning lighting would add a developed/industrial visual element to views that were previously characterized by dark, open ocean, broken only by transient lighted vessels and aircraft passing through the view.

In addition to recreational fishing, some recreational boating in the region involves whale watching and other wildlife-viewing activity. A 2013 BOEM study evaluated the impacts of WTG lighting on birds, bats, marine mammals, sea turtles, and fish. The study found that existing guidelines "appear to provide for the marking and lighting of [WTGs] that will pose minimal if any impacts on birds, bats, marine mammals, sea turtles or fish" (Orr et al. 2013). By extension, existing lighting guidelines or ADLS (if implemented) would impose a minimal impact on recreational fishing or wildlife viewing.

As a result, although lighting on WTGs would have a continuous, long-term, adverse impact on recreation and tourism, the impact in the geographic analysis area is likely to be limited to individual decisions by visitors to the Jersey Shore and elevated areas, with less impact on the recreation and tourism industry as a whole. Lighting impacts on recreation and tourism are anticipated to be negligible.

The implementation of ADLS would activate the hazard lighting system in response to detection of nearby aircraft. The synchronized flashing of the navigational lights, if ADLS is implemented, would result in shorter-duration night sky impacts on the seascape, landscape, and viewers. The shorter-duration synchronized flashing of the ADLS is anticipated to have reduced visual impacts at night as compared to the standard continuous, medium-intensity red strobe FAA warning system due to the duration of activation. Based on recent studies (Atlantic Shores 2021), activation of the Ocean Wind 1 ADLS, if implemented, would occur for less than 11 hours per year, as compared to standard continuous FAA hazard lighting. It is anticipated that the reduced time of FAA hazard lighting resulting from an implemented ADLS would reduce the duration of potential impacts of nighttime aviation lighting to less than 1 percent of the normal operating time that would occur without using ADLS.

Cable emplacement and maintenance: Under the No Action Alternative, other offshore wind export cables in the recreation and tourism geographic analysis area could total 961 miles, while inter-array cables could total 1,466 miles (excluding the Proposed Action). Cables for other offshore wind projects would likely be emplaced within the geographic analysis area between 2023 and 2030. Offshore cable emplacement for offshore wind development projects would have temporary, localized, adverse impacts on recreational boating while cables are being installed, because vessels would need to navigate around work areas and recreational boaters would likely prefer to avoid the noise and disruption caused by installation. Cable installation could also have temporary impacts on fish and invertebrates of interest for recreational fishing, due to the required dredging, turbulence, and disturbance; however, species would recover upon completion (Section 3.13). The degree of temporal and geographic overlap of each cable is unknown, although cables for some projects could be installed simultaneously. Active work and restricted areas would only occur over the cable segment being emplaced at a given time. Once installed, cables would affect recreational boating only during maintenance operations, except that the mattresses covering cables in hard-bottom areas could hinder anchoring and result in gear entanglement or loss.

Impacts of cable emplacement and maintenance on recreational boating and tourism would be short term, continuous, adverse, and localized. Disruptions from cable emplacement and maintenance are anticipated to have a minor impact of recreation and tourism.

Noise: Noise from construction, pile driving, HRG survey activities, trenching, O&M, and vessels could result in adverse impacts on recreation and tourism.

Onshore construction noise from cable installation at the landfall sites, and inland if cable routes are near parkland, recreation areas, or other areas of public interest, would temporarily disturb the quiet enjoyment of the site (in locations where such quiet is an expected or typical condition). Similarly, offshore noise from HRG survey activities, pile driving, trenching, and construction-related vessels would intrude upon the natural sounds of the marine environment. This noise could cause some boaters to avoid areas of noise-generating activity, although some of the most intense noise could be within safety zones that USCG may establish within 12 nm of the coast for areas of active construction, which would be off-limits to boaters. Noise from pile driving, the noisiest aspect of WTG installation, is estimated to be 101 A-weighted decibels (dBA) at 50 feet (COP Volume III, Appendix R-1, Section 2.5; Ocean Wind 2023). BOEM conducted a qualitative analysis of impacts on recreational fisheries for the construction phases of offshore wind development in the Atlantic OCS region. Results showed the construction phase is expected to have a slightly negative to neutral impact on recreational fisheries due to both direct exclusion of fishing activities and displacement of mobile target species by the construction noise (Kirkpatrick et al. 2017). The impact of noise on recreation and tourism during construction would be adverse, intense, and disruptive, but short term and localized.

Adverse impacts of noise on recreation and tourism would also result from the adverse impacts on species important to recreational fishing and sightseeing within the recreation and tourism geographic analysis area and along cable routes, as discussed in Sections 3.9, 3.13, and 3.15. HRG survey noise and pile driving would cause the most impactful noises (COP Volume III, Appendix R-2, Section C-3; Ocean Wind 2023). Because most recreational fishing takes place closer to shore, only a small proportion of recreational fishing would be affected by construction noise of WTGs, 15.3 miles (25.9 kilometers) offshore. Recreational fishing for highly migratory species, such as tuna, shark, and marlin, is more likely to be affected, as the highly migratory species fishery usually occurs farther offshore than most recreational fisheries and, therefore, is more likely to experience temporary impacts resulting from the noise generated by offshore wind construction. Construction noise could contribute to temporary impacts on marine mammals, with resulting impacts on marine sightseeing that relies on the presence of mammals, primarily whales. However, as noted in Section 3.15, other projects are expected to comply with mitigation measures (e.g., exclusion zones, protected species observers) that would avoid and minimize underwater noise impacts on marine mammals.

Offshore wind surveying and construction would occur within the geographic analysis area between 2023 and 2030. Based on the discussion above, offshore wind construction would result in short-term, localized, adverse impacts on recreational fishing and marine sightseeing related to fish and marine mammal populations. Multiple construction projects would increase the spatial and temporal extent of temporary disturbance to marine species within the geographic analysis area. BOEM's assumed construction schedule for offshore wind projects in Table F2-1 in Appendix F indicates the possibility of up to eight (not including the Proposed Action) wind projects under development between 2024 and 2030 in the recreation and tourism geographic analysis area. As indicated in Appendix F, up to 851 offshore WTGs could be installed within a 6- to 10-year period within the recreation and tourism geographic analysis area, not including the Proposed Action. No long-term, adverse impacts are anticipated that would result in population-level harm to fish and marine mammal populations.

During operations, the continuous noise generated by WTG operation would occur at least 13 nm offshore and is not expected to produce sound in excess of background levels at any onshore locations (COP Volume III, Appendix R-1, Section 2.6; Ocean Wind 2023). Noise from operational WTGs would be expected to have little effect on finfish, invertebrates, and marine mammals and, therefore, little effect on recreational fishing or sightseeing. The impact of noise during O&M is anticipated to be negligible and localized, continuous, and long term, with brief, more-intensive noise during occasional repair activities.

Port utilization: Ports within the geographic analysis area for recreation and tourism that could be used for construction and O&M of offshore wind development include ports in Atlantic City and Port Elizabeth, New Jersey. These ports may also provide facilities for recreational vessels or may be on waterways shared with recreational marinas, and may experience increased activity, expansion, or dredging. The ports listed above and other regional ports suitable for staging and construction of other offshore wind development are primarily industrial in character, with recreational activity as a secondary use.

Port improvements could result in short-term delays and crowding during construction but could provide long-term benefits to recreational boating if the improvements result in increased berths and amenities for recreational vessels, or improved navigational channels. The impact of port utilization on recreation and tourism is anticipated to be negligible.

Presence of structures: The placement of 761 WTGs (excluding the Proposed Action) within the recreation and tourism geographic analysis area would contribute to impacts on recreational fishing and boating. The offshore structures would have long-term, adverse impacts on recreational boating and fishing through the risk of allision; risk of gear entanglement, damage, or loss; navigational hazards; space use conflicts; presence of cable infrastructure; and visual impacts. However, offshore wind structures could have beneficial impacts on recreation through fish aggregation and reef effects.

The WTGs installed for offshore wind development (excluding the Proposed Action) are expected to serve as additional artificial reef structures, providing additional locations for recreational for-hire fishing trips, potentially increasing the number of trips and revenue. The increased number of fishing trips out of nearby ports could also support increased angler expenditures at local bait shops, gas stations, and other shore-side dependents.

The presence of offshore wind structures would increase the risk of allision or collision with other vessels and the complexity of navigation within the recreation and tourism geographic analysis area. Generally, the vessels more likely to allide with WTGs or substations would be smaller vessels moving within and near wind installations, such as recreational vessels. USCG would need to adjust its SAR planning and search patterns to allow aircraft to fly within the geographic analysis area, leading to a less-optimized search pattern and a lower probability of success, as described in greater detail in Section 3.17, *Other Uses (Marine Minerals, Military Use, Aviation).*

Offshore wind development could require adjustment of routes for recreational boaters, anglers, sailboat races, and sightseeing boats, but the adverse impact of the offshore wind structures on recreational boating would be limited by the distance offshore. Recreational boating routes in the geographic analysis area are highly concentrated in Great Egg Harbor Bay and Great Egg Inlet, with mid-level concentrations in Absecon Inlet, far from offshore wind developments. In addition, sailing in the geographic analysis area primarily occurs in relatively small areas within the bays and inlets and just along the coastline (COP Volume II, Section 2.3.3.1; Ocean Wind 2023).

The recreation and tourism geographic analysis area would have an estimated 761 WTG foundations with scour protection and cable protection for export and inter-array cables, which results in an increased risk of entanglement. The cable protection would also present a hazard for anchoring, as anchors could have difficulty holding or become snagged and lost. Accurate marine charts could make operators of recreational vessels aware of the locations of the cable protection and scour protection. If the hazards are not noted on charts, operators may lose anchors, leading to increased risks associated with drifting vessels that are not securely anchored. Buried offshore cables would not pose a risk for most recreational vessels, as smaller-vessel anchors would not penetrate to the target burial depth for the cables. Because anchoring is uncommon in water depths where the No Action Alternative WTGs would be installed, anchoring risk is more likely to be an impact over export cables in shallower water closer to coastlines. The risk to recreational boating would be localized, continuous, and long term.

Offshore WTGs could provide new opportunities for offshore tourism by attracting recreational fishing and sightseeing. The structures could produce artificial reef effects. The “reef effect” refers to the introduction of a new hard-bottom habitat that has been shown to attract numerous species of algae, shellfish, finfish, and sea turtles to new benthic habitat (COP Volume II, Section 2.2.5; Ocean Wind 2023). The reef effect could attract species of interest for recreational fishing, including spearfishing, and result in an increase in recreational boaters traveling farther from shore to fish within the recreation and tourism geographic analysis area. The potential attraction of sea turtles to the structures may also attract recreational boaters and sightseeing vessels. Although the likelihood of recreational vessels visiting the offshore WTGs would diminish with distance from shore (Parsons et al. 2020), increasing numbers of offshore structures may encourage a greater volume of recreational vessels to travel to the offshore wind lease areas. Additional fishing and tourism activity generated by the presence of structures could also increase the likelihood of allisions and collisions involving recreational fishing or sightseeing vessels, as well as commercial fishing vessels (Section 3.9).

As it relates to the visual impacts of structures, the vertical presence of WTGs on the offshore horizon may affect recreational experience and tourism in the geographic analysis area. Section 3.20 describes the visual impacts from offshore wind infrastructure. If the purpose of the viewer’s sightseeing excursion is to observe the mass and scale of the WTGs’ offshore presence, then the increasing visual dominance would benefit the recreation/tourism experience as the viewer navigates toward the WTGs. However, if experiencing a vast pristine ocean condition is the purpose of the viewer’s sightseeing excursion, then the increasing visual dominance may detract from the viewer’s recreation/tourism experience.

Studies and surveys that have evaluated the impacts of offshore wind facilities on tourism found that established offshore wind facilities in Europe did not result in decreased tourist numbers, tourist experience, or tourist revenue, and that Block Island Wind Farm’s WTGs provide excellent sites for fishing and shellfishing (Smythe et al. 2018). A survey-based study found that, for prospective offshore wind facilities (based on visual simulations), proximity of WTGs to shore is correlated to the share of respondents who would expect a worsened experience visiting the coast (Parsons and Firestone 2018).

- At 15 miles (24.1 kilometers), the percentage of respondents who reported that their beach experience would be worsened by the visibility of WTGs was about the same as the percentage of those who reported that their experience would be improved (e.g., by knowledge of the benefits of offshore wind).
- About 68 percent of respondents indicated that the visibility of WTGs would neither improve nor worsen their experience.

- Reported trip loss (respondents who stated that they would visit a different beach without offshore wind development) averaged 8 percent when wind projects were 12.5 miles (20 kilometers) offshore, 6 percent when 15 miles (24.1 kilometers) offshore, and 5 percent when 20 miles (32 kilometers) offshore.
- About 2.6 percent of respondents were more likely to visit a beach with visible offshore wind facilities at any distance.

A study focused on the changes to the vacation rental market after the construction of Block Island Wind Farm found that Block Island Wind Farm led to significantly increased nightly reservations, occupancy rates, and monthly revenues for properties in Block Island during peak tourism season in July and August (Carr-Harris and Lang 2019). The study estimates that the Block Island Wind Farm caused a 7-night increase in reservations, a 19-percent increase in occupancy rates, and a $3,490 increase in rental property revenue during July and August. Outside of peak tourism season, the Block Island Wind Farm did not have an impact on the vacation rental market.

However, a 2003 survey focused on tourist feelings about potential offshore wind development in Cape Cod, Massachusetts found that, based on visual simulations of prospective offshore wind facilities, 3.2 percent of tourists said they would spend an average of 2.9 fewer days in Cape Cod, and a further 1.8 percent said they would not visit at all if the wind turbines were built (Haughton et al. 2003).

A 2019 survey of 553 coastal recreation users in New Hampshire included participants in water-based recreation activities such as fishing from shore and boats, motorized and non-motorized boating, beach activities, and surfing at the New Hampshire seacoast. Most (77 percent) supported offshore wind development along the New Hampshire coast, while 12 percent opposed it and 11 percent were neutral. Regarding the impact on their outdoor recreation experience, 43 percent anticipated that offshore wind development would have a beneficial impact, 31 percent anticipated a neutral impact, and 26 percent anticipated an adverse impact (BOEM 2021a).

It is important to note that the wind turbines used for the visual simulations in the studies above used smaller WTGs than are proposed for the planned offshore wind projects in the region, including the Proposed Action. At an eye level of 5.5 feet (1.7 meters) above sea level, the 579-foot (176.5-meter) WTGs used in the Parsons and Firestone 2018 study would be visible out to 32.4 miles (52.1 kilometers). The 906-foot (276-meter) Ocean Wind 1 WTGs would be visible out to 39.6 miles (63.7 kilometers). Greater eye-level heights would increase the visible distance in both cases. At Ocean Wind 1’s distance from the nearest beach of 15.3 miles (24.6 kilometers), the upper 476 feet (145.1 meters) of the Delaware study’s 579-foot (176.5-meter) WTG would be visible to viewers. At this distance, the upper 803 feet (245 meters) of Ocean Wind 1 WTGs would be visible. Therefore, in both the 2018 Parsons and Firestone study and Ocean Wind 1’s cases, the WTGs’ hubs, nacelles, navigation lights, and rotor blades would be visible to viewers on the nearest beach. The taller Ocean Wind 1 WTGs would result in increased numbers of WTGs visible in the wind farm. Such additional WTGs would be seen as lower than/below the tops of the forward row of WTGs and would be increasingly obscured by those intervening in the view. The wind farm would be perceived as a mass of WTGs, rather than as individual WTGs.

As described under the IPF for light, the Jersey Shore within the viewshed of the WTGs is highly developed. Public beaches and tourism attractions in this area are highly valued for scenic, historic, and recreational qualities and draw large numbers of daytime visitors during the summertime tourism seasons. When visible (i.e., on clear days, in locations with unobstructed ocean views), WTGs would add a developed/industrial visual element to ocean views that were previously characterized by open ocean, broken only by transient vessels and aircraft passing through the view.

Based on the currently available studies, portions of the 761 WTGs associated with the No Action Alternative could be visible from shorelines (depending on vegetation, topography, weather, atmospheric conditions, and the viewers' visual acuity). WTGs visible from some shoreline locations in the geographic analysis area would have adverse impacts on visual resources when discernable due to the introduction of industrial elements in previously undeveloped views. Based on the relationship between visual impacts and impacts on recreational experience, the impact of visible WTGs on recreation would be moderate, long term, continuous, and adverse. Seaside locations could experience some reduced recreational and tourism activity, but the visible presence of WTGs would be unlikely to affect shore-based or marine recreation and tourism in the geographic analysis area as a whole.

Traffic: Other offshore wind project construction and decommissioning and, to a lesser extent, offshore wind project operation would generate increased vessel traffic that could inconvenience recreational vessel traffic within the geographic analysis area. The impacts would occur primarily during construction, along routes between ports and the offshore wind construction areas.

Vessel traffic for each project is not known but is anticipated to be similar to that of the Proposed Action, which is projected to generate between 20 and 65 vessels operating in the Wind Farm Area or over the offshore export cable route at any given time. As shown in Table F-3 in Appendix F, between 2023 and 2030 as many as eight offshore wind projects (not including the Proposed Action) could be under construction. During periods of overlapping construction and assuming similar vessel counts as under the Proposed Action, construction of offshore wind projects would generate up to 520 vessels (either underway or at anchor) at any given time within the recreation and tourism geographic analysis area.

Establishment of up to eight offshore wind projects could occur within the recreation and tourism geographic analysis area between 2023 and 2030 (not including the Proposed Action). O&M activities for the Proposed Action are anticipated to generate an average of 10 vessel trips per day between a port and the Wind Farm Area. Based on the estimates for the Proposed Action, operation of the No Action Alternative would generate an average of 80 vessel trips per day associated with the recreation and tourism geographic analysis area.

Increased vessel traffic would require increased alertness on the part of recreational or tourist-related vessels and would result in minor delays or route adjustments. The likelihood of vessel collisions would increase as a result of the higher volumes of vessel traffic during construction. The possibility of delays and risk of collisions would increase if more than one offshore wind facility is under construction at the same time. Vessel traffic associated with offshore wind would have long-term, variable, adverse impacts on vessel traffic related to recreation and tourism. Higher volumes during construction would result in greater inconvenience, disruption of the natural marine environment, and risk of collision. Vessel traffic during operations would represent only a modest increase in the background volumes of vessel traffic, with minimal, minor impacts on recreational vessels.

EMF: Installation of other offshore wind export cables in the recreation and tourism geographic analysis area would generate EMF during operation of the wind farms. Where installation occurs near beaches, fishing sites, and other areas of recreational activity, visitors may be exposed to EMF. Common household items including television sets, hair dryers, and electric drills can emit magnetic fields similar to or higher in intensity than those emitted by undersea power cables (CSA Ocean Sciences, Inc. and Exponent 2019). Based on typical EMF values from submarine cables buried at a depth of 3 feet (1 meter), maximum emissions directly above the onshore export cable would not exceed 165 milliGauss. From 10 to 25 feet (3 to 7.5 meters) away from the onshore export cable, emissions values drop to less than 0.1 to 12 milliGauss. These values are below the reported human health reference levels of 2,000 and 9,040 milliGauss for the general population (BOEM 2021b). Even if other offshore wind export cables were of higher voltage or buried closer to the surface, EMF levels are still anticipated to be well below the human health reference levels and, therefore, EMF impacts on recreation and tourism would be long term but negligible.

3.18.3.3. Conclusions

Impacts of the No Action Alternative. Under the No Action Alternative, current environmental trends and activities would continue, and recreation and tourism would continue to be affected by natural and human-caused IPFs. Recreation and tourism in the geographic analysis area would continue to be affected by ongoing activities, especially ongoing vessel traffic; noise and trenching from periodic maintenance or installation of piers, pilings, seawalls, and offshore cables; and onshore development activities. These activities would contribute to periodic disruptions to recreation and tourism activities but are typical of the New Jersey coastline and would not substantially affect recreational enjoyment in the geographic analysis area. The No Action Alternative would result in **negligible** impacts on recreation and tourism from ongoing activities

Cumulative Impacts of the No Action Alternative. Planned non-offshore wind activities that may affect recreation and tourism include emplacement of submarine cables and pipelines, dredging and port improvements, marine mineral use, and military use. Like ongoing activities, other planned non-offshore wind activities may result in periodic disruptions to recreation and tourism activities along the coast through the primary IPFs of vessel traffic, noise, and cable emplacement. Planned activities other than offshore wind would have localized, temporary impacts on recreational boating and would not affect the area's scenic quality. Other offshore wind activities are expected to contribute considerably to several IPFs, the most prominent being noise and vessel traffic during construction and the presence of offshore structures during operations. Noise and vessel traffic would have impacts on visitors, who may avoid onshore and offshore noise sources and vessels, and on recreational fishing and sightseeing as a result of the impacts on fish, invertebrates, and marine mammals. The long-term presence of offshore wind structures would result in increased navigational constraints and risks, potential entanglement and loss, and visual impacts from offshore structures. Offshore wind activities in the geographic analysis area would result in beneficial impacts due to the presence of offshore structures and cable hardcover, which could provide opportunities for fishing and sightseeing. The No Action Alternative combined with all planned activities in the geographic analysis area (including other offshore wind activities) would result in **moderate** adverse and **minor beneficial** impacts on recreation and tourism.

3.18.4 Relevant Design Parameters & Potential Variances in Impacts for the Action Alternatives

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than described in the sections below. The following proposed PDE parameters (Appendix E) would influence the magnitude of the impacts on recreation and tourism:

- The Project layout including the number, type, height, and placement of the WTGs and OSS, and the design and visibility of lighting on the structures;
- Arrangement of WTGs and accessibility of the Wind Farm Area to recreational boaters; and
- The time of year during which onshore and nearshore construction occurs.

Variability of the proposed Project design exists as outlined in Appendix E. Below is a summary of potential variances in impacts:

- WTG number, size, location, and lighting: More WTGs and larger turbine sizes closer to shore could increase visual impacts that affect onshore recreation and tourism as well as recreational boaters. Arrangement and type of lighting systems would affect nighttime visibility of WTGs onshore.

- WTG arrangement and orientation: Different arrangements of WTG arrays may affect navigational patterns and safety of recreational boaters.
- Time of construction: Tourism and recreational activities in the geographic analysis area tend to be higher from May through September, and especially from June through August (Parsons and Firestone 2018). Impacts on recreation and tourism would be greater if Project construction were to occur during this season.

Ocean Wind has committed to measure to minimize impacts on recreation and tourism, which include developing a construction schedule to minimize activities in the onshore export cable route during the peak summer recreation and tourism season, where practicable (REC-01) and coordinating with local municipalities to minimize impacts on popular events in the area during construction, to the extent practicable (REC-02) (COP Volume II, Table 1.1-2; Ocean Wind 2023).

3.18.5 Impacts of the Proposed Action on Recreation and Tourism

3.18.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.18.7, *Impacts of Alternative E on Recreation and Tourism*.

The Proposed Action would have long-term, moderate impacts on recreation and tourism in the geographic analysis area due to the visual impact of the 98 WTGs from coastal locations and the greater navigational risks for recreational vessels within the Wind Farm Area. It would also have long-term, minor beneficial impacts due to the fish aggregation and habitat conversion impacts of the WTGs and OSS, resulting in new fishing and sightseeing opportunities. The Proposed Action would have short-term, minor impacts during construction due to the temporary impacts of noise and vessel traffic on recreational vessel traffic, the natural environment, and species important for recreational fishing and sightseeing.

Anchoring: Anchoring by Proposed Action construction, O&M, and decommissioning vessels would contribute to disturbance of marine species and inconvenience to recreational vessels that must navigate around the anchored vessels. Construction of the Proposed Action would generate between 20 and 65 vessels operating in the Wind Farm Area or over the offshore export cable route at any given time (Section 3.16). BOEM anticipates that USCG may establish temporary safety zones around offshore wind construction areas within 12 nm of the coast, which would minimize the potential for recreational boater interaction with anchored construction vessels in these areas (Section 3.16). Vessel anchoring for construction of the Proposed Action would have localized, short-term, minor impacts on tourism and recreation due to the need to navigate around vessels and work areas and the disturbance of species important to recreational fishing (Section 3.13).

Land disturbance: Onshore construction and installation of the export cables would affect recreation and tourism where construction activity interferes with access to recreation sites or increases traffic, noise, or temporary emissions that degrade the recreational experience. Installation of the cables would occur within a 50-foot-wide temporary construction corridor. Based on the landfall options with the longest onshore cable routes, construction of the Oyster Creek onshore export cable could result in up to 32 acres of temporary disturbance, and construction of the BL England onshore export cable could result in up to 48 acres of temporary disturbance (COP Volume I, Table 6.2.1-1; Ocean Wind 2023). As discussed in Section 3.11, the employment and economic impact would be localized, short term, and minor. As discussed in Section 3.14, *Land Use and Coastal Infrastructure*, technologies may be used to minimize impacts on land disturbance, including using HDD to avoid surface disturbance for one of the routes crossing Island Beach State Park. Depending on the route selected for the Oyster Creek offshore export cable route across Island Beach State Park, Ocean Wind may use either HDD to cross the island or burying of the cables within an auxiliary parking lot of Swimming Area 2 and under Shore Road. Because Island Beach State Park has received Land and Water Conservation Fund funding, the National Park Service would need to assess impacts on the property to determine if there would be a conversion of the property from a use other than public outdoor recreation in accordance with 36 CFR 59.3, Conversion Requirements. In addition to impacts on Island Beach State Park, other recreational sites that may potentially be affected during cable placement activity and maintenance include shoreside recreational fishing sites. Recreational fishing and related sites in proximity to the Oyster Creek and BL England onshore export cable routes include Ocean City Fishing pier and All Seasons Marina in Cape May County and Holiday Harbor Marina and Oyster Creek Bridge in Ocean County (NOAA 2022a). Recreational anglers at these sites may experience elevated noise, increased vehicle traffic, and temporary disruptions due to nearby construction activity, although none of the sites would be permanently affected. The Ocean County Natural Lands Trust along Bay Parkway may be affected by landfall workspace and would include temporary ground disturbance and excavation of HDD pits associated with the landfall workspace; impacts would be temporary during construction and would be restored to preconstruction conditions after construction (COP Volume II, Section 2.3.3.2.1; Ocean Wind 2023).

Ocean Wind has committed to implementing a construction schedule to minimize activities in the onshore export cable route during the peak summer recreation and tourism season and to coordinate with local municipalities to minimize impacts on popular events in the area during construction, to the extent practicable (REC-01 and REC-02; COP Volume II, Table 1.1-2; Ocean Wind 2023). These APMs would minimize impacts on recreation and tourism from construction activities. The Proposed Action is anticipated to have short-term and minor impacts on recreation and tourism, primarily surrounding the onshore cable installation and maintenance.

Lighting: When nighttime construction occurs, the vessel lighting for vessels traveling to and working at the Proposed Action’s offshore construction areas may be visible from onshore locations depending upon the distance from shore, vessel height, and atmospheric conditions. Visibility would be sporadic and variable. Although most construction is expected to occur during daylight hours, construction vessels would use work lights to improve visibility during night or poor visibility, in accordance with USCG requirements.

During operations, the Proposed Action would have a discrete contribution to nighttime visibility of the WTGs due to required aviation hazard lighting. Hazard lighting from all of the Proposed Action’s WTGs could be visible up to 40.1 miles (64.5 kilometers) away (COP Volume III, Appendix L; Ocean Wind 2023) depending on weather and viewing conditions. Ocean Wind has committed to voluntarily implement ADLS as an APM that would activate the Proposed Action’s WTG lighting only when aircraft approach the WTGs. The implementation of ADLS would reduce the duration of the potential impacts of nighttime aviation lighting to less than 1 percent of the normal operating time that would occur without using ADLS. During times when the Proposed Action’s aviation warning lighting is visible, this lighting would add a developed/industrial visual element to views that were previously characterized by dark, open ocean. Due to the limited duration and frequency of such events and the distance of the Proposed Action’s WTGs from shore, visible aviation hazard lighting for the Proposed Action would result in a long-term, intermittent, negligible impact on recreation and tourism. Onshore, operational security lighting at substations and related onshore facilities would be down-shielded to mitigate light pollution (VIS-04; COP Volume II, Table 1.1-2; Ocean Wind 2023).

Cable emplacement and maintenance: The Proposed Action’s cable emplacement would generate vessel anchoring and dredging at the worksite, requiring recreational vessels to avoid and navigate around the worksites and resulting in short-term disturbance to species important to recreation and tourism. The Proposed Action would require export cables that would cross 143 miles (230 kilometers) for Oyster

Creek and 32 miles (51 kilometers) for BL England, while inter-array cables could cross a maximum total cable length of 190 miles (300 kilometers) (COP Volume I, Section 4.4, Table 4.4-1; Ocean Wind 2023). Array cable installation would require a maximum of 18 vessels (three main laying, three burial, and 12 support vessels) (COP Volume I, Table 6.1.2-3; Ocean Wind 2023). Offshore export cable installation would require a maximum of 24 vessels (three main laying, three main cable jointing, three burial, and 15 support vessels) (COP Volume I, Table 6.1.2-5; Ocean Wind 2023). While it is not specified how long vessels would be present at a given location, there would be at least one location where cable splicing is necessary, which could require a vessel to remain at the same location for several days (COP Volume I, Table 4.4-1; Ocean Wind 2023). Recreational vessels traveling near the offshore export cable routes would need to navigate around vessels and access-restricted areas associated with the offshore export cable installation. Ocean Wind has committed to developing a communication plan to inform recreational fishers, among others, of construction and maintenance activities and vessel movements, which would minimize potential adverse impacts associated with cable emplacement and maintenance activity (GEN-14; COP Volume II, Table 1.1-2; Ocean Wind 2023). The localized, temporary need for changes in navigation routes due to Proposed Action construction would constitute a minor impact.

Cable installation could also affect fish and marine mammals of interest for recreational fishing and sightseeing through dredging and turbulence, although species would recover upon completion (Section 3.19, Sea *Turtles*, and Section 3.15, *Marine Mammals*), resulting in localized, short-term, minor impacts on recreation and tourism. Cable emplacement and maintenance that occur near beaches, fishing sites, or nearshore recreational activities could contribute to recreational impacts due to temporary water quality impacts during construction and maintenance. As discussed in Section 3.21, *Water Quality*, impacts on water quality from cable installation and maintenance would be short term and minor and are therefore not anticipated to result in substantive impacts on recreation and tourism.

Noise: Noise from O&M, pile driving and trenching, and vessels could result in impacts on recreation and tourism. Temporary impacts on recreation and tourism would result from impacts within the Wind Farm Area and along the offshore export cable route on species important to recreational fishing and marine sightseeing. The temporary disruptions to or changes in offshore fish, shellfish, and whale populations (Sections 3.13 and 3.15) would have a moderate impact on recreational fishing or marine sightseeing.

In addition to the temporary disruption to fish and shellfish, noise generated by offshore construction and onshore cable installation would have impacts on the recreational enjoyment of the marine and coastal environments, with minor impacts on recreation and tourism. Offshore construction noise would occur from vessels, trenching, and pile driving along the offshore export cable route and within the Wind Farm Area. Noise from pile driving, the noisiest aspect of WTG installation, is estimated to be 101 dBA at a distance of 50 feet. Overwater, the piling noise would be barely audible at 7 miles downwind (COP Volume III, Appendix R-1; Ocean Wind 2023). Accordingly, even where areas within or near the offshore export cable route and Wind Farm Area are available for recreational boating during construction, increased noise from construction would temporarily inconvenience recreational boaters.

Overall, construction noise from the Proposed Action alone would have localized, short-term, minor to moderate impacts on recreation and tourism. Offshore operational noise from the WTGs would be similar to the noise described for other projects under the No Action Alternative, and would therefore have continuous, long-term, negligible impacts.

Port utilization: Within the geographic analysis area, the Proposed Action would use facilities at Atlantic City, New Jersey as a construction management base and for O&M and Port Elizabeth, New Jersey for cable staging during construction. At the O&M facility in Atlantic City, New Jersey, planned marina upgrades, namely dredging in the marina and at Absecon Inlet, would benefit multiple marina users (COP Volume I; Ocean Wind 2023). Most ports supporting Proposed Action construction would be outside the geographic analysis area, including Paulsboro, New Jersey or Europe for foundation scoping; Hope

Creek, New Jersey or Norfolk, Virginia for WTG scoping; and Charleston, South Carolina or Europe for cable staging. Increased vessel traffic and construction activity during marina upgrades at Atlantic City, New Jersey may result in short-term delays and crowding during construction. The Proposed Action would have a short-term, negligible impact on recreation and tourism due to port utilization within the geographic analysis area.

Presence of structures: The Proposed Action's 98 WTGs and three OSS would affect recreation and tourism through increased navigational complexity; risk of allision or collision; attraction of recreational vessels to offshore wind structures for fishing and sightseeing; the adjustment of vessel routes used for sightseeing and recreational fishing; the risk of fishing gear loss or damage by entanglement due to scour or cable protection; and potential difficulties in anchoring over scour or cable protection.

Construction and installation, expected to begin in 2023 and be completed in 2025, would affect recreational boaters. Risk of allision with anchored vessels would increase incrementally during construction, as more anchored vessels would be within the recreation and tourism geographic analysis area. Ocean Wind has committed to developing a communication plan to inform the public of construction and maintenance activities and vessel movements, which would minimize potential adverse impacts associated with structure construction activities (GEN-14; COP Volume II, Table 1.1-2; Ocean Wind 2023). Recreational boating routes in the geographic analysis area for recreation and tourism are highly concentrated in Barnegat Bay, Barnegat Inlet, Great Egg Harbor Bay, and Great Egg Inlet, with mid-level concentrations in Absecon Inlet (COP Volume II, Section 2.3.3.1.2; Ocean Wind 2023). Recreational boating activity within the Wind Farm Area, approximately 15 miles from Atlantic City, New Jersey, is much less frequent than in areas closer to the coast. Ocean Wind proposes to mitigate impacts through the navigation-related APMs listed in Section 3.16.

During O&M of the Proposed Action, the permanent presence of WTGs would create obstacles for recreational vessels. At their lowest point, WTG blade tips would be 70.8 feet (22 meters) above the surface (COP Volume I, Section 4.4, Table 4.4-1; Ocean Wind 2023). At this height, larger sailboats would need to navigate around the Wind Farm Area, while smaller vessels could navigate unobstructed (except for the WTG monopiles).

Outside of avoiding certain operations during the construction phase, there are no planned or enforceable restrictions to vessels operating within the Wind Farm Area (COP Volume III, Appendix M, Section 6.1; Ocean Wind 2023). USCG would need to adjust its SAR planning and search patterns to allow aircraft to fly within the geographic analysis area, leading to a less-optimized search pattern and a lower probability of success, as described in greater detail in Section 3.16. Over a 10-year period (2009 through 2018), USCG executed four SAR missions in the Wind Farm Area: three cases were responding to recreational vessels in distress and one case was responding to commercial fishing vessels in distress (COP Volume III, Appendix M, Section 11.1; Ocean Wind 2023).

Recreational anglers may avoid fishing in the Wind Farm Area due to concerns about their ability to safely fish within or navigate through the area. As noted in Section 3.9, navigational hazards and scour/cable protection due to the presence of structures from ongoing and planned activities, including the Proposed Action, would result in substantial adverse impacts on commercial fisheries and for-hire recreational fishing. Recreational fishing exposure quantifies the amount of recreational fishing that would occur in the Lease Area and represents the total recreational fishing activity that may be affected by the development if anglers opt to no longer fish in this area and cannot go to a different location. Recreational fishing was considered "exposed" to potential impact if at least part of the trip occurred within 1 nm (1.9 kilometers) of the New Jersey WEA during the study period (2007–2012). Angler trips from Cape May, New Jersey, and smaller ports in Atlantic County, New Jersey are most exposed to the New Jersey WEA, with 47,348 private angler trips, or 9.7 percent of total angler trips, originating from Cape May that would be exposed (Kirkpatrick et al. 2017). See Section 3.9.5 for more information on for-hire fishery exposure. Minimal beneficial impacts on recreational fishing due to the artificial reef effect are expected and would be long term. Noise from construction can lead to the disbursement of fish in and around the construction sites, which could then lead to spatial competition depending on migration patterns. Disruption of the seabed during construction, in addition to activities that reduce water quality, increase underwater noise, or introduce artificial lighting, causing changes to fish distribution and behaviors could result in decreased catchability for recreational anglers. However, BOEM does not anticipate that habitat conversion and fish aggregation due to the presence of structures would result in considerable changes in fish distributions across the geographic analysis area after construction. For-hire fishing operations are part of the recreation and tourism industry and are included in the impacts on recreational boating and fishing anticipated in this section. The detailed discussion of impacts on for-hire fishing activities provided in Section 3.9 may also be applicable to impacts on recreational fishing in general. Overall, the impacts on recreational fishing, boating, and sailing generally would be minor, while the impacts on for-hire fishing would be moderate because these enterprises are more likely to be materially affected by displacement.

Although some recreational anglers would avoid the Wind Farm Area, the scour protection around the WTG foundations would likely attract forage fish as well as game fish, which could provide new opportunities for certain recreational anglers. Evidence from Block Island Wind Farm indicates an increase in recreational fishing near the WTGs (Smythe et al. 2018). The fish aggregation and reef effects of the Proposed Action could also create foraging opportunities for seals, small odontocetes, and sea turtles, attracting recreational boaters and sightseeing vessels. In addition, future offshore wind development could attract sightseeing boats offering tours of the wind facilities. Based on the impacts of the WTGs and OSS on navigation and fishing, the potential reef effects of these structures, and the risks to anchoring and gear loss associated with scour or cable protection, the Proposed Action would have long-term, continuous, minor beneficial and minor adverse impacts on recreation and tourism.

As it relates to visual impacts of presence of structures, the Proposed Action’s WTGs would also affect recreation and tourism through visual impacts. During construction, viewers on the Jersey Shore would see the upper portions of tall equipment such as mobile cranes. These cranes would move from turbine to turbine as construction progresses, and thus would not be long-term fixtures. Based on the duration of construction activity, visual contrast associated with construction of the Proposed Action would have a temporary, negligible impact on recreation and tourism.

The WTGs would be in open ocean approximately 15 miles east of Atlantic City, New Jersey. As described in Section 3.20 (Table 3.20-16), the maximum-case WTGs would have a height of 906 feet at the tip of the rotor blade, a navigation light height of 531 feet, and a mid-tower light at 256 feet. At maximum vertical extension, the blade tips of the WTGs would be theoretically visible to a viewer at the ocean surface or at beach elevations at distances up to 39.6 miles with clear-day conditions. Between 39.6 miles and 31 miles, only the WTG blades would be potentially visible above the horizon from the perspective of a beach-elevation viewer. Ocean Wind has voluntarily committed to use ADLS and non-reflective pure white (RAL Number 9010) or light gray (RAL Number 7035) paint colors as described in Appendix H to reduce impacts. Additionally, the lower sections of each WTG would be marked with high-visibility (RAL Number 1023) yellow paint from the water line to a minimum height of 50 feet (15.2 meters). Due to Earth curvature (EC), the yellow paint would be below the horizon beyond approximately 11.4 miles (18.3 kilometers) from eye levels of 5 feet (1.5 meters).

The visual impact of future offshore wind structures could affect recreation and tourism. The visual contrast created by the WTGs could have a beneficial, adverse, or neutral impact on the quality of the recreation and tourism experience depending on the viewer’s orientation, activity, and purpose for visiting the area. As discussed in Section 3.20.3, the Proposed Action’s landscape/seascape evaluation scale ranges from faint, to apparent, to conspicuous, to prominent, to dominant. No onshore viewpoints would result in either prominent or dominant conditions. Offshore potential viewpoints’ evaluations range from faint to dominant. Some of the limited available research on the link between visual impacts of future offshore wind, and resultant impacts on recreation and tourism, is summarized in Section 3.18.3.2.

BOEM expects the impact of visible WTGs on the use and enjoyment of recreation and tourist facilities and activities during O&M of the Proposed Action to be long term, continuous, and moderate. Beaches with views of WTGs could gain trips from the estimated 2.6 percent of beach visitors for whom viewing the WTGs would be a positive result, offsetting some lost trips from visitors who consider views of WTGs to be negative and the 8 percent of respondents who stated they would visit a different beach without offshore wind development (Parsons and Firestone 2018).

Traffic: The Proposed Action would contribute to increased vessel traffic and associated vessel collision risk, primarily during Project construction and decommissioning, along routes between ports and the offshore construction areas. Construction of the Proposed Action would generate between 20 and 65 vessels operating in the Wind Farm Area or over the offshore export cable route at any given time (Section 3.16). Recreational vessels may experience delays within the ports serving construction (outside the geographic analysis area), but most recreational boaters in the geographic analysis area would experience only minor inconvenience from construction-related vessel traffic. Vessel travel requiring a specific route that crosses or approaches the offshore export cable routes could potentially experience minor impacts.

For regularly scheduled maintenance and inspections, Ocean Wind anticipates that, on average, the Proposed Action would generate approximately 10 trips daily. Operation of the Proposed Action would have localized, long-term, intermittent, minor impacts on recreational vessel traffic near ports and in open waters. Impacts during decommissioning would be similar to the impacts during construction and installation.

Section 2.2 describes the non-routine activities associated with the Proposed Action. Activities requiring repair of WTGs, equipment or cables, or spills from maintenance or repair vessels, which could affect water quality, would generally require intense, temporary activity to address emergency conditions or respond to an oil spill. Non-routine activities could temporarily prevent or deter recreation or tourist activities near the site of a given non-routine event. With implementation of the navigation-related APMs listed in Section 3.16, the impacts of non-routine activities on recreation and tourism would be minor.

EMF: Once installed, onshore export cables would generate EMF during operations of the Project. The cables, which would be buried at a target depth of 4 feet, would be in and near areas of recreation and tourism use, including at Island Beach State Park, where visitors may be exposed to EMF generated by the cables. Buried power cables produce weak field strengths well below the recommended threshold values for human exposure (CSA Ocean Sciences, Inc. and Exponent 2019). Based on typical EMF values from submarine cables buried at a depth of 3 feet (1 meter), maximum emissions directly above the onshore export cable would not exceed 165 milliGauss. From 10 to 25 feet (3 to 7.5 meters) away from the onshore export cable, emissions values drop to less than 0.1 to 12 milliGauss (Ocean Wind 2023). These values are well below the reported human health reference levels of 2,000 and 9,040 milliGauss for the general population (BOEM 2021b). EMF impacts from onshore cable routes on recreation and tourism would be long term but negligible.

3.18.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned activities.

Anchoring: The Proposed Action would contribute a noticeable increment to the cumulative anchoring impacts on recreational boating, which would likely be localized, short term, and minor to moderate during the period in which offshore wind projects are being constructed in the geographic analysis area. A greater number of vessels would be anchored when multiple offshore wind projects are under construction at one time within the recreation and tourism geographic analysis area, potentially resulting in moderate impacts.

Land disturbance: The exact extent of land disturbance associated with other projects would depend on the locations of landfall, onshore transmission cable routes, and onshore substations for other offshore wind energy projects. Therefore, the Proposed Action would contribute a noticeable increment to the cumulative land disturbance impacts on recreation and tourism, which would be localized, short term, and minor.

Lighting: Offshore wind projects could cause aviation hazard lighting from 761 additional WTGs (859 total WTGs, including the Proposed Action) to be potentially visible within the geographic analysis area. As described in Section 3.18.3 and Section 3.20, without use of ADLS, lighting from offshore wind projects would include red flashing lights on top of WTG nacelles and at the midpoint of WTG towers. The Proposed Action would contribute a noticeable increment to the cumulative lighting impacts, which would be negligible.

Cable emplacement and maintenance: Specific cable locations associated with other offshore wind projects have not been identified within the geographic analysis area, except for Atlantic Shores South. The Proposed Action would contribute a noticeable increment to the cumulative impacts of cable emplacement and maintenance on recreational marine activities, which would likely be short term and minor.

Noise: The Proposed Action would contribute a noticeable increment to the cumulative noise impacts on marine recreation activities, which would likely be localized, short term, and minor to moderate during construction, and long term and negligible during operation.

Port utilization: The Proposed Action would result in negligible cumulative port utilization impacts on recreation and tourism.

Presence of structures: Structures from other planned offshore wind development would generate comparable types of impacts on recreation and tourism as the Proposed Action alone. The geographic extent of impacts would increase as additional offshore wind projects are constructed, but the level of impacts would likely be the same: minor to moderate adverse impacts on recreational fishing, recreational sailing and boating, and for-hire recreational fishing, as well as minor beneficial impacts. As described in Section 3.16, the lack of a common turbine spacing and layout throughout all adjoining wind projects could make it more difficult for SAR aircraft to perform operations in the Lease Area. The Proposed Action would contribute a noticeable increment to the cumulative impacts on marine recreational activities, which would be minor to moderate.

Portions of 859 WTGs from the Proposed Action combined with future offshore wind projects could potentially be visible from coastal and elevated locations in the geographic analysis area and contribute to impacts on recreation and tourism. The simulations prepared by Ocean Wind show anticipated views in clear conditions of future offshore wind projects associated with the No Action Alternative combined with the Proposed Action (Appendix M). The WTGs would be discernable on a clear day, with the color and irregular forms of the WTGs contrasting with the uninterrupted horizontal horizon line associated with the open ocean. As shown in the simulations, the Proposed Action WTGs would contribute the most from the closest locations, the northernmost coast of Cape May County and the coast of Atlantic County. The Proposed Action would be visually subordinate to future offshore wind projects along the shore of Ocean County. Atmospheric conditions could limit the number of WTGs discernable during daylight hours for a significant portion of the year (COP Volume III, Appendix L; Ocean Wind 2023). The

Proposed Action would contribute a noticeable increment to the cumulative visual impacts on recreation and tourism from ongoing and planned activities including offshore wind, which would be moderate.

Traffic: Overlapping construction schedules of offshore wind projects in the geographic analysis area would increase traffic between ports and work areas, requiring increased alertness on the part of recreational or tourist-related vessels, and possibly resulting in a greater number of minor delays or route adjustments. The likelihood of vessel collisions would increase as a result of the higher volumes of vessel traffic during construction. Modest levels of vessel traffic are anticipated from offshore wind operations (Section 3.16). The Proposed Action would contribute an undetectable increment to the cumulative vessel traffic impacts on recreation and tourism, which would be short term, variable, and minor during construction and long term, intermittent, localized, and negligible during operations.

EMF: The Proposed Action would contribute an undetectable increment to the cumulative EMF impact on recreation and tourism, which would be long term and negligible.

3.18.5.3. Conclusions

Impacts of the Proposed Action. Overall, the impacts of the Proposed Action are anticipated to be **moderate** and **minor beneficial**. Impacts would result from short-term impacts during construction: noise, anchored vessels, and hindrances to navigation from the installation of the export cable and WTGs; and the long-term presence of cable hardcover and structures in the Wind Farm Area during operations, with resulting impacts on recreational vessel navigation and visual quality. Beneficial impacts would result from the reef effect and sightseeing attraction of offshore wind energy structures.

Cumulative Impacts of the Proposed Action. The incremental impacts contributed by the Proposed Action to the cumulative impacts on recreation and tourism would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts associated with the Proposed Action would be **moderate** with **minor beneficial** impacts. The main drivers for this impact rating are the minor visual impacts associated with the presence of structures and lighting; impacts on fishing and other recreational activity from noise, vessel traffic, and cable emplacement during construction; and beneficial impacts on fishing from the reef effect.

3.18.6 Impacts of Alternatives B, C, and D on Recreation and Tourism

Impacts of Alternatives B, C, and D. Impacts of Alternatives B-1, B-2, and D would be similar to those of the Proposed Action for recreation and tourism except for the impact of the presence of structures. Construction of Alternatives B-1, B-2, and D would install fewer WTGs (up to 9 fewer WTGs for Alternative B-1, up to 19 fewer WTGs for Alternative B-2, and up to 15 fewer WTGs for Alternative D) and associated inter-array cables, which would slightly reduce the construction impact footprint and installation period. The removal of 9 and 19 WTGs for Alternatives B-1 and B-2, respectively, would result in a negligible reduction of impacts on visual resources compared to the Proposed Action, unnoticeable to the casual viewer (Section 3.20). Alternatives B-1, B-2, and D could potentially reduce gear entanglements and loss as well as allisions, and recreational fishing may see a slight decrease due to fewer structures providing reef habitat for targeted species. Fewer vessels and vessel trips would be expected, which would reduce the risk of discharges, fuel spills, and trash in the area and decrease the risk of collision with marine mammals and sea turtles (Sections 3.15 and 3.19).

Impacts of Alternative C-1 would be similar to those of the Proposed Action for recreation and tourism except for the impact of the presence of structures. As described in Section 3.20, the visual differences between the Alternative C-1 WTG array and the Proposed Action WTG array would not be noticeable to the casual viewer and would not have a substantive effect on recreation and tourism. As described in Section 3.16, the proposed buffer (0.81 to 1.08 nm) between WTGs in the Ocean Wind 1 Lease Area and

WTGs in the Atlantic Shores South Lease Area would be an improvement to vessel navigation and SAR considerations over no separation between lease areas. This buffer would allow for the transit of larger fishing vessels through the Wind Farm Area and address navigational safety concerns as recommended by USCG (Section 3.16). The buffer could improve safety for recreational fishing vessels in the Wind Farm Area.

Impacts of Alternative C-2 would be similar to those of the Proposed Action for recreation and tourism except for the impact of the presence of structures. As described in Section 3.16, the reduced turbine array row spacing distance (from 1 nm to no less than 0.99 nm) is within the preferred range for the safe navigation of vessels less than 200 feet in length and would not result in a substantive difference in impacts compared to the Proposed Action. The buffer between WTGs in the Ocean Wind 1 Lease Area and WTGs in the Atlantic Shores South Lease Area would allow for the transit of larger fishing vessels or survey vessels through the Wind Farm Area. The buffer could improve safety for recreational fishing vessels in the Wind Farm Area.

Cumulative Impacts of Alternatives B, C, and D. The incremental impacts contributed by Alternatives B, C, and D to the cumulative impacts on recreation and tourism would be similar to those described under the Proposed Action.

3.18.6.1. Conclusions

Impacts of Alternatives B, C, and D. The **moderate** impacts and **minor beneficial** impacts associated with the Proposed Action would not change substantially under Alternatives B-1, B-2, C-1, C-2, and D. The impacts associated with these action alternatives would be slight improvements over the Proposed Action's impacts, but the impact level would not change.

Cumulative Impacts of Alternatives B, C, and D. The incremental impacts contributed by Alternatives B-1, B-2, C-1, C-2, and D to the cumulative impacts on recreation and tourism would be the same as under the Proposed Action and would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts of these action alternatives would likely be **moderate** and **minor beneficial**.

3.18.7 Impacts of Alternative E on Recreation and Tourism

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. The impacts of Alternative E on recreation and tourism would be the same as those of the Proposed Action except for noise and vehicle traffic produced during construction. The impacts resulting from individual IPFs associated with the construction and installation, O&M, and decommissioning of the Project under Alternative E would be similar to those described under the Proposed Action. Island Beach State Park is one of the state's most visited parks. Increased onshore construction activity on Island Beach State Park may potentially disturb and restrict park operations and visitation due to typical construction impacts such as increased noise, traffic, and road disturbances. Construction activities would be planned to occur during the off season; however, future maintenance and emergency repairs may be needed during times of heavy park visitation. Impacts on recreation and tourism would remain localized and short term while the cables are being installed and BOEM does not anticipate impacts to be materially different than those described under the Proposed Action.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impact on recreation and tourism would be similar to those described under the Proposed Action.

3.18.7.1. Conclusions

Impacts of Alternative E. Alternative E could result in increased impacts on land use associated with temporary construction activity compared to the southern export cable route on Island Beach State Park and Barnegat Bay under the Proposed Action. The impact magnitudes would be the same as that of the Proposed Action because the cable corridor would largely follow existing right-of-way and the primary impacts would be limited to the duration of construction. The impacts resulting from individual IPFs associated with Alternative E are anticipated to be **moderate** and **minor beneficial**.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts on recreation and tourism would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts of Alternative E would be **moderate** and **minor beneficial**.

3.18.8 Proposed Mitigation Measures

A measure is proposed to minimize impacts on recreation and tourism (Appendix H, Table H-3). If the measure analyzed below is adopted by BOEM or cooperating agencies, some adverse impacts would be further reduced.

Table 3.18-2 Additional Proposed Measures (Also Identified in Appendix H, Table H-3): Recreation and Tourism

Measure	Description	Effect
Recreational fishing	BOEM would ensure that Ocean Wind develops a construction schedule that minimizes overlap with recreational fishing tournaments and other important seasonal recreational fishing events.	If this mitigation measure is adopted by BOEM or cooperating agencies, construction activities would not occur during recreational fishing events, avoiding impacts such as vessel traffic, noise, and other construction activity that might otherwise adversely affect these events. This mitigation measure would minimize impacts on recreational fishing but would not reduce the cumulative impact level. Impacts from the Proposed Action and other action alternatives would remain moderate and minor beneficial.

3.18.8.1. Measures Incorporated in the Preferred Alternative

BOEM has not identified any additional measures in Table 3.18-2 to be incorporated in the preferred alternative.

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3.19. Sea Turtles (see Appendix G)

The reader is referred to Appendix G for a discussion of current conditions and potential impacts on sea turtles from implementation of the No Action Alternative, the Proposed Action, and other action alternatives.

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3.20. Scenic and Visual Resources

This section discusses potential impacts on seascape, open ocean, and landscape character and viewers from the proposed Project, alternatives, and ongoing and planned activities in the scenic and visual resources geographic analysis area, as advised in the *Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Developments on the Outer Continental Shelf of the United States* (BOEM 2021c) and the *Guidelines for Landscape and Visual Impact Assessment* (3rd Edition) (Landscape Institute and Institute of Environmental Management and Assessment 2016). The 40-mile (64.4-kilometer) geographic analysis area, as shown on Figure 3.20-1, includes the New Jersey coastline from Cape May Borough to Berkeley Township and extends 64 miles (103 kilometers) offshore and 25 miles (40.2 kilometers) inland to incorporate potential views of the Project. The onshore geographic analysis area encompasses the 1-mile perimeters for the Oyster Creek and BL England onshore substations, landfalls, onshore export cable routes to the onshore substations, and the connections from the onshore substations to the existing grid (0.25-mile perimeters). This geographic analysis area was selected to coincide with Ocean Wind's Visual Impact Assessment (VIA) analysis area (COP Volume III, Appendix L; Ocean Wind 2023) to address Project visibility from sensitive resources and encompass all locations where BOEM anticipates impacts associated with Project construction, O&M, and conceptual decommissioning. Appendix M, *Seascape, Landscape, and Visual Impact Assessment*, contains additional analysis of the seascape character units, open ocean character unit, landscape character units, and viewer experiences that would be affected by Proposed Action and alternatives, and visual simulations of the Proposed Action, No Action Alternative, Alternative B, and Alternative C.

3.20.1 Description of the Affected Environment for Scenic and Visual Resources

New Jersey's Public Trust Doctrine (NJDEP 2006) holds all tidally flowed lands in trust for the use and enjoyment of the public. This includes the ocean, bays, and tidal rivers, as well as the adjacent shoreline over which these waters flow and, in certain circumstances, some amount of upland area, even if the upland area is privately owned. This section summarizes the seascape, open ocean, landscape, and viewer baseline conditions as described in Volume III, Appendix L (Visual Impact Assessment) of the Ocean Wind 1 COP (Ocean Wind 2023). The demarcation line between seascape and open ocean is the most-distant edge of the sea visible from the coastline's mean high tide line. This shared boundary (3.45 miles [5.6 kilometers]) is based on a 5.5-foot eye level and EC, and aligns with the state seaward jurisdictional boundary for New Jersey (U.S. Congress Submerged Lands Act, 1953). The line defining the separation of seascape and landscape is based on the juxtaposition of seacoast and landward landscape elements, including topography, water (bays and estuaries), vegetation, and structures.

The geographic analysis area is classified by broadly defined land and water areas and more specific Landscape Similarity Zones. The land and water areas are based on major differences in landscape structure that define the physical character of the geographic analysis area and include open ocean, shoreline, marsh and bay, and inland areas. Each area is subdivided into Landscape Similarity Zones, areas defined by similar land use patterns, topography, ecological characteristics, and proximity to the ocean. Landscape Similarity Zones provide a more specific description of the existing landscape and provide a framework to systematically analyze potential visual effects throughout the geographic analysis area (COP Volume III, Appendix L, Section 5.5; Ocean Wind 2023). The land and water areas and Landscape Similarity Zones, or character units, used in this analysis are summarized in Table 3.20-1.

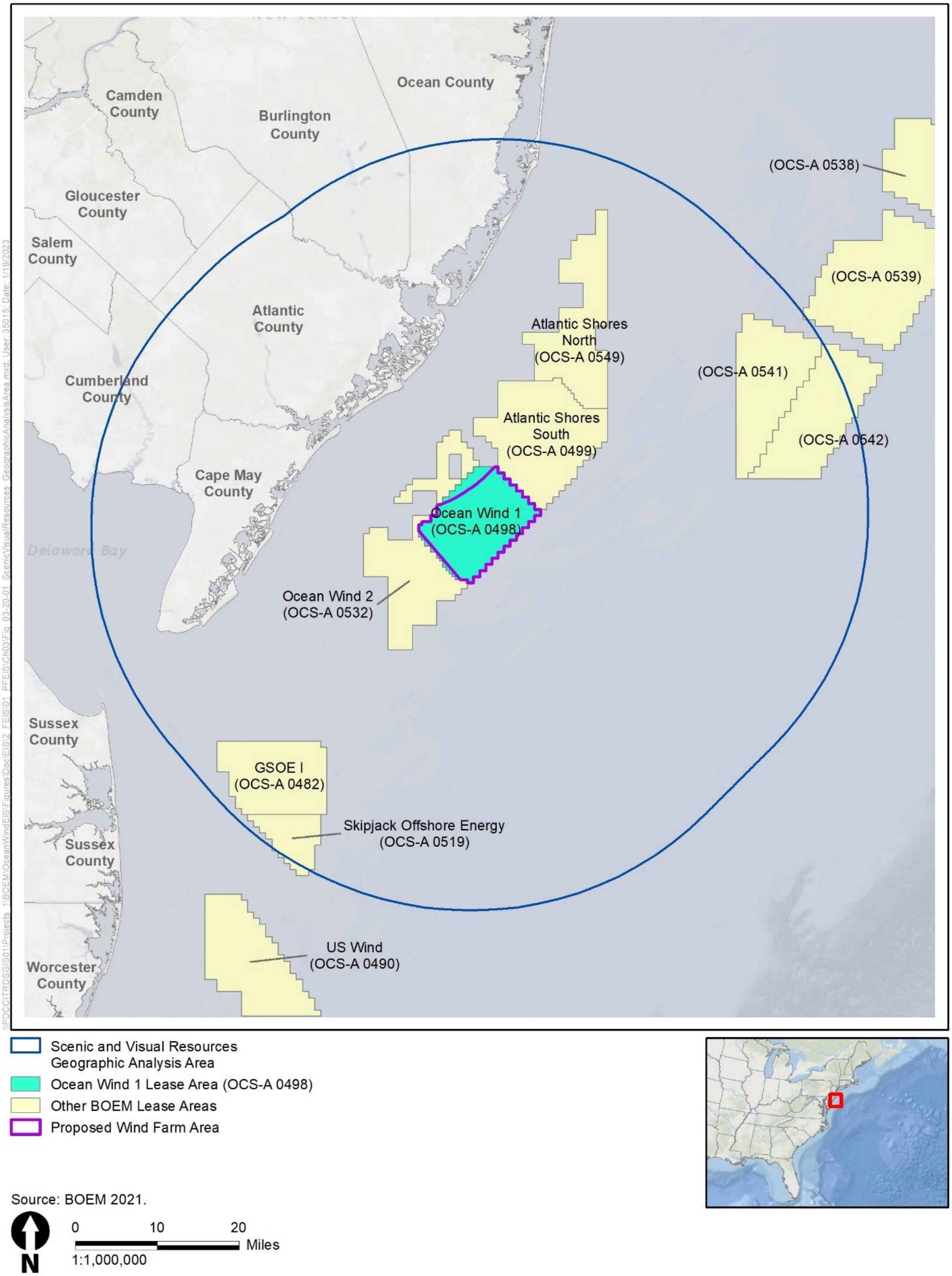

Figure 3.20-1 Scenic and Visual Resources Geographic Analysis Area

Table 3.20-1 Land and Water Areas and Landscape Similarity Zones

Land and Water Areas	Landscape Similarity Zones/Character Units
Atlantic Ocean	Open Ocean
Shoreline	Jetty/Seawall, Beachfront, Coastal Dune, Boardwalk, Island Community
Marsh and Bay	Marshland, Bay/Shoreline, Ridges
Inland	Mainland

Existing scenic resources in the geographic analysis area including conservation areas, historic resources, scenic byways, national wild and scenic rivers, and other resources are mapped on the Scenic Resources Overview Map in Attachment M-1 to Appendix M. The geographic analysis area's landforms, water, vegetation, and built environment structures contain common and distinctive landscape features as outlined in Table 3.20-2.

Table 3.20-2 Landform, Water, Vegetation, and Structures

Category	Landscape Features
Landform	Flat shorelines to gently sloping beaches, dunes, islands, and inland topography
Water	Ocean, bay, estuary, tidal river, river, and stream water patterns
Vegetation	Tidal salt marshes and estuarine biomes, beach grass, meadows, and maritime forests; vegetation community indicator species: beach plum (*Prunus maritime*), sweet pepperbush (*Clethra alnifolia*), highbush blueberry (*Vaccinium corymbosum*), poison ivy (*Toxicodendron radicans*), sour gum (*Nyssa sylvatica*), swamp magnolia (*Magnolia virginiana*), red cedar (*Juniperus virginiana*), and red maple (*Acer rubrum*)
Structures	Buildings, plazas, signage, walks, parking, roads, trails, seawalls, jetties, and infrastructure

The visual characteristics of the seascape, open ocean, and landscape conditions in the geographic analysis area, including surroundings of the Wind Farm Area, landfall sites, offshore and onshore export cable corridors, and onshore substation areas, contain both locally common and regionally distinctive physical features, characters, and experiential views (Table 3.20-3).

Table 3.20-3 Seascape, Open Ocean, and Landscape Conditions

Category	Seascape, Open Ocean, and Landscape
Seascape	Inter-visibility by pedestrians and boaters within coastal and adjacent marine areas (3.45 miles [5.6 kilometers]) within the 40-mile (64.4-kilometer) geographic analysis area.
Seascape Features	Physical features range from built elements, landscape, dunes, and beaches to flat water and ripples, waves, swells, surf, foam, chop, and whitecaps.

Category	Seascape, Open Ocean, and Landscape
Seascape Character	Experiential characteristics stem from built and natural landscape forms, lines, colors, and textures to the foreground water's tranquil, mirrored, and flat; active, rolling, and angular; vibrant, churning, and precipitous. Forms range from horizontal planar to vertical structures', landscapes', and water's slopes; lines range from continuous to fragmented and angular; colors of structures, landscape, and the water's foam, and spray reflect the changing colors of the daytime and nighttime, built environment, land cover, sky, clouds, fog, and haze; and textures range from mirrored smooth to disjointed coarse.
Open Ocean	Inter-visibility within the open ocean (beyond the 3.45-mile [5.6-kilometer] seascape area) within the 40-mile (64.4-kilometer) geographic analysis area from seagoing vessels, including recreational cruising and fishing, commercial "cruise ship" routes, commercial fishing activities, tankers and cargo vessels; and air traffic over and near the WTG array and cable routes.
Open Ocean Features	Physical features range from flat water to ripples, waves, swells, surf, foam, chop, and whitecaps.
Open Ocean Character	Experiential characteristics range from tranquil, mirrored, and flat; to active, rolling, and angular; to vibrant, churning, and precipitous. Forms range from horizontal planar to vertical slopes; lines range from continuous and horizontal to fragmented and angular; colors of water, foam, and spray reflect the changing colors of sky, clouds, fog, haze, and the daytime and nighttime, built environment and land cover; and textures range from mirrored smooth to disjointed coarse.
Landscape	Inter-visibility within the adjacent inland areas, seascape, and open ocean; nighttime views diminished by ambient light levels of shorefront development; open, modulated, and closed views of water, landscape, and built environment; and pedestrian, bike, and vehicular traffic throughout the region.
Landscape Features	Natural elements: landward areas of barrier islands, bays, marshlands, shorelines, vegetation, tidal rivers, flat topography, and natural areas. Built elements: boardwalks, bridges, buildings, gardens, jetties, landscapes, life-saving stations, umbrellas, lighthouses, parks, piers, roads, seawalls, skylines, trails, single-family residences, commercial corridors, village centers, mid-rise motels, moderate to high-density residences, and high-rise casinos.
Landscape Character	Tranquil and pristine natural, to vibrant and ordered, to chaotic and disordered.
Designated Public Places	Barnegat Branch Trail, Barnegat Lighthouse State Park, Bass River State Forest, Belleplain State Forest, Cape May National Wildlife Refuge, Cape May State Park, Corson's Inlet State Park, Crook Horn Creek, Edwin B. Forsythe National Wildlife Refuge, Emil Palmer Park, Enos Pond County Park, Forked River State Marina, Forked River Mountain WMA, Garden State Parkway, Gillian's Wonderland Pier, Great Egg Harbor Bay, Island Beach State Park, National Natural Landmark Manahawkin Bottomland Hardwood Forest, Ocean City Boardwalk, Ocean City Park, Peck Bay, Sandcastle Park, Southern Pinelands Natural Heritage Trail, Stainton Wildlife Refuge, Stone Harbor Bird Sanctuary, Tuckahoe WMA, Upper Barnegat Bay WMA, Vincent Klune Park, and Wharton State Forest.

WMA = Wildlife Management Area

The sensitivity of the geographic analysis area's seascape character is defined by its innate features, elements, and value to residents and visitors. Seascape sensitivity rating criteria are high, medium, or low defined as follows:

- High: Seascape character is distinctive and highly valued by residents and visitors.

- Medium: Seascape character is moderately distinctive and moderately valued by residents and visitors.
- Low: Seascape character is common and unimportant to residents and visitors.

The sensitivity of the open ocean is defined by the activities of viewers; innate character; and susceptibility to the type of change proposed by the Project.

- High: Open ocean characteristics are pristine, highly distinctive, and highly valued by residents and visitors.
- Medium: Open ocean characteristics are moderately distinctive and moderately valued by residents and visitors.
- Low: Open ocean characteristics are common or with minimal scenic value.

The sensitivity of the geographic analysis area's landscape character is defined by its innate features, elements, and value to residents and visitors. Landscape sensitivity rating criteria are high, medium, or low defined as follows:

- High: Landscape characteristics are highly distinctive, highly valued by residents and visitors, or within a designated scenic or historic landscape.
- Medium: Landscape characteristics are moderately distinctive and moderately valued by residents and visitors.
- Low: Landscape characteristics are common or within a landscape of minimal scenic value.

Table 3.20-4 summarizes the conditions within seascape, open ocean, and landscape settings with high, medium, and low innate sensitivity.

Table 3.20-4 Seascape, Open Ocean, and Landscape Sensitivity

Settings	Conditions
High-Sensitivity Seascape[1]	Ocean shoreline, beach, and dune areas, and ocean areas within 3.45 statute miles (5.5 kilometers) of the shoreline (Table 3.20-1) Seascapes with national, state, or local designations: Barnegat Branch Trail, Barnegat Lighthouse State Park, Bass River State Forest, Belleplain State Forest, Cape May National Wildlife Refuge, Cape May State Park, Corson's Inlet State Park, Crook Horn Creek, Edwin B. Forsythe National Wildlife Refuge, Emil Palmer Park, Enos Pond County Park, Forked River State Marina, Forked River Mountain WMA, Garden State Parkway, Gillian's Wonderland Pier, Great Egg Harbor Bay, Island Beach State Park, National Natural Landmark Manahawkin Bottomland Hardwood Forest, Ocean City Boardwalk, Ocean City Park, Peck Bay, Sandcastle Park, Southern Pinelands Natural Heritage Trail, Stainton Wildlife Refuge, Stone Harbor Bird Sanctuary, Tuckahoe WMA, Upper Barnegat Bay WMA, Vincent Klune Park, and Wharton State Forest Beaches, seaward boardwalks, jetties, and piers
High-Sensitivity Open Ocean	Ocean areas within the geographic analysis area

Settings	Conditions
High-Sensitivity Landscape[2]	Scenic and medium to high resident and visitor use volume coastal areas and bays, islands, sounds, and adjoining estuaries. Cemeteries, churches, historic sites, lighthouses, scenic overlooks, schools, town halls, and residential areas within the geographic analysis area. Landscapes with national, state, local designations or valued places: Absecon Bay, All Wars Memorial Park, Barnegat Bay, Barnegat Branch Trail, Barnegat Lighthouse State Park, Bass River State Forest, Belleplain State Forest, Birch Grove Park, Cape May National Wildlife Refuge, Cape May County Park and Zoo, Cape May Point State Park, Corson's Inlet State Park, Crook Horn Creek, Doc Cramer Park, Edwin B. Forsythe National Wildlife Refuge, Egg Harbor City Park, Egg Island State WMA, Emil Palmer Park, Enos Pond County Park, Estelle Manor County Park, Forked River State Marina, Forked River Mountain WMA, Garden State Parkway, Gillian's Wonderland Pier, Great Bay, Great Egg Harbor Bay, Great Sound, Green Acres Park, Green Bank State Forest, Harold N Peek Preserve, Hartshorn Park, Heritage Park, Heislerville WMA, Island Beach State Park, John F. Kennedy Park, Keyrec Field, Lakes Bay, Lenape Park, Little Bay, Ludlam Bay, Manahawkin Bay, Manahawkin Wildlife Area, Michael Debbi Park, Millville State Conservation Area, Mystic Island Park, National Natural Landmark Manahawkin Bottomland Hardwood Forest, Ocean City Boardwalk, Ocean City Park, Park Avenue Park, Peaslee State Conservation Area, Peck Bay, Penn State Park, Port Republic State Conservation Area, Reeds Bay, River Bend County Park, Sandcastle Park, Sedge Island Marine Conservation Zone, Southern Pinelands Natural Heritage Trail, Stafford Forge State Conservation Area, Stainton Wildlife Refuge, Stites Sound, Stone Harbor Bird Sanctuary, Tony Canale Park, Townsend Sound, Tuckahoe WMA, Upper Barnegat Bay WMA, Veterans Memorial Park, Vincent Klune Park, Weymouth Furance Park, and Wharton State Forest.
Medium-Sensitivity Landscape	Moderately distinctive areas of medium scenic value and low resident or visitor use volume inland areas
Low-Sensitivity Landscape	Indistinctive areas with low scenic value and limited to no resident or visitor use volume

[1] Locations also listed under Landscape extend to both Seascape and Landscape.
[2] Locations also listed under Seascape extend to both Landscape and Seascape.
WMA = Wildlife Management Area

The susceptibility of the geographic analysis area's seascape character is defined by both the susceptibility to impacts from the Project and its visual resources' rarity and scenic value. Seascape susceptibility rating criteria include:

- High: Seascape character is highly vulnerable to the type of change proposed, distinctive, and highly valued by residents and visitors.
- Medium: Seascape character is reasonably resilient to the type of change proposed, moderately distinctive, and moderately valued by residents and visitors.
- Low: Seascape character is unlikely to be affected by the type of change proposed, common, and unimportant to residents and visitors.

The susceptibility of the geographic analysis area's open ocean character is defined by both the susceptibility to impacts from the Project and its visual resources' rarity and scenic value. Open ocean susceptibility rating criteria include:

- High: Open ocean character is highly vulnerable to the type of change proposed, distinctive, and highly valued by residents and visitors.

- Medium: Open ocean character is reasonably resilient to the type of change proposed, moderately distinctive, and moderately valued by residents and visitors.
- Low: Open ocean character is unlikely to be affected by the type of change proposed, common, and unimportant to residents and visitors.

The susceptibility of the geographic analysis area's landscape character is defined by both the vulnerability to impacts from the Project, and the visual resources' rarity and scenic value. Landscape susceptibility ratings include:

- High: The character is highly vulnerable to the type of change proposed, distinctive, and highly valued by residents and visitors.
- Medium: The character is reasonably resilient to the type of change proposed, moderately distinctive, and moderately valued by residents and visitors.
- Low: The character is unlikely to be affected by the type of change proposed, common, and unimportant to residents and visitors.

Table 3.20-5 summarizes the conditions within seascape, open ocean, and landscape settings with high, medium, and low susceptibility.

Table 3.20-5 Seascape, Open Ocean, and Landscape Susceptibility

Settings	Conditions
High-Susceptibility Seascape[1]	Ocean shoreline, beach, and dune areas, and ocean areas within 3.45 statute miles (5.5 kilometers) of the shoreline (Table 3.20-1) Seascapes with national, state, or local designations: 26th Street Playground, 32nd Street Veterans Memorial, 42nd Street Recreation Area, Absecon State WMA, Altman Field Park, Artlantic Wonder Park, Barnegat Lighthouse State Park, Beaver Swamp State Conservation Area, Brighton Park, Cape May National Wildlife Refuge, Corson's Inlet State Park, Dennis Creek State Conservation Area, Edwin B. Forsythe National Wildlife Refuge, Emil Palmer Park, Gillian's Wonderland Pier, Illinois Avenue Park, Island Beach State Park, Jerome Avenue Park, Maine Avenue Waterfront Park, Ocean City Boardwalk, Ocean City Park, O'Donnell Park, Sandcastle Park, and Veterans Park Beaches, seaward boardwalks, jetties, and piers
High-Susceptibility Open Ocean	Ocean areas within the geographic analysis area

Settings	Conditions
High-Susceptibility Landscape[2]	Landscapes with national, state, or local designations or valued places: Absecon Bay, All Wars Memorial Park, Barnegat Bay, Barnegat Branch Trail, Barnegat Lighthouse, Barnegat Lighthouse State Park, Bass River State Forest, Belleplain State Forest, Birch Grove Park, Bowen Memorial Park, Cape May National Wildlife Refuge, Cape May County Park and Zoo, Cape May State Park, Corson's Inlet State Park, Crook Horn Creek, Dennis Creek State Conservation Area, Edwin B. Forsythe National Wildlife Refuge, Egg Harbor City Park, Emil Palmer Park, Enos Pond County Park, Estelle Manor County Park, Forked River State Marina, Forked River Mountain WMA, Garden State Parkway, Gillian's Wonderland Pier, Great Bay, Great Egg Harbor Bay, Great Sound, Green Acres Park, Green Bank State Forest, Harold N Peek Preserve, Hartshorn Park, Heislerville WMA, Heritage Park, Island Beach State Park, John F. Kennedy Park, Keyrec Field, Lakes Bay, Little Bay, Ludlam Bay, Manahawkin Bay, National Natural Landmark Manahawkin Bottomland Hardwood Forest, Manahawkin Wildlife Area, Michael Debbi Park, Mill Creek Park, Millville State Conservation Area, Multica Recreation Field, Mystic Island Park, Ocean City Boardwalk, Ocean City Park, Park Avenue Park, Peaslee State Conservation Area, Peck Bay, Penn State Forest, Playground Park, Port Republic State Conservation Area, Reeds Bay, River Bend County Park, Sandcastle Park, Sedge Island Marine Conservation Zone, Southern Pinelands Natural Heritage Trail, Stafford Forge State Conservation Area, Stainton Wildlife Refuge, Stites Sound, Stone Harbor Bird Sanctuary, Tony Canale Park, Townsend Sound, Tuckahoe WMA, Upper Barnegat Bay WMA, Vincent Klune Park, Weymouth Furance Park, Veterans Memorial Park, and Wharton State Forest
Medium-Susceptibility Landscape	N/A
Low-Susceptibility Landscape	N/A

[1] Locations also listed under Landscape extend to both Seascape and Landscape.
[2] Locations also listed under Seascape extend to both Landscape and Seascape.
N/A = not applicable; WMA = Wildlife Management Area

Table 3.20-6 lists the jurisdictions with ocean beach views to the Project Wind Farm Area. The nearest and most distant view conditions, Atlantic City Beachfront and Barnegat Lighthouse, respectively, are portrayed on Figure 3.20-2 and Figure 3.20-3, respectively (Appendix D to COP Volume III, Appendix L; Ocean Wind 2023).

Table 3.20-6 Jurisdictions with Ocean Beach Views

Ocean View	Jurisdiction
Ocean view from a seascape beach	Atlantic City, Avalon Borough, Barnegat Light Borough, Beach Haven Borough, Berkeley Township, Brigantine, Cape May, Galloway Township, Harvey Cedars Borough, Long Beach Township, Longport Borough, Lower Township, Margate City, North Wildwood, Ocean City, Sea Isle City, Ship Bottom Borough, Stone Harbor Borough, Surf City Borough, Upper Township, and Ventnor City, Wildwood, and Wildwood Crest
Ocean view from an inland landscape	Absecon, Atlantic City, Avalon Borough, Barnegat Light Borough, Barnegat Township, Bass River Township, Beach Haven Borough, Berkeley Township, Brigantine, Buena Vista Township, Cape May, Cape May Point Borough, Commercial Township, Corbin City, Dennis Township, Downe Township, Eagleswood Township, Egg Harbor Township, Estell Manor, Folsom Borough, Galloway Township, Hamilton Township, Hammonton, Harvey Cedars Borough, Linwood, Little Egg Harbor Township, Long Beach Township, Longport Borough, Lower Township, Margate City, Maurice River Township, Middle Township, Millville, Mullica Township, North Wildwood, Northfield, Ocean City, Ocean Township, Pleasantville, Port Republic, Sea Isle City, Ship Bottom Borough, Somers Point, Stafford Township, Stone Harbor Borough, Surf City Borough, Tuckerton Borough, Upper Township, Ventnor City, Vineland, Washington Township, West Cape May Borough, West Wildwood Borough, Weymouth Township, and Wildwood

Figure 3.20-2 Atlantic City Beachfront View

Figure 3.20-3 Barnegat Lighthouse View

Onshore to offshore view distances to the Project Wind Farm Area range from 15.3 miles (24.6 kilometers) to 40 miles (64.4 kilometers). At the 15.3-mile (25.6-kilometer) distance, the Project wind farm would occupy 37.6° (30 percent) of the typical human's 124° horizontal field of view (FOV) and 0.6° (1 percent) of the typical 55° vertical FOV (measured from eye level). This vertical measure also indicates the perceived proportional size and relative height of the wind farm. At 40 miles (64.4 kilometers) distance, the Project may appear 0.03° above the horizon and 16° along the horizon, 0.04 percent and 12 percent of the human vertical and horizontal FOV, respectively. WTG and OSS visibility would be variable throughout the day depending on specific factors. View angle, sun angle, atmospheric conditions, and distance would affect the visibility and noticeability. Visual contrast of WTGs and OSS would vary throughout the day depending on whether the WTGs and OSS are backlit, side-lit, or front-lit and based on the visual character of the horizon's backdrop. These variations through the course of the day may result in periods of moderate to major visual effects while at other times of day would have minor or negligible effects.

At distances of 12 miles or closer, the form of the WTG may be the dominant visual element creating the visual contrast regardless of color. At greater distances, color may become the dominant visual element creating visual contrast under certain visual conditions that give visual definition to the WTG's form and line.

The range of sensitivity of view receptors and people viewing the Project is determined by their engagement and view expectations. Table 3.20-7 lists the sensitivity issues identified for the seascape, open ocean, landscape, and visual impact assessment (SLVIA) and the indicators and criteria used to assess impacts for the Final EIS.

Table 3.20-7 View Receptor Sensitivity Ranking Criteria

Sensitivity	Sensitivity Criteria
High	Residents with views of the Project from their homes; people with a strong cultural, historic, religious, or spiritual connection to landscape or seascape views; people engaged in outdoor recreation whose attention or interest is focused on the seascape and landscape and on particular views; visitors to historic or culturally important sites, where views of the surroundings are an important contributor to the experience; people who regard the visual environment as an important asset to their community, churches, schools, cemeteries, public buildings, and parks; and people traveling on scenic highways and roads, or walking on beaches and trails, specifically for enjoyment of views
Medium	People engaged in outdoor recreation whose attention or interest is unlikely to be focused on the landscape and on particular views because of the type of activity; people at their places of livelihood, commerce, and personal needs (inside or outside) whose attention is generally focused on that engagement, not on scenery, and where the seascape and landscape setting is not important to the quality of their activity; and, generally, those commuters and other travelers traversing routes that are dominated by non-scenic developments
Low	People who regard the visual environment as an unvalued asset

Key Observation Points (KOP) represent individuals or groups of people who may be affected by changes in views and visual amenity. Based on higher viewer sensitivity, viewer exposure, and context photography, 32 designated KOPs provide the locational bases for detailed analyses of the geographic analysis area’s seascape, open ocean, landscape, and viewer experiences as shown on Figure 3.20-4 (COP Volume III, Appendix L; Ocean Wind 2023). Sensitive receptors in the vicinity of the BL England and Oyster Creek substations and onshore export cable corridors are identified in COP Volume III, Appendix L, Section 8.2 (Ocean Wind 2023). KOPs and their view contexts are summarized in Table 3.20-8.

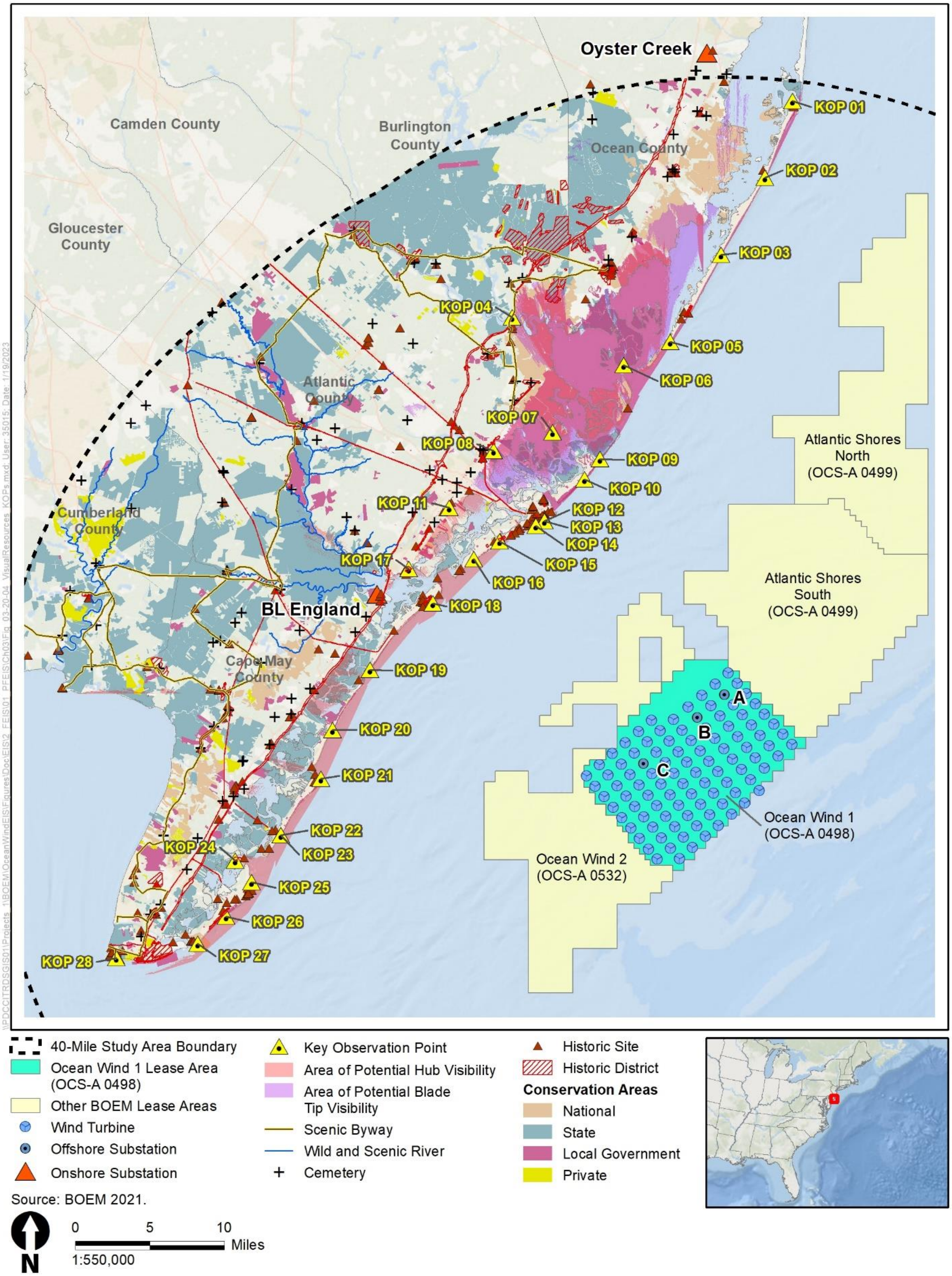

Figure 3.20-4 Scenic Resources and Key Observation Points

Table 3.20-8 Representative View Receptor Contexts and Key Observation Points

View Context	Key Observation Points
Vantage Point	KOP-1 Barnegat Lighthouse KOP-2 Harvey Cedars Beach Access KOP-3 Bay View Park KOP-8 Absecon Creek Boat Ramp KOP-9 North Brigantine Natural Area Wildlife Observation Deck KOP-14 Atlantic City Playground Pier KOP-15 Ventor City, City Hall KOP-16 Lucy the Elephant National Historic Landmark KOP-18 Ocean City Boardwalk KOP-21 Avalon Beach Jetty KOP-25 Hereford Inlet Lighthouse KOP-26 Wildwood Crest Fishing Pier KOP-28 Cape May Lighthouse
Linear Receptor	KOP-4 Garden State Parkway KOP-10 16th Street Park Beachfront KOP-12 Atlantic City Beachfront—Daytime KOP-13 Atlantic City Beachfront—Nighttime KOP-20 Sea Isle City Promenade KOP-22 Stone Harbor Beach—Daytime KOP-23 Stone Harbor Beach—Nighttime KOP-24 North Wildwood Boulevard Bridge Representative KOP-32 Cruise Ship Shipping Lanes
Scenic Area	KOP-3 Bayview Park KOP-5 Edwin B. Forsythe National Wildlife Refuge - Holgate Unit KOP-6 Great Bay Boulevard WMA KOP-7 Edwin B. Forsythe National Wildlife Refuge KOP-11 Atlantic City Country Club KOP-17 Bay Front Historic District, Municipal Beach Park KOP-19 Corson's Inlet State Park KOP-27 Cape May National Wildlife Refuge Representative KOP-31 Recreational Fishing, Pleasure, and Tour Boat Area
Substation Area	KOP-29 BL England Substation Area KOP-30 Oyster Creek Substation Area

WMA = Wildlife Management Area

The sensitivity of KOPs is determined with reference to view location and activity through (1) review of relevant designations and the level of policy importance that they signify (such as landscapes designated at the national, state, or local level); and (2) application of criteria that indicate value (such as scenic quality, rarity, recreational value, representativeness, conservation interests, perceptual aspects, and artistic associations). Judgements regarding seascape, open ocean, landscape, and KOP sensitivity are informed by COP Volume III, Appendix L (Ocean Wind 2023). Table 3.20-9 lists onshore KOP viewer sensitivity ratings.

Table 3.20-9 Onshore Key Observation Point Viewer Sensitivity Ratings

Rating	Key Observation Points
High	KOP-1 Barnegat Lighthouse KOP-2 Harvey Cedars Beach Access KOP-3 Bayview Park KOP-4 Garden State Parkway KOP-5 Edwin B. Forsythe National Wildlife Refuge - Holgate Unit KOP-6 Great Bay Boulevard WMA KOP-7 Edwin B. Forsythe National Wildlife Refuge KOP-8 Absecon Creek Boat Ramp KOP-9 North Brigantine Natural Area Wildlife Observation Deck KOP-10 16th Street Park Beachfront KOP-11 Atlantic City Country Club KOP-12 Atlantic City Beachfront—Daytime KOP-13 Atlantic City Beachfront—Nighttime KOP-14 Atlantic City Playground Pier KOP-15 Ventor City, City Hall KOP-16 Lucy the Elephant National Historic Landmark KOP-17 Bay Front Historic District, Municipal Beach Park KOP-18 Ocean City Boardwalk KOP-19 Corson’s Inlet State Park KOP-20 Sea Isle City Promenade KOP-21 Avalon Beach Jetty KOP-22 Stone Harbor Beach—Daytime KOP-23 Stone Harbor Beach—Nighttime KOP-24 North Wildwood Boulevard Bridge KOP-25 Hereford Inlet Lighthouse KOP-26 Wildwood Crest Fishing Pier KOP-27 Cape May National Wildlife Refuge KOP-28 Cape May Lighthouse KOP-31 Recreational Fishing, Pleasure, and Tour Boat Area KOP-32 Cruise Ship Shipping Lanes
Medium	KOP-29 BL England Substation Area KOP-30 Oyster Creek Substation Area
Low	None

WMA = Wildlife Management Area

Offshore viewing receptors include the fishing boats, pleasure craft, cruise ships, and undefined craft (60.3 percent) that represent marine traffic in the area (COP Volume II, Figure 2.3.6-3; Ocean Wind 2023). Daytime and nighttime views range from immediate foreground (0-mile [0-kilometer]) to 40-mile (64.4-kilometer) distances.

Daytime and nighttime aircraft receptors, arriving and departing Ocean City Municipal Airport and Atlantic City International Airport traffic, and others traversing the coast, range from foreground to background viewing situations. Aircraft receptors are more frequently affected by view-limiting atmospheric conditions than are land and water receptors.

Typical meteorological conditions limit visibility of the Wind Farm Area from inland and the coast on 77 percent of days and provide clear visibility on 23 percent of days (1 of every 4 to 5 days) (Atlantic Shores 2021). Views from nearer the shoreline are more limited by atmospheric conditions than views from inland areas. Many viewers, particularly recreational users, are more likely to be present on beaches, seawalls, and jetties on clearer days, when viewing conditions are better than on rainy, hazy, or foggy days. Therefore, affected environment and VIAs of the Project are based on clear-day and clear-night visibility. Elevated boardwalks, jetties, and seawalls afford greater visibility of offshore elements for viewers in tidal beach areas. Nighttime views toward the ocean from the beach and adjacent inland areas are diminished by ambient light levels and glare of shorefront developments.

3.20.2 Environmental Consequences

3.20.2.1. Impact Level Definitions for Scenic and Visual Resources

Definitions of impact levels are provided in Table 3.20-10. There are no beneficial impacts on scenic and visual resources.

Table 3.20-10 Impact Level Definitions for Scenic and Visual Resources

Impact Level	Impact Type	Definition
Negligible	Adverse	SLIA: Very little or no effect on seascape/landscape unit character, features, elements, or key qualities either because unit lacks distinctive character, features, elements, or key qualities; values for these are low; or Project visibility would be minimal. VIA: Very little or no effect on viewers' visual experience because view value is low, viewers are relatively insensitive to view changes, or Project visibility would be minimal.
Minor	Adverse	SLIA: The Project would introduce features that may have low to medium levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The Project features may introduce a visual character that is slightly inconsistent with the character of the unit, which may have minor to medium negative effects on the unit's features, elements, or key qualities, but the unit's features, elements, or key qualities have low susceptibility or value. VIA: The visibility of the Project would introduce a small but noticeable to medium level of change to the view's character; have a low to medium level of visual prominence that attracts but may or may not hold the viewer's attention; and have a small to medium effect on the viewer's experience. The viewer receptor sensitivity/susceptibility/value is low. If the value, susceptibility, and viewer concern for change is medium or high, the nature of the sensitivity is evaluated to determine if elevating the impact to the next level is justified. For instance, a KOP with a low magnitude of change but a high level of viewer concern (combination of susceptibility/value) may justify adjusting to a moderate level of impact.

Impact Level	Impact Type	Definition
Moderate	Adverse	SLIA: The Project would introduce features that would have medium to large levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The Project would introduce a visual character that is inconsistent with the character of the unit, which may have a moderate negative effect on the unit's features, elements, or key qualities. In areas affected by large magnitudes of change, the unit's features, elements, or key qualities have low susceptibility or value. VIA: The visibility of the Project would introduce a moderate to large level of change to the view's character; may have moderate to large levels of visual prominence that attracts and holds but may or may not dominate the viewer's attention; and has a moderate effect on the viewer's visual experience. The viewer receptor sensitivity/susceptibility/value is medium to low. Moderate impacts are typically associated with medium viewer receptor sensitivity (combination of susceptibility/value) in areas where the view's character has medium levels of change, or low viewer receptor sensitivity (combination of susceptibility/value) in areas where the view's character has large changes to the character. If the value, susceptibility, and viewer concern for change is high, the nature of the sensitivity is evaluated to determine if elevating the impact to the next level is justified.
Major	Adverse	SLIA: The Project would introduce features that would have dominant levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The Project would introduce a visual character that is inconsistent with the character of the unit, which may have a major negative effect on the unit's features, elements, or key qualities. The concern for change (combination of susceptibility/value) to the character unit is high. VIA: The visibility of the Project would introduce a major level of character change to the view; attract, hold, and dominate the viewer's attention; and have a moderate to major effect on the viewer's visual experience. The viewer receptor sensitivity/susceptibility/value is medium to high. If the magnitude of change to the view's character is medium but the susceptibility or value at the KOP is high, the nature of the sensitivity is evaluated to determine if elevating the impact to major is justified. If the sensitivity (combination of susceptibility/value) at the KOP is low in an area where the magnitude of change is large, the nature of the sensitivity is evaluated to determine if lowering the impact to moderate is justified.

SLIA = seascape, open ocean, and landscape impact assessment

3.20.3 Impacts of the No Action Alternative on Scenic and Visual Resources

Section 3.1 of the Final EIS explains the approach to predicting impacts related to the No Action Alternative. When analyzing the impacts of the No Action Alternative on scenic and visual resources, BOEM considered the impacts of past and ongoing trends and activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for scenic and visual resources. BOEM separately analyzes how resource conditions will be affected over time as reasonably foreseeable activities are implemented. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*. Separate impact conclusions are presented for both scenarios.

3.20.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for seascape, open ocean, landscape, and viewers described in Section 3.20.1, *Description of the Affected Environment for Scenic and Visual Resources*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing activities that contribute to impacts on scenic and visual resources in the geographic analysis area primarily involve onshore development and construction activities and offshore vessel traffic. These activities have the potential to contribute to new structures, traffic congestion, and nighttime light impacts. There are no ongoing offshore wind activities within the geographic analysis area for scenic and visual resources.

3.20.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with other planned activities (without the Proposed Action). Planned non-offshore wind activities within the geographic analysis area that contribute to impacts on seascape, open ocean, landscape, and viewers include activities related to development of undersea transmission lines, gas pipelines, and submarine cables; dredging and port improvements; marine minerals extraction; military use; and marine transportation (see Section F.2 in Appendix F for a description of planned activities in the geographic analysis area). Planned activities have the potential to affect seascape character, open ocean character, landscape character, and viewer experience through the introduction of structures, light, land disturbance, traffic, air emissions, and accidental releases to the landscape or seascape. Table F1-22 in Appendix F provides additional information on potential impacts on scenic and visual resources associated with ongoing and planned non-offshore wind activities.

BOEM expects planned offshore wind development activities to affect seascape character, open ocean character, landscape character, and viewer experience through the following primary IPFs. Tables M-13 through M-16 in Appendix M consider effects on seascape, open ocean, landscape, and viewers of offshore wind development without the Proposed Action and in combination with the Proposed Action.

Presence of structures: Other offshore wind development will add structures offshore including WTGs and OSS. Under the No Action Alternative, seven offshore wind projects (Atlantic Shores South, Atlantic Shores North, Hudson South Lease Areas OCS-A 0541 and OCS-A 0542, Ocean Wind 2, Garden State, and Skipjack) would be constructed in the geographic analysis area between 2024 and 2030. The placement of 761 WTGs (excluding the Proposed Action) within the geographic analysis area under the planned activities scenario (Appendix F, Table F2-1) would contribute to adverse impacts on scenic and visual resources. Appendix M provides simulations of offshore wind development without the Proposed Action from four KOPs with views to the northeast and southeast (see Appendix M, simulations 1C, 2C, 3C, 4C, 5C, 6C, 7C, and 8C). Although seven offshore wind projects are planned within the geographic analysis area, it was determined that the Hudson South Lease Areas OCS-A 0541 and OCS-A 0542 would not have the potential to be seen within the same viewshed as the Project from ground-level coastal KOPs; therefore, these projects were not included in the simulations of other planned future offshore wind development. The total number of WTGs that would be visible from any single KOP would be substantially less than the 761 WTGs considered under the planned activities scenario. For example, a total of 406 WTGs would be theoretically visible from KOP-14 (Playground Pier) in Atlantic City and a total of 488 WTGs would be theoretically visible from KOP-22 Stone Harbor Beach Access (BOEM 2022). The presence of structures associated with offshore wind development would affect seascape character, open ocean character, landscape character, and viewer experience, as simulated from sensitive onshore receptors (Appendix M). The seascape character and open ocean character would reach the maximum level of change to their features and characters from formerly undeveloped ocean to dominant wind farm character by approximately 2030, which would result in major impacts.

Lighting: Construction-related nighttime vessel lighting would be used if offshore wind development projects include nighttime, dusk, or early morning construction or material transport. In a maximum-case scenario, lights could be active throughout nighttime hours for up to seven offshore wind projects within the geographic analysis area (excluding the Proposed Action). The impact of vessel lighting on scenic and visual resources during construction would be localized and short term. Visual impacts of nighttime lighting on vessels would continue during O&M of planned offshore wind facilities and the impact on seascape character, open ocean character, nighttime viewer experience, and valued scenery from vessel lighting would be intermittent and long term.

Permanent aviation warning lighting required on the WTGs would be visible from beaches and coastlines within the geographic analysis area and would have major to negligible impacts on scenic and visual resources. FAA hazard lighting systems would be in use for the duration of O&M for up to 761 WTGs. The cumulative effect of these WTGs and associated synchronized flashing strobe lights affixed with a minimum of three red flashing lights at the mid-section of each tower and one at the top of each WTG nacelle within the offshore wind lease areas would have long-term minor to major impacts on sensitive onshore and offshore viewing locations, based on viewer distance and angle of view and assuming no obstructions. Atmospheric and environmental factors such as haze and fog would influence visibility and perception of hazard lighting from sensitive viewing locations.

The implementation of ADLS would activate the hazard lighting system in response to detection of nearby aircraft. The synchronized flashing of the aviation lights, if ADLS is implemented, would result in shorter-duration night sky impacts on the seascape, open ocean, landscape, and viewers. The shorter-duration synchronized flashing of the ADLS is anticipated to have reduced visual impacts at night compared to the standard continuous, medium-intensity red strobe FAA warning system due to the reduced duration of activation. A Capital Airspace Group analysis estimated that ADLS-controlled obstruction lights would be activated for 1 hour 19 minutes and 17 seconds over a 1-year period based on historical air traffic data (Capital Airspace Group 2020). It is anticipated that the reduced time of FAA hazard lighting resulting from an implemented ADLS would reduce the duration of potential impacts of nighttime aviation lighting to less than 1 percent of the normal operating time that would occur without using ADLS. Although when lit the nighttime impacts of FAA aviation lighting would fall within BOEM's major impact definition, BOEM has concluded that the ADLS-activated lighting system would reduce the impacts from major to negligible and moderate to negligible during those periods when the ADLS is not activated. Moonlit night times would increase the overall impacts of the wind farm from negligible to minor.

Traffic (vessel): Other offshore wind project construction and decommissioning and, to a lesser extent, O&M would generate increased vessel traffic that could contribute to adverse moderate to major impacts on scenic and visual resources within the geographic analysis area. The impacts would occur primarily during construction along routes between ports and the offshore wind construction areas. Vessel traffic for each project is not known but is anticipated to be similar to that of the Proposed Action, which is projected to generate between 20 and 65 vessels operating in the Wind Farm Area or over the offshore export cable route at any given time during the construction phase (Section 3.16). As shown in Table F2-1 in Appendix F, between 2023 and 2030 as many as seven offshore wind projects (excluding the Proposed Action) could be under construction simultaneously (in 2026). During such periods, assuming similar vessel counts as under the Proposed Action, construction of offshore wind projects would generate an average of 140 vessel trips daily from Atlantic Coast ports to worksites in the geographic analysis area, with as many as 455 vessels present (either underway or at anchor) during times of peak construction. Stationary and moving vessels would change the daytime and nighttime seascape and open ocean character from open ocean to active waterway.

Onshore and offshore visual impacts would continue from visible vessel activity related to O&M of offshore wind facilities. O&M activities for the Proposed Action are anticipated to generate an average of

10 vessel trips per day between a port and the Wind Farm Area. Based on the estimates for the Proposed Action, O&M of seven offshore wind projects under the No Action Alternative would generate an average of 70 vessel trips per day within the geographic analysis area. During O&M of offshore wind projects (excluding the Proposed Action), vessel traffic would result in long-term, intermittent contrasts to seascape and open ocean character and in the viewer experience of valued scenery. Vessel activity would increase again during decommissioning at the end of the assumed 35-year operating period of each project, with impacts similar to those described for construction.

Land disturbance: Other offshore wind development would require installation of onshore export cables, onshore substations, and transmission infrastructure to connect to the electric grid, which would result in localized, temporary visual impacts near construction sites due to land disturbance for vegetation clearing, site grading or trenching, and construction staging. These impacts would last through construction and continue until disturbed areas are restored. Intermittent land disturbance may also be required to maintain onshore infrastructure during O&M. The exact extent of impacts would depend on the locations of project infrastructure for offshore wind energy projects; however, the No Action Alternative would generally have localized, short-term minor to moderate impacts on scenic and visual resources during construction or O&M due to land disturbance.

Accidental releases: Accidental releases during construction, O&M, and decommissioning of offshore wind projects (excluding the Proposed Action) could affect nearby seascape character, open ocean character, landscape character, and viewers through the accidental release of fuel, trash, debris, or suspended sediments. Nearshore accidental releases could cause temporary closure of beaches, which would limit the opportunity for viewer experience of affected seascapes, open ocean area, and landscapes. The potential for accidental releases would be greatest during construction and decommissioning of offshore wind projects, and would be lower but continuous during O&M. Accidental releases would cause short-term moderate to major impacts.

3.20.3.3. Conclusions

Impacts of the No Action Alternative. Under the No Action Alternative, current regional trends and activities would continue, and scenic and visual resources would continue to be affected by natural and human-caused IPFs. Ongoing non-offshore wind activities would have continuing short- and long-term impacts on seascape, open ocean, landscape, and viewer experience, primarily through the daytime and nighttime presence of structures, lighting, and vessel traffic. The character of the coastal landscape would change in the short term and long term through natural processes and planned activities that would continue to shape onshore features, character, and viewer experience. Ongoing activities in the geographic analysis area that contribute to visual impacts include construction activities and vessel traffic, which lead to increased nighttime lighting, visible congestion, and the introduction of new structures. The No Action Alternative would result in **minor** to **moderate** impacts on scenic and visual resources from ongoing activities.

Cumulative Impacts of the No Action Alternative. Planned activities in the geographic analysis area other than offshore wind include new cable emplacement and maintenance, dredging and port improvements, marine minerals extraction, military use, marine transportation, and onshore development activities. Other offshore wind projects planned within the geographic analysis area would lead to the construction of approximately 761 WTGs in areas where no offshore structures currently exist, and would change the surrounding marine environment from undeveloped ocean to a wind farm environment. The seascape character and open ocean character would reach the maximum level of change to their features and characters from formerly undeveloped ocean to dominant wind farm character by approximately 2030. The No Action Alternative combined with all other planned activities (including other offshore wind activities) would result in **major** impacts on visual and scenic resources within the geographic analysis area due to addition of new structures, nighttime lighting, onshore construction, and increased vessel traffic.

3.20.4 Relevant Design Parameters & Potential Variances in Impacts for the Action Alternatives

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in impacts similar to or less than those described in the sections below. The following proposed PDE parameters (Appendix E) would influence the magnitude of the impacts on scenic and visual resources:

- The Project layout, including the number, size, and placement of the WTGs and OSS, and the design of lighting systems for structures;
- The number and type of vessels involved in construction, O&M, and decommissioning, and time of day that construction, O&M, and decommissioning would occur; and
- Onshore cable export route options and the size and location of onshore substations.

Variability of the proposed Project design exists as outlined in Appendix E. Below is a summary of potential variances in impacts:

- WTG number, size, location, and lighting: More WTGs and larger turbine sizes closer to shore would increase visual impacts from onshore KOPs.
- The design and type of WTG lighting would affect nighttime visibility of WTGs from shore. Implementation of ADLS technology would reduce visual impacts.
- Vessel lighting: Nighttime construction, O&M, and decommissioning activities that involve nighttime lighting would increase visibility at night.
- Location and scale of onshore Project components: Installation of larger-scale onshore Project components in closer proximity to sensitive receptors would have greater impacts.

Ocean Wind has committed to measures to minimize impacts on scenic and visual resources such as addressing key design elements including visual uniformity, use of tubular towers, and proportion and color of turbines (VIS-01) and seeking public input in evaluating the visual site design elements of proposed wind energy facilities (VIS-03). Ocean Wind has also committed to screening the onshore substations where they are visible and highly contrasting to their surroundings (VIS-05) and to giving consideration to visually adapting the buildings and other substation components into their physical context, including using non-reflective paint (VIS-06) (COP Volume II, Table 1.1-2; Ocean Wind 2023).

3.20.5 Impacts of the Proposed Action on Scenic and Visual Resources

3.20.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.20.8, *Impacts of Alternative E on Scenic and Visual Resources*.

This section addresses the impacts associated with construction, O&M, and decommissioning of the Proposed Action on seascape character, open ocean character, landscape character, and viewer experience in the geographic analysis area. The impact level is judged with reference to the sensitivity of the view receptor and the magnitude of impact, which considers the noticeable features; distance and FOV effects;

view framing and intervening foregrounds; and the form, line, color, and texture contrasts, scale of change, and prominence in the characteristic seascape, open ocean, and landscape.

The degree of adverse effects is determined by the following criteria:

- The Proposed Action's characteristics, contrasts, scale of change, prominence, and spatial interactions with the special qualities and extents of the baseline seascape, open ocean, and landscape characters;
- Intervisibility between viewer locations and the Proposed Action's features; and
- The sensitivities of viewers.

Viewers or visual receptors within the Proposed Action's zone of theoretical visibility include:

- Residents living in coastal communities or individual residences;
- Tourists visiting, staying in, or traveling through the area;
- Recreational users of the seascape, including those using ocean beaches and tidal areas;
- Recreational users of the open ocean, including those involved in yachting, fishing, boating, and passage on ships;
- Recreational users of the landscape, including those using landward beaches, golf courses, cycle routes, and footpaths;
- Tourists, workers, visitors, or local people using transport routes;
- People working in the countryside, commerce, or dwellings; and
- People working in the marine environment, such as those on fishing vessels and crews of ships.

KOPs 1 through 30 (Figure 3.20-4) are representative of sensitive receptors (and their vicinities) in the shoreward (seascape and landscape) parts of the geographic analysis area, and two representative offshore (open ocean) KOPs (KOP-31 and KOP-32) are typical of views of the Lease Area from boats, cruise ships, and commercial ships. KOP-13 Atlantic City Beachfront—nighttime and KOP-23 Stone Harbor Beach Access—nighttime represent the nighttime assessment. Appendix D to COP Volume III, Appendix L presents visual simulations from each of 30 onshore KOPs considered in this analysis. Cumulative visual simulations in Appendix M, Attachment 2 portray future conditions of the Proposed Action and in combination with other offshore wind development (including Atlantic Shores South, Atlantic Shores North, Ocean Wind 2, Garden State, and Skipjack) from four representative KOPs: KOP-6 Great Bay Boulevard Wildlife Management Area; KOP-14 Playground Pier, Atlantic City; KOP-19 Corson's Inlet State Park, Ocean City; and KOP-22 Stone Harbor Beach Access. Tables M-13 through M-16 in Appendix M consider effects on seascape, open ocean, landscape, and viewers of offshore wind development without the Proposed Action and in combination with the Proposed Action.

Presence of structures: The Proposed Action would install 98 WTGs extending up to 906 feet (276 meters) above MLLW and three OSS extending up to 296 feet (90.2 meters) above MLLW within the Lease Area. The WTGs would be painted white or light gray, no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey. RAL 7035 Light Grey would help reduce potential visibility against the horizon. Additionally, the lower sections of each WTG would be marked with high-visibility (RAL 1023) yellow paint from the water line to a minimum height of 50 feet (15.2 meters). The presence of structures within the geographic analysis area under the Proposed Action would affect seascape character, open ocean character, landscape character, and viewer experience. The magnitude of WTG and OSS impact is defined by the contrast, scale of the change, prominence, FOV, viewer experience, geographical extent, and duration, correlated against the sensitivity of the receptor, as simulated from onshore KOPs. Appendix D to COP Volume III, Appendix L presents WTG and OSS visual simulations from each of 30 onshore KOPs considered in this analysis. The effects analyses involved consideration of those COP VIA clear-day simulations of similar distance, variability of viewer location within KOP vicinity, variability of sun angles throughout the day, and nighttime variability of cloud cover, ocean reflections, and moonlight.

Distance-based comparison of the perceived size of a typical onshore cell tower with the perceived size of an Ocean Wind 1 offshore turbine is as follows: A 100-foot (30.5-meter)-tall microwave tower seen at 1.7 miles (2.7 kilometers) distance would be perceived as the same height and occupy the same vertical portion of the view (0.64-degree-vertical in the overall 55-degree vertical FOV) as a 906-foot (276.1-meter)-tall Ocean Wind 1 WTG seen at 15.3 miles (24.6 kilometers) distance.

Appendix M in this Final EIS provides additional (cumulative effects) simulations of the Proposed Action from four KOPs with views to the northeast and southeast (see Appendix M, simulations 1A, 2A, 3A, 4A, 5A, 6A, 7A, and 8A) and provides an assessment of the Proposed Action's noticeable elements, distance effects, FOV effects, foreground elements and influence, scale effects, prominence effects, and contrast rating effects by seashore character unit, open ocean character unit, landscape character unit, and offshore and onshore KOP.

The seascape character units, open ocean character unit, landscape character units, and viewer experiences would be affected by the Proposed Action's noticeable elements (Table M-6), applicable distances (Table M-7), and FOV extents (Table M-8), open views versus view framing or intervening foregrounds (Table M-9), and form, line, color, and texture contrasts in the characteristic seascape, open ocean, and landscape (Table M-10). Higher impact significance stems from unique, extensive, and long-term appearance of strongly contrasting vertical structures in the otherwise horizontal open ocean environment, where structures are an unexpected element and viewer experience includes formerly open views of high-sensitivity seascape, open ocean, and landscape, and from high-sensitivity view receptors. Table 3.20-11 considers the totality of the Proposed Action's level of impact by seascape character unit, open ocean character unit, and landscape character unit.

Table 3.20-11 Proposed Action Impact on Seascape Character, Open Ocean Character, and Landscape Character

Level of Impact	Seascape Character Units, Open Ocean Character Unit, and Landscape Character Units
Major	SLIA: Open Ocean Character Unit
Moderate	SLIA: Seascape Character Units and Landscape Character Units: Beachfront and Jetty/Seawall, Boardwalk, Coastal Dune, and Island Community
Minor	SLIA: Landscape Character Units: Bay/Shoreline, Island, Mainland, Marshland, and Ridges
Negligible	SLIA: Landscape Character Units: Island, Mainland, and Ridges

SLIA = seascape, open ocean, and landscape impact assessment

Table 3.20-12 considers the totality of the Proposed Action's level of impact by offshore and onshore KOPs.

Table 3.20-12 Proposed Action Impact on Viewer Experience

Level of Impact	Offshore and Onshore Key Observation Points
Major	VIA: KOP-31 Recreational Fishing, Pleasure, and Tour Boat Area KOP-32 Cruise Ship Shipping Lanes KOP-13 Atlantic City Beachfront—Nighttime[1]
Moderate	VIA: KOP-9 North Brigantine Natural Area Wildlife Observation Deck KOP-10 16th Street Park Beachfront KOP-12 Atlantic City Beachfront—Daytime KOP-14 Atlantic City Playground Pier KOP-16 Lucy the Elephant National Historic Landmark KOP-18 Ocean City Boardwalk KOP-19 Corson's Inlet State Park KOP-21 Avalon Beach Jetty KOP-22 Stone Harbor Beach—Daytime KOP-23 Stone Harbor Beach—Nighttime[2]
Minor	VIA: KOP-1 Barnegat Lighthouse KOP-3 Bayview Park KOP-4 Garden State Parkway KOP-5 Edwin B. Forsythe National Wildlife Refuge - Holgate Unit KOP-6 Great Bay Boulevard WMA KOP-7 Edwin B. Forsythe National Wildlife Refuge KOP-8 Absecon Creek Boat Ramp KOP-11 Atlantic City Country Club KOP-17 Bay Front Historic District, Municipal Beach Park KOP-24 North Wildwood Boulevard Bridge KOP-25 Hereford Inlet Lighthouse KOP-26 Wildwood Crest Fishing Pier KOP-28 Cape May Lighthouse KOP-29 BL England Substation Area KOP-30 Oyster Creek Substation Area
Negligible	VIA: KOP-2 Harvey Cedars Beach Access KOP-13 Atlantic City Beachfront—Nighttime[3] KOP-15 Ventor City, City Hall KOP-20 Sea Isle City Promenade KOP-23 Stone Harbor Beach—Nighttime[3] KOP-27 Cape May National Wildlife Refuge

[1] Major impacts when ADLS is activated.
[2] Moderate impacts when ADLS is activated.
[3] Negligible impacts when ADLS is not activated.
SLIA = seascape, open ocean, and landscape impact assessment; WMA = Wildlife Management Area

The Proposed Action would also add two onshore substations in the vicinity of Oyster Creek and BL England. Considering the location of the sites relative to scenic resources and public viewpoints, context of the sites and surrounding land uses, visual contrast between the substations and the surrounding landscape, and ability to screen the substations from public viewpoints, impacts of the substations on scenic and visual resources would be negligible to minor. All landfall export cable infrastructure would be underground and would not contribute to impacts on scenic and visual resources through the presence of structures IPF.

Lighting: Nighttime vessel lighting could result from construction, O&M, and decommissioning of the Proposed Action if these activities are undertaken during nighttime, evening, or early morning hours. Vessel lighting, depending on the quantity, intensity, and location, could be visible from unobstructed sensitive onshore and offshore viewing locations based on viewer distance and atmospheric conditions. The impact of vessel lighting on scenic and visual resources during construction and decommissioning would be moderate to major, localized, and short term. Visual impacts of nighttime lighting on vessels would continue during O&M but long-term impacts would be less due to the lower number of forecast vessel trips.

Vessel lights could be active during nighttime hours for up to eight offshore wind projects including the Proposed Action. Nighttime vessel lighting for the Proposed Action in combination with other offshore wind development would affect seascape character, open ocean character, nighttime viewer experience, and valued scenery. This impact would be localized and short-term during construction and decommissioning and intermittent and long-term during O&M.

Permanent aviation warning lighting on Proposed Action WTGs would be visible from beaches and coastlines within the geographic analysis area and would have impacts on scenic and visual resources. Field observations associated with visibility of FAA hazard lighting under clear-sky conditions indicate that FAA hazard lighting may be visible at a distance of 40 miles or more from the viewer. Darker-sky conditions may increase this distance due to increased contrast of the light dome (reflections from the ocean) and cloud reflections caused by the hazard lights.

Ocean Wind has committed to installing ADLS on WTGs, which activates the hazard lighting system in response to detection of nearby aircraft (GEN-07, COP Volume II, Table 1.1-2; Ocean Wind 2023). The synchronized flashing of the aviation lights occurs only when aircraft are present, resulting in shorter-duration night sky impacts on the seascape, open ocean, landscape, and viewers. Historical air traffic data for flights indicates that ADLS-controlled obstruction lights would be activated for an estimated 1 hour 19 minutes and 17 seconds over a 1-year period. Considering the local sunrise and sunset times, an ADLS-controlled obstruction lighting system could result in over a 99-percent reduction in system activated duration as compared to a traditional always-on obstruction lighting system (Capitol Airspace Group 2020). The shorter-duration synchronized flashing of ADLS is anticipated to have reduced visual impacts at night as compared to the standard continuous, medium-intensity red strobe FAA warning system due to the duration of activation. ADLS hazard lighting would be in use for the duration of O&M of the Proposed Action and would have intermittent and long-term effects on sensitive onshore and offshore viewing locations based on viewer distance and angle of view, and assuming no obstructions. Although when lit the nighttime impacts of FAA aviation lighting would fall within BOEM's major impact definition, BOEM has concluded that the ADLS-activated lighting system would reduce the impacts from major to negligible and moderate to negligible during periods when the ADLS is not activated. A nighttime visual simulation that simulates activation of ADLS lighting is provided in Appendix M, Attachment M-4.

The OSS would be lit and marked in accordance with Occupational Safety and Health Administration lighting standards to provide safe working conditions when O&M personnel are present. The OSS would have nighttime lighting up to 296 feet (90.2 meters) above sea level. Due to EC, from eye levels of 5 feet

(1.5 meters), these lights would become invisible above the ocean surface beyond approximately 23.8 miles (38.3 kilometers). Lights of the three OSS, when lit for maintenance, potentially would be visible from beaches and adjoining areas during hours of darkness. The nighttime sky light dome and cloud lighting caused by reflections from the water surface may be seen from distances beyond the 40-mile (64.4-kilometer) geographic analysis area, depending on variable ocean surface and meteorological reflectivity.

The WTGs would be lit and marked in accordance with FAA and USCG lighting standards and consistent with BOEM best practices. Per USCG requirements, a mid-tower light would be located 256 feet (78 meters) above sea level. FAA hazard lighting systems would be in use for the duration of O&M for up to 859 WTGs including the Proposed Action and other offshore wind development. These WTGs and associated synchronized flashing strobe lights affixed with a minimum of three red flashing lights at the mid-section of each tower and one at the top of each WTG nacelle within the offshore wind lease areas would have long-term impacts on sensitive onshore and offshore viewing locations, based on viewer distance and angle of view and assuming no obstructions. Atmospheric and environmental factors such as haze and fog would influence visibility and perception of hazard lighting from sensitive viewing locations.

Traffic (vessel): Construction and installation, O&M, and decommissioning of the Proposed Action would generate increased vessel traffic that could contribute to adverse impacts on scenic and visual resources within the geographic analysis area. The impacts would occur primarily during construction along routes between ports and the offshore wind construction areas. Construction and installation of the Proposed Action is projected to generate between 20 and 65 vessels operating in the Wind Farm Area or over the offshore export cable route at any given time (Section 3.16). O&M activities for the Proposed Action are anticipated to generate an average of 10 vessel trips per day between a port and the Wind Farm Area. Impacts from the Proposed Action related to vessel traffic would be moderate to major.

Vessel traffic for each project is not known but is anticipated to be similar to that of the Proposed Action. As shown in Table F2-1 in Appendix F, between 2023 and 2030 as many as seven offshore wind projects (excluding the Proposed Action) could be under construction simultaneously (in 2026). During such periods, assuming similar vessel counts as under the Proposed Action, construction of offshore wind projects would generate an average of 140 vessel trips daily from Atlantic Coast ports to worksites in the geographic analysis area, with as many as 455 vessels present (either underway or at anchor) during times of peak construction. Stationary and moving vessels would change the daytime and nighttime seascape and open ocean characters from open ocean to active waterway.

Onshore and offshore visual impacts would continue from visible vessel activity related to O&M of offshore wind facilities. Based on the estimates for the Proposed Action, O&M of eight offshore wind projects (including the Proposed Action) would generate an estimated 80 vessel trips per day within the geographic analysis area. Vessel traffic during O&M would result in long-term, intermittent contrasts to open ocean character and in the viewer experience of valued scenery. Vessel activity would increase again during decommissioning at the end of the assumed 35-year operating period of each project, with impacts similar to those described for construction. Maintenance activities would cause minor effects on seascape character and open ocean character due to increased O&M vessel traffic to and from the offshore wind lease areas. Increases in these vessel movements would be noticeable to onshore and offshore viewers, but are unlikely to have a significant effect.

Land disturbance: The Proposed Action would require installation of onshore export cables, onshore substations, and transmission infrastructure to connect to the electrical grid, which would result in localized, temporary visual impacts near construction sites due to land disturbance for vegetation clearing, site grading or trenching, and construction staging. These impacts would last through construction and continue until disturbed areas are restored. Intermittent land disturbance may also be required to maintain onshore infrastructure during O&M. Impacts from the Proposed Action related to land disturbance would be minor to moderate.

Accidental releases: Accidental releases during construction, O&M, and decommissioning of the Proposed Action could affect nearby seascape character, open ocean character, landscape character, and viewers through the accidental release of fuel, trash, debris, or suspended sediments. Nearshore accidental releases could cause temporary closure of beaches, which would limit the opportunity for viewer experience of affected seascapes, open ocean, and landscapes.

3.20.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned activities.

Presence of structures: The Proposed Action would contribute 98 of a combined total of 859 WTGs that would be installed in the geographic analysis area between 2024 and 2030, which accounts for approximately 11 percent of offshore wind development planned for the geographic analysis area. The total number of WTGs that would be visible from any single KOP would be substantially fewer than the 859 WTGs considered under the planned activities scenario in combination with the Proposed Action. For example, a total of 504 WTGs would be theoretically visible from KOP-14 (Playground Pier) in Atlantic City and a total of 587 WTGs would be theoretically visible from KOP-22 Stone Harbor Beach Access (BOEM 2022). Appendix M provides simulations of the Proposed Action in combination with other offshore wind projects that would be theoretically visible within the same viewshed as the Project, including Atlantic Shores South, Atlantic Shores North, Ocean Wind 2, Garden State, and Skipjack. The presence of structures associated with offshore wind development in combination with the Proposed Action would have major seascape character, open ocean character, landscape character, and viewer experience impacts, as simulated from sensitive onshore receptors (see Appendix M, simulations 1B, 2B, 3B, 4B, 5B, 6B, 7B, and 8B). The open ocean character would reach the maximum level of change to its features and characters from formerly undeveloped ocean to dominant wind farm character by approximately 2030, which would result in major impacts.

Lighting: The extent to which other offshore wind projects would implement ADLS is unknown. Impacts from lighting would be reduced if ADLS is implemented across all offshore wind projects in the geographic analysis area and would be more adverse if other projects do not commit to using ADLS. Based on recent studies (Atlantic Shores 2021), activation of ADLS, if implemented, would occur for less than 11 hours per year, compared to standard continuous FAA hazard lighting. It is estimated that the reduced time of FAA hazard lighting resulting from an implemented ADLS would reduce the duration of potential impacts of nighttime aviation lighting to less than 1 percent of the normal operating time that would occur without using ADLS. Atmospheric and environmental factors such as haze and fog would influence visibility and perception of hazard lighting from sensitive viewing locations. Each offshore wind project would also have at least one OSS that would be lit and marked in accordance with USCG and Occupational Safety and Health Administration lighting standards. The Proposed Action would contribute an appreciable increment to the combined lighting impacts on scenic and visual resources from ongoing and planned activities including offshore wind, which would be major. Due to variable distances from visually sensitive viewing locations and potential use of ADLS, other reasonably foreseeable offshore wind projects in combination with the Proposed Action would have minor to major long-term impacts on visually sensitive viewing areas due to lighting. The recreational and commercial fishing, pleasure, and tour boating community would experience major adverse effects in foreground views.

Vessel traffic: The Proposed Action would contribute a noticeable increment to the combined vessel traffic impacts on scenic and visual resources from ongoing and planned activities including offshore wind, which would be moderate to major. Offshore wind activities would increase vessel traffic in the geographic analysis area beyond what the Proposed Action would generate in isolation.

Land disturbance: The Proposed Action would contribute a noticeable increment to the combined land disturbance impacts on scenic and visual resources from ongoing and planned activities including offshore wind, which would be minor to moderate. The exact extent of impacts would depend on the locations of project infrastructure for other offshore wind energy projects.

Accidental releases: The Proposed Action would contribute an appreciable increment to the combined impacts on scenic and visual resources from ongoing and planned activities including offshore wind, which would be moderate to major. The potential for accidental releases would be greatest during construction and decommissioning of offshore wind projects, and would be lower but continuous during O&M.

3.20.5.3. Conclusions

Impacts of the Proposed Action. The seascape character units, open ocean character unit, landscape character units, and viewer experience would be affected during construction, O&M, and decommissioning by the Project's features, applicable distances, horizontal and vertical FOV extents, view framing or intervening foregrounds, and form, line, color, and texture contrasts, scale of change, and prominence. These assessments are documented in Appendix M. Project decommissioning effects would be similar to construction effects. Due to distance, extensive FOVs, strong contrasts, large scale of change, and level 6 prominence, and heretofore undeveloped ocean views, the Proposed Action would have major impacts on the open ocean character unit and viewer boating and cruise ship experiences. Due to view distances (effects ranges discussion in Appendix M), moderate FOVs, moderate and weak visual contrasts, clear-day conditions, and nighttime ADLS activation, Proposed Action effects on high- and moderate-sensitivity seascape character units and landscape character units would be moderate to major. The daytime presence of offshore WTGs and OSS, as well as their nighttime lighting, would change perception of ocean scenes from natural and undeveloped to a developed wind energy environment characterized by WTGs and OSS. In clear weather, the WTGs and OSS would be an unavoidable presence in views from the coastline, with moderate to major effects on seascape character and landscape character.

Onshore, temporary moderate effects would occur during construction and decommissioning of the landfalls and onshore export cables. Effects during O&M activities would involve temporary vehicular and personnel presence and would be negligible. The context of the onshore substation sites surrounding industrial elements, strong visual contrast between the sites and the surrounding landscape, and the scale of change would be insubstantial as viewed from the KOPs. While the Project's visibility would be moderately prominent from the KOPs, the value of the onshore view is low, having little or no effect on viewers' quality of visual experience. Impacts of the onshore substations on scenic and visual resources would be negligible to minor. Impacts of the Proposed Action on scenic and visual resources would range from **minor** to **major**.

Cumulative Impacts of the Proposed Action. The incremental impacts contributed by the Proposed Action to the cumulative impacts on scenic and visual resources would be appreciable. BOEM anticipates that the impacts associated with the Proposed Action when combined with the impacts from ongoing and planned activities including other offshore wind development would be **major**. The main drivers for this impact rating are the major visual impacts associated with the presence of structures, lighting, and vessel traffic.

3.20.6 Impacts of Alternative B on Scenic and Visual Resources

Impacts of Alternative B. Alternative B was developed through the scoping process for the Draft EIS in response to public comments concerning the visual impacts of the Project. Under Alternative B, no surface occupancy would occur at select WTG positions to reduce the visual impacts of the proposed Project. Alternative B-1 would exclude placement of WTGs at up to nine WTG positions that are nearest to coastal communities (positions F01 to K01 and B02 to D02). Alternative B-2 would exclude placement of WTGs at up to 19 WTG positions that are nearest to coastal communities (positions F01 to K01, A02 to K02, A03, and C03). Selection of Alternative B-2 would be contingent on the larger WTG with a 240-meter rotor diameter being commercially available when BOEM issues its ROD.

The impacts of Alternatives B-1 and B-2 on seascape character units, open ocean character unit, and landscape character units are summarized in Table 3.20-13. Appendix M presents the methods, analyses, and visual simulations used to assess the impact of Alternatives B-1 and B-2.

Table 3.20-13 Alternatives B-1 and B-2 Impact on Seascape Character, Open Ocean Character, and Landscape Character

Level of Impact	Seascape Character Units, Open Ocean Character Unit, and Landscape Character Units
Major	SLIA: Open Ocean Character Unit
Moderate	SLIA: Seascape Character Units and Landscape Character Units: Beachfront and Jetty/Seawall, Boardwalk, Coastal Dune, and Island Community
Minor	SLIA: Landscape Character Units: Bay/Shoreline, Island, Mainland, Marshland, and Ridges
Negligible	SLIA: Landscape Character Units: Island, Mainland, and Ridges

SLIA = seascape, open ocean, and landscape impact assessment

The impacts of Alternatives B-1 and B-2 on viewer experience from offshore and onshore KOPs are summarized in Table 3.20-14.

Table 3.20-14 Impact of Alternatives B-1 and B-2 on Viewer Experience

Impact Level	Offshore and Onshore Key Observation Points
Major	VIA: KOP-13 Atlantic City Beachfront—Nighttime[1] KOP-31 Recreational Fishing, Pleasure, and Tour Boat Area KOP-32 Cruise Ship Shipping Lanes
Moderate	VIA: KOP-9 North Brigantine Natural Area Wildlife Observation Deck KOP-10 16th Street Park Beachfront KOP-12 Atlantic City Beachfront—Daytime KOP-14 Atlantic City Playground Pier KOP-16 Lucy the Elephant National Historic Landmark KOP-18 Ocean City Boardwalk KOP-19 Corson's Inlet State Park KOP-21 Avalon Beach Jetty KOP-22 Stone Harbor Beach—Daytime KOP-23 Stone Harbor Beach—Nighttime[2]

Impact Level	Offshore and Onshore Key Observation Points
Minor	SLIA: Landscape Character Units: Marshland, and Bay/Shoreline KOP-1 Barnegat Lighthouse VIA: KOP-2 Harvey Cedars Beach Access KOP-3 Bayview Park KOP-4 Garden State Parkway KOP-5 Edwin B. Forsythe National Wildlife Refuge - Holgate Unit KOP-6 Great Bay Boulevard WMA KOP-7 Edwin B. Forsythe National Wildlife Refuge KOP-8 Absecon Creek Boat Ramp KOP-11 Atlantic City Country Club KOP-17 Bay Front Historic District, Municipal Beach Park KOP-24 North Wildwood Boulevard Bridge KOP-25 Hereford Inlet Lighthouse KOP-26 Wildwood Crest Fishing Pier KOP-28 Cape May Lighthouse KOP-29 BL England Substation Area KOP-30 Oyster Creek Substation Area
Negligible	VIA: KOP-2 Harvey Cedars Beach Access KOP-13 Atlantic City Beachfront—Nighttime[3] KOP-15 Ventor City, City Hall KOP-20 Sea Isle City Promenade KOP-23 Stone Harbor Beach—Nighttime[3] KOP-27 Cape May National Wildlife Refuge

[1] Major impacts when ADLS is activated.
[2] Moderate impacts when ADLS is activated.
[3] Negligible impacts when ADLS is not activated.
SLIA = seascape, open ocean, and landscape impact assessment; WMA = Wildlife Management Area

Cumulative Impacts of Alternative B. The incremental impacts resulting from individual IPFs would be appreciable.

3.20.6.1. Conclusions

Impacts of Alternative B. The seascape character units, open ocean character unit, landscape character units, and viewer experience would be affected by construction, O&M, and decommissioning of Alternatives B-1 and B-2 due to the noticeable elements, distance effects, FOV extents, view framing and intervening foregrounds, and visual contrasts, scale of change, and prominence effects as presented in Appendix M and summarized below.

Alternative B-1: For those shoreline viewers directly northwest of the Wind Farm Area, the distance to the nearest WTG would increase from 15.3 miles (24.6 kilometers) under the Proposed Action to 16.1 miles (25.9 kilometers) under Alternative B-1. The width of the front edge of the Wind Farm Area would be similar to that of the Proposed Action. Because WTG and OSS construction specifications would remain constant, the minimal change in Project size, character, and contrasts would be unnoticeable to viewers, particularly because the Proposed Action view would not be seen for comparison. This negligible reduction within the overall clear-day 124° horizontal FOV and 55° vertical FOV would be unnoticeable to the casual viewer at this distance and would not have noticeable differences in form, line, color, or texture contrasts to seascape unit character, open ocean unit character, or landscape unit character, or onshore or offshore viewer experience as compared to the Proposed Action.

Alternative B-2: For those onshore viewers directly northwest of the Wind Farm Area, increasing the distance to the nearest WTG from 15.3 miles (24.6 kilometers) under the Proposed Action to 16.9 miles (25.9 kilometers) under Alternative B-2 would decrease the wind farm's horizontal FOV by 0.8 percent (1°) and the vertical FOV (perceived height) of the nearest WTGs by 0.02 percent (0.03°) in a typical human's overall 55° vertical FOV. At a baseline distance of 15.3 miles (24.6 kilometers), removal of one row of WTGs from the northwestern side of the layout would decrease the FOV from 37.6° to 35.4°. This 2.2° difference within the typical overall 124° horizontal FOV would be unnoticeable to the casual viewer at this distance and would not have noticeable differences in form, line, color, or texture contrasts to seascape unit character or landscape unit character, or onshore or offshore viewer experience compared to under the Proposed Action.

The effects of Alternatives B-1 and B-2 on seascape character, open ocean character, landscape character, and viewer experience would be similar to the effects of the Proposed Action. Due to distance, extensive FOVs, strong contrasts, and heretofore undeveloped ocean views, Alternatives B-1 or B-2 would have **major** effects on the seascape unit character and viewer boating and cruise ship experiences. Due to view distances, moderate FOVs, moderate and weak visual contrasts, clear-day conditions, and nighttime ADLS activation, effects of Alternatives B-1 or B-2 on high- and moderate-sensitivity landscape character units would be **moderate**. The daytime presence of offshore WTGs and OSS, as well as their nighttime lighting, would change perception of ocean scenes from natural and undeveloped to a developed wind energy environment characterized by WTGs and OSS. In clear weather, the WTGs and OSS would be an unavoidable presence in views from the coastline, with moderate to major effects on landscape character.

Onshore, temporary minor to moderate effects would occur during construction and decommissioning of the landfalls and onshore export cables. Effects during O&M activities would involve temporary vehicular and personnel presence and would be negligible. The context of the onshore substation sites surrounding industrial elements, strong visual contrast between the sites and the surrounding landscape, and the scale of change would be substantial as viewed from the KOPs. While the Project's visibility would be prominent from the KOP, the value of the view is low, having little or no effect on viewers' quality of visual experience. Impacts of the onshore substations on scenic and visual resources would be **minor** to **moderate**.

Cumulative Impacts of Alternative B. The incremental impacts contributed by Alternatives B-1 or B-2 to the cumulative impacts on scenic and visual resources would be appreciable. BOEM anticipates that the cumulative impacts of Alternatives B-1 or B-2 would be **major**. The main drivers for this impact rating are the major visual impacts associated with the presence of structures, lighting, and vessel traffic.

3.20.7 Impacts of Alternatives C and D on Scenic and Visual Resources

Impacts of Alternatives C and D. Impacts of Alternative C and Alternative D related to the primary IPFs (presence of structures, light, vessel traffic, land disturbance, and accidental releases) would be similar to the impacts described for the Proposed Action. The seascape character units, open ocean character unit, landscape character units, and viewer experience would be affected by construction, O&M, and decommissioning of Alternatives C-1, C-2, and D due to the noticeable elements, distance effects, FOV extents, view framing and intervening foregrounds, and contrast rating effects as presented in Appendix M and summarized below.

The effects of Alternatives C-1, C-2, or D on seascape character, open ocean character, landscape character, and viewer experience would be similar to the effects of the Proposed Action. Alternative C-1 would relocate eight WTGs, Alternative C-2 would compress the WTG array layout, and Alternative D would install up to 15 fewer WTGs in the northeastern portion of the Lease Area. Horizontal and vertical FOV extent would be similar for all alternatives (Table 3.20-15 and Table 3.20-16) and differences between the alternatives and the Proposed Action would not be noticeable to the casual viewer at applicable distances to the WTG array.

Table 3.20-15 Horizontal FOV Occupied by Alternatives C-1, C-2, and D

Noticeable Element	Width miles (km)	Distance miles (km)	Horizontal FOV	Human FOV	Percent of FOV
C-1 WTGs	10.6 (17.1)	14.1 (22.7)	36.9°	124°	30%
C-2 WTGs	10.7 (17.2)	15.1 (24.3)	35.3°	124°	30%
D WTG	11.8 (19.0)	15.3 (25.9)	37.6°	124°	30%

km = kilometers

Table 3.20-16 Vertical FOV Occupied by Alternatives C-1, C-2, and D

Noticeable Element	Height feet (m) MLLW	Distance miles (km)	Visible Height[1] feet (m)	Vertical FOV	Human FOV	Percent of FOV
C-1 Rotor Blade Tip	906 (276.1)	14.1 (22.7)	820 (244)	0.6°	55°	1%
C-2 Rotor Blade Tip	906 (276.1)	15.1 (24.3)	804 (244)	0.6°	55°	1%
D Rotor Blade Tip	906 (276.1)	15.3 (25.9)	801 (244)	0.6°	55°	1%

[1] Based on intervening EC and clear-day conditions.
km = kilometers; m = miles

Cumulative Impacts of Alternatives C and D. The incremental impacts resulting from individual IPFs would be appreciable.

3.20.7.1. Conclusions

Impacts of Alternatives C and D. The effects of Alternatives C-1, C-2, or D on seascape character, open ocean character, landscape character, and viewer experience would be similar to the effects of the Proposed Action. Due to distance, extensive FOVs, strong contrasts, and heretofore undeveloped ocean views, Alternatives C-1, C-2, or D would have **major** effects on the open ocean character unit and viewer boating and cruise ship experiences. Due to view distances, moderate FOVs, moderate and weak visual contrasts, clear-day conditions, and nighttime ADLS activation, effects of Alternatives C-1, C-2, or D on high- and moderate-sensitivity seascape character units and landscape character units would be **moderate**. The daytime presence of offshore WTGs and OSS, as well as their nighttime lighting, would change perception of ocean scenes from natural and undeveloped to a developed energy environment characterized by WTGs and OSS. In clear weather, the WTGs and OSS would be an unavoidable presence in views from the coastline, with **moderate** effects on landscape character.

Onshore, temporary **moderate** effects would occur during construction and decommissioning of the landfalls and onshore export cables. Effects during O&M activities would involve temporary vehicular and personnel presence and would be **negligible**. The context of the onshore substation sites' surrounding industrial elements, strong visual contrast between the sites and the surrounding landscape, and the scale of change would be substantial as viewed from the KOPs. While the Project's visibility would be prominent from the KOP, the value of the view is low, having little or no effect on viewers' quality of visual experience; as such, impacts of the onshore substations on scenic and visual resources would be **negligible** to **minor**. Impacts of Alternatives C-1, C-2, or D on scenic and visual resources would range from **negligible** to **major**.

Cumulative Impacts of Alternatives C and D. The incremental impacts resulting from individual IPFs would be appreciable. BOEM anticipates that the cumulative impacts of Alternatives C-1, C-2, or D would be **major**. The main drivers for this impact rating are the major visual impacts associated with the presence of structures, lighting, and vessel traffic.

3.20.8 Impacts of Alternative E on Scenic and Visual Resources

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. Alternative E would lead to the same types of impacts on scenic and visual resources from construction and installation, O&M, and conceptual decommissioning activities in the Offshore Project area as described for the Proposed Action. The longer northern export cable route on Island Beach State Park could result in a slight increase to the localized, temporary visual impacts due to land disturbance for vegetation clearing, site grading or trenching, and construction staging as compared to the southern export cable route option under the Proposed Action. These impacts would last through construction and continue until disturbed areas are restored. Intermittent land disturbance may also be required to maintain onshore infrastructure during O&M.

Cumulative Impacts of Alternative E. The incremental impacts resulting from individual IPFs would be similar to those of the Proposed Action.

3.20.8.1. Conclusion

Impacts of Alternative E. The impacts of Alternative E on seascape character, open ocean character, landscape character, and viewer experience would be approximately the same as those of the Proposed Action, and would be **major** on the open ocean character unit and viewer boating and cruise ship experiences and **moderate** to **major** on high- and moderate-sensitivity seascape character units and landscape character units. The daytime presence of offshore WTGs and OSS, as well as their nighttime lighting, would change viewers' perception of ocean scenes from natural and undeveloped to a developed energy environment characterized by WTGs and OSS. In clear weather, the WTGs and OSS would be unavoidable presences in views from the coastline, with **moderate** to **major** impacts on seascape character, open ocean character, and landscape character.

Onshore, temporary **minor** to **moderate** impacts would occur during construction and decommissioning of the landfalls and onshore export cables. Impacts during O&M activities would involve temporary vehicular and personnel presence and would be negligible. The context of the onshore substation sites surrounding industrial elements, strong visual contrast between the sites and the surrounding landscape, and the scale of change would be substantial as viewed from the KOPs. While the Project's visibility would be prominent from the KOP, the value of the view is low, having little or no impact on viewers' quality of visual experience; as such, impacts of the onshore substations on scenic and visual resources would be **minor** to **moderate**. Impacts of Alternative E on scenic and visual resources would range from **moderate** to **major**.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the overall impacts on scenic and visual resources would be appreciable. BOEM anticipates that the cumulative impacts of Alternative E would be **minor** to **major**. The main drivers for this impact rating are the major visual impacts associated with the presence of structures, lighting, and vessel traffic.

3.20.9 Proposed Mitigation Measures

The National Park Service has proposed measures to minimize impacts on scenic and visual resources (Appendix H, Table H-3). If the measures analyzed below are adopted some adverse impacts could be further reduced.

Table 3.20-17 Additional Proposed Measures (Also Identified in Appendix H, Table H-3): Scenic and Visual Resources

Measure	Description	Effect
Adopt sustainable lighting practices	Adopt NPS-recommended sustainable lighting practices for outdoor lighting at onshore facilities (e.g., onshore substation and O&M facility). Sustainable outdoor lighting specifications include use of LEDs in warm colors, recessed and fully shielded lights, fixtures that include timers, motion detectors, hue adaptors, and dimmers, reducing light intensity, and proper installation of lights (see https://www.nps.gov/subjects/nightskies/sustainable-outdoor-lighting.htm).	Implementation of this measure would reduce the visual impact contributed by lighting at onshore facilities. Implementation of this measure would not reduce the major impact of the Proposed Action because the major impact level is primarily associated with the presence of structures in the offshore environment, including WTGs and OSS that are lit according to BOEM’s Lighting and Marking Guidelines and FAA and USCG lighting standards.

LED = light-emitting diode; NPS = National Park Service

3.20.9.1. Measures Incorporated in the Preferred Alternative

BOEM has identified the following additional measures in Table 3.20-17 as incorporated in the Preferred Alternative: adopt sustainable lighting practices. The effect of this measure, if adopted, is described in Table 3.20-17.

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3.21. Water Quality (see Appendix G)

The reader is referred to Appendix G for a discussion of current conditions and potential impacts on water quality from implementation of the No Action Alternative, the Proposed Action, and other action alternatives.

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3.22. Wetlands

This section discusses potential impacts on wetlands from the proposed Project, alternatives, and ongoing and planned activities in the geographic analysis area. The wetlands geographic analysis area, as shown on Figure 3.22-1, includes all subwatersheds that intersect the Onshore Project area, which encompasses all wetlands and surface waters that are most likely to experience impacts from the proposed Project. See Section 3.21 for a discussion of impacts on water quality.

3.22.1 Description of the Affected Environment for Wetlands

The National Wetlands Inventory (NWI) and NJDEP wetland data were used to determine the potential presence of wetlands. NWI information is provided in Appendix I and NJDEP information is provided in this section. NWI and NJDEP data rely on trained image analysts to identify potential wetlands. Tidal wetlands are areas where the Atlantic Ocean and estuaries meet land, are found below the spring high tide line, and are subject to regular flooding by the tides. Tidal wetlands are typically categorized into two zones, high marsh and low marsh. Non-tidal wetlands, otherwise referred to as freshwater wetlands, are not influenced directly by tides and are typically categorized based on their hydrology and predominant vegetation.

The BL England Onshore Project area lies within four watersheds: Cedar Swamp Creek (hydrologic unit code [HUC] 12 No. 020403020304), Corson Inlet-Ludlam Bay (HUC 12 No. 020403020407), Great Egg Harbor Bay-Atlantic Ocean Deep (HUC 12 No. 020403020500), and Great Egg Harbor Bay-Great Egg Harbor Inlet (HUC 12 No. 020403020408). All of these watersheds are within the Great Egg Harbor Watershed Management Area. The major watercourses draining these watersheds into the bays include Patcong Creek and the Great Egg Harbor, Middle, and Tuckahoe Rivers in the southern portion of the Project area. According to NJDEP and NWI wetland data, estuarine wetlands within the BL England Onshore Project area are dominated by large, contiguous swaths of tidal saline low marsh communities fringed by Phragmites (see COP Volume II, Figure 2.2.1-3; Ocean Wind 2023). Tidal wetlands are limited to areas adjacent to Roosevelt Boulevard and the Great Egg Harbor shoreline at the BL England substation. Freshwater wetlands are dominated by forested wetland communities. A large expanse of freshwater forested/shrub wetland is also identified within the Tuckahoe Wildlife Management Area along the BL England Onshore Project area boundary. NWI data are consistent with NJDEP wetland data that show estuarine and marine wetlands present along the backbays, major watercourses, and their tributaries (Ocean Wind 2023).

The Oyster Creek Onshore Project area lies within two watersheds: Forked River-Barnegat Bay (HUC 12 No. 020403010405) and Oyster Creek-Barnegat Bay (HUC 12 No. 020403010407). Both watersheds are within the Barnegat Bay Watershed Management Area. Oyster Creek and the South Branch of the Forked River are the major river systems within this area. Based on the NJDEP and NWI wetland data, estuarine and freshwater wetlands are found within the Oyster Creek Onshore Project area (See COP Volume II, Figure 2.2.1-4; Ocean Wind 2023). According to NJDEP data, wetlands are concentrated along the Forked River, Oyster Creek, and their tributaries. Freshwater wetlands are dominated by forested wetlands with large areas of Atlantic white cedar wetlands. Tidal wetlands are limited to areas adjacent to Barnegat Bay and the mouth of Oyster Creek and the Forked River. A large area of low-saline marsh dominates the area at the mouth of the Forked River. Low-saline marsh Phragmites-dominated coastal wetlands and scrub shrub wetlands dominate the area at the mouth of Oyster Creek (Ocean Wind 2023).

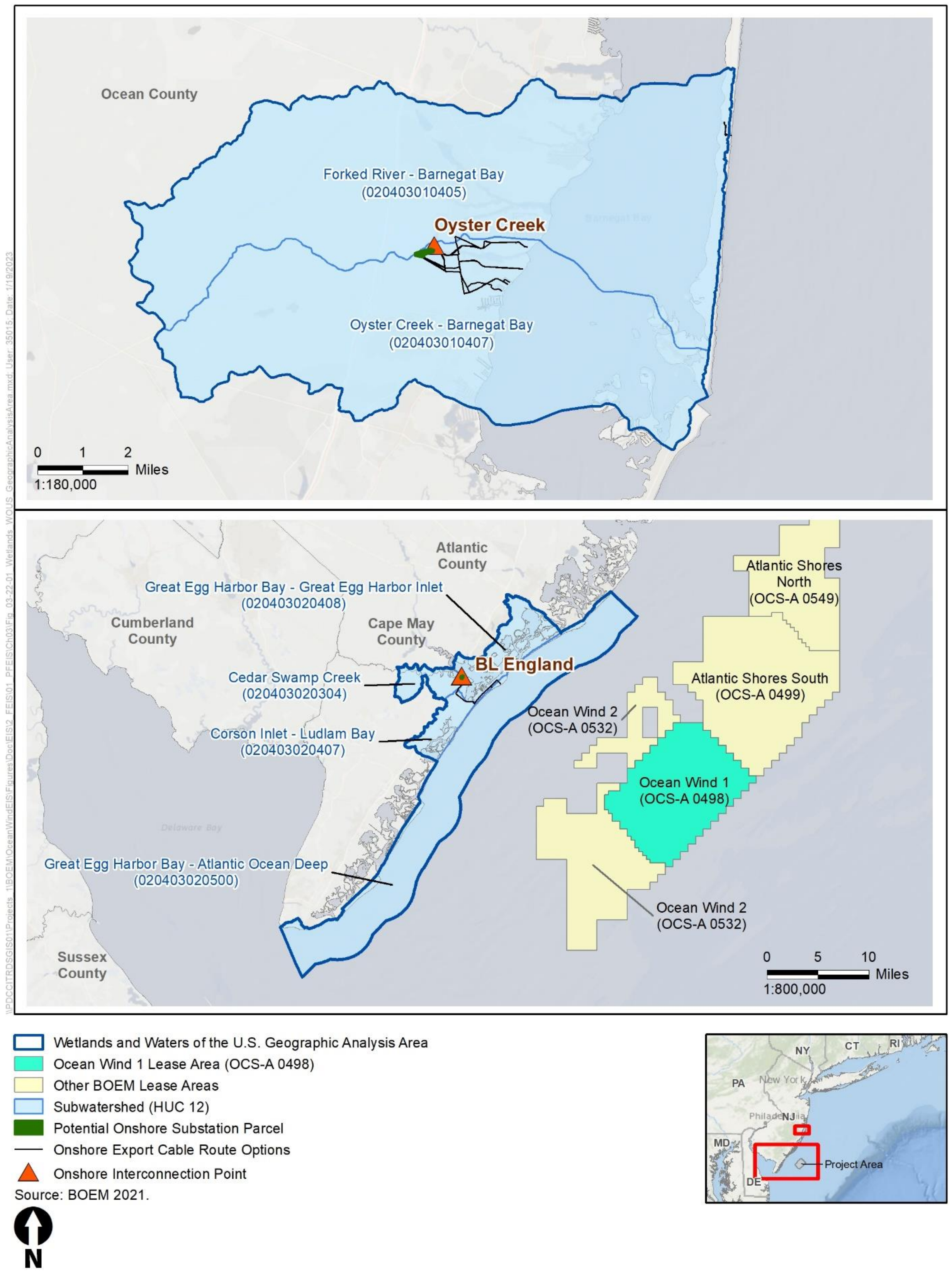

Figure 3.22-1 Wetlands Geographic Analysis Area

Wetlands are important features in the landscape that provide numerous beneficial services or functions. Some of these include protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters, providing aesthetic value, ensuring biological productivity, filtering pollutant loads, and maintaining surface water flow during dry periods. The majority of the wetlands in the geographic analysis area are tidally influenced saline marshes, which provide shelter, food, and nursery grounds for coastal fisheries species including shrimp, crab, and many finfish. Saline marshes also protect shorelines from erosion by creating a buffer against wave action and by trapping soils. In flood-prone areas, saline marshes reduce the flow of flood waters and absorb rainwater. Tidal wetlands also serve as carbon sinks, holding carbon that would otherwise be released into the atmosphere and contribute to climate change. Wetlands in and around Barnegat Bay provide flood protection during storm events and function to sequester a significant amount of the nitrogen and phosphorous loading to the bay. These coastal wetlands can remove (through deposition and plant growth) approximately 85 percent of the nitrogen and 54 percent of the phosphorus entering the bay from upland sources (NJDEP 2021). Wetlands can provide habitat for a variety of wildlife species. COP Volume II, Tables 2.2.2-1 and 2.2.2-2, provide a list species associated with habitats in the onshore export cable study area, including species that may utilize wetland habitats. With more than 28 percent of Barnegat Bay's salt marshes having been lost to development, stabilizing and restoring existing wetlands and preventing the loss of any more wetlands is of significant importance (NJDEP 2021).

Table 3.22-1 displays the wetland communities within the geographic analysis area based on NJDEP wetland data.

Table 3.22-1 Wetland Communities in the Geographic Analysis Area

Wetland Community	Acres	Percent of Total
Freshwater		
Agricultural Wetlands (Modified)	26	0.1%
Atlantic White Cedar Wetlands	1,672	5.5%
Coniferous Scrub/Shrub Wetlands	375	1.2%
Coniferous Wooded Wetlands	1,664	5.4%
Deciduous Scrub/Shrub Wetlands	471	1.5%
Deciduous Wooded Wetlands	665	2.2%
Disturbed Wetlands (Modified)	45	0.1%
Former Agricultural Wetland (Becoming Shrubby, Not Built-Up)	3	0.0%
Herbaceous Wetlands	335	1.1%
Managed Wetland in Built-Up Maintained Rec Area	71	0.2%
Managed Wetland in Maintained Lawn Greenspace	22	0.1%
Mixed Scrub/Shrub Wetlands (Coniferous Dom.)	298	1.0%
Mixed Scrub/Shrub Wetlands (Deciduous Dom.)	415	1.4%
Mixed Wooded Wetlands (Coniferous Dom.)	1,470	4.8%
Mixed Wooded Wetlands (Deciduous Dom.)	971	3.2%
Phragmites Dominate Interior Wetlands	222	0.7%
Phragmites Dominate Urban Area	9	0.0%
Vegetated Dune Communities	1,622	5.3%
Wetland Rights-of-Way	67	0.2%

Wetland Community	Acres	Percent of Total
Tidal		
Saline Marsh (High Marsh)	465	1.5%
Saline Marsh (Low Marsh)	18,961	62.0%
Disturbed Tidal Wetlands	34	0.1%
Phragmites Dominate Coastal Wetlands	700	2.3%
Total	**30,581**	**100.0%**

Source: NJDEP 2015.

3.22.2 Environmental Consequences

3.22.2.1. Impact Level Definitions for Wetlands

As described in Section 3.3, this EIS uses a four-level classification scheme to characterize potential beneficial and adverse impacts of alternatives, including the Proposed Action. The definitions of impact levels are provided in Table 3.22-2. There are no beneficial impacts on wetlands. USACE and NJDEP define wetland impacts differently than BOEM due to requirements under CWA Section 404 and the New Jersey Freshwater Protection Act (as summarized below).

Table 3.22-2 Impact Level Definitions for Wetlands

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts on wetlands would be so small as to be unmeasurable and impacts would not result in a detectable change in wetland quality and function.
Minor	Adverse	Impacts on wetlands would be minimized and would be relatively small and localized. If impacts occur, wetlands would completely recover.
Moderate	Adverse	Impacts on wetlands would be minimized; however, permanent impacts would be unavoidable. Compensatory mitigation required to offset impacts on wetland functions and values and would have a high probability of success.
Major	Adverse	Impacts on wetlands would be minimized; however, permanent impacts would be regionally detectable. Extensive compensatory mitigation required to offset impacts on wetland functions and values would have a marginal or unknown probability of success.

New Jersey Administrative Code 7:7A, Freshwater Wetlands Protection Act Rules, defines temporary disturbance as a regulated activity that occupies, persists, or occurs on a site for no more than 6 months. Impacts on wetlands that persist longer than 6 months are considered permanent. USACE defines temporary impacts as those that occur when fill or cut impacts occur in wetlands that are restored to preconstruction contours when construction activities are complete. (e.g., stockpile, temporary access). Conversion of a wetland type is also considered a permanent impact.

All earth disturbances from construction activities would be conducted in compliance with the New Jersey Pollutant Discharge Elimination System General Permit for Stormwater Discharges associated with Construction Activities and the approved stormwater pollution prevention plan (SWPPP) for the Project. Any work in wetlands would require a CWA Section 404 permit from USACE or NJDEP and a

Section 401 Water Quality Certification from NJDEP; any wetlands permanently lost would require compensatory mitigation.

3.22.3 Impacts of the No Action Alternative on Wetlands

Section 3.1 of the Final EIS explains the approach to predicting impacts related to the No Action Alternative. When analyzing the impacts of the No Action Alternative on wetlands, BOEM considered the impacts of past and ongoing trends and activities, including ongoing non-offshore wind and ongoing offshore wind activities, on the baseline conditions for wetlands. BOEM separately analyzes how resource conditions will be affected over time as reasonably foreseeable activities are implemented. The cumulative impacts of the No Action Alternative considered the impacts of the No Action Alternative in combination with other planned non-offshore wind and offshore wind activities as described in Appendix F, *Planned Activities Scenario*. Separate impact conclusions are presented for both scenarios.

3.22.3.1. Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for wetlands described in Section 3.22.1, *Description of the Affected Environment for Wetlands*, would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities. Ongoing non-offshore activities within the geographic analysis area that may contribute to impacts on wetlands are generally associated with onshore development activities and climate change (see Section F.2 in Appendix F for a description of ongoing and planned activities). Onshore construction activities and associated impacts are expected to continue at current trends and have the potential to affect wetlands through activities that can have permanent (e.g., fill placement) and short-term (e.g., vegetation removal) impacts on wetland habitat, water quality, and hydrology functions. All activities would be required to comply with federal, state, and local regulations related to the protection of wetlands by avoiding or minimizing impacts. If impacts would not be entirely avoided, mitigation would be anticipated to compensate for wetland loss. Climate change–induced sea level rise in the geographic analysis area is also anticipated to continue to affect wetlands. Inundation and rising water levels would result in the conversion of vegetated areas into areas of open water, with a consequent loss of wetland functions associated with the loss of vegetated wetlands. Wetlands have very specific water elevation tolerances; if water is not deep enough, it is no longer a wetland. Slowly rising waters on a gentle, continuously rising surface can result in wetlands migrating landward. In areas where slopes are not gradual or where there are other features blocking flow (e.g., bulkhead or surrounding developed landscape), wetland migration would be slowed or impeded. Rising coastal waters would also continue to cause saltwater intrusion, which occurs when saltwater starts to move farther inland and creeps into freshwater/non-tidal areas. Saltwater intrusion would continue to change wetland plant communities and habitat (i.e., freshwater species to saltwater species) and overall wetland functions. In Barnegat Bay, recent estimates indicate a 2.9-percent loss of tidal marsh wetlands per decade (NJDEP 2020). See Table F1-24 for a summary of potential impacts associated with ongoing and planned non-offshore wind activities by IPF for wetlands. There are no ongoing offshore wind activities within the geographic analysis area for wetlands.

3.22.3.2. Cumulative Impacts of the No Action Alternative

The cumulative impact analysis for the No Action Alternative considers the impacts of the No Action Alternative in combination with other planned non-offshore wind activities and planned offshore wind activities (without the Proposed Action). Planned non-offshore wind activities that may affect wetlands would primarily include increasing onshore construction and development activities (see Appendix F, Table F-8). These activities may permanently (e.g., fill placement) and temporarily (e.g., vegetation removal) affect wetland habitat, water quality, and hydrology functions. All activities would be required to comply with federal, state, and local regulations related to the protection of wetlands by avoiding or minimizing impacts. If impacts would not be entirely avoided, mitigation would be anticipated to compensate for wetland loss.

Impacts on wetlands from other offshore wind projects may occur if onshore and nearshore activity from these projects overlaps with the geographic analysis area. Atlantic Shores North and Ocean Wind 2, which are adjacent to the proposed Project, could have cable landings along the New Jersey coast that intersect the geographic analysis area. Atlantic Shores South currently has a landfall site proposed in the geographic analysis area in Atlantic City. The impacts of these offshore wind activities on wetlands would be of the same type as those of the Proposed Action, including impacts related to land disturbance.

BOEM expects planned offshore wind activities to affect wetlands through accidental releases, land disturbance, and cable emplacement and maintenance. The land disturbance IPF discusses impacts on freshwater/non-tidal wetlands landward of the mean high water line. The cable emplacement and maintenance IPF discusses impacts on tidally influenced wetlands below the mean high water line.

Accidental releases: During onshore construction of offshore wind projects in the geographic analysis area, oil leaks and accidental spills from construction equipment are potential sources of wetland water contamination. While many wetlands act to filter out contaminants, any significant increase in contaminant loading could exceed the capacity of a wetland to perform its normal water quality functions. Although degradation of water quality in wetlands could occur during construction, decommissioning, and, to a lesser extent, O&M, due to the small volumes of spilled material anticipated these impacts would all be short term until the source of the contamination is removed. Compliance with applicable state and federal regulations related to oil spills and waste handling would minimize potential impacts from accidental releases. These include the Resource Conservation and Recovery Act, Department of Transportation Hazardous Material regulations, and implementation of a Spill Prevention, Control, and Countermeasure Plan. Impacts from accidental releases on wetlands would be minor because accidental releases would be small and localized, and compliance with state and federal regulations would avoid or minimize potential impacts on wetland quality or functions.

Land disturbance: Construction of onshore components (e.g., onshore export cables, substations) in the geographic analysis area for Atlantic Shores South, Atlantic Shores North, and Ocean Wind 2 is anticipated to require clearing, excavating, trenching, fill, and grading, which could result in the loss or alteration of wetlands, causing adverse effects on wetland habitat, water quality, and flood and storage capacity functions. Fill material permanently placed in wetlands during construction would result in the permanent loss of wetlands, including any habitat, flood and storage capacity, and water quality functions that the wetlands may provide. If a wetland were partially filled and fragmented or if wetland vegetation were trimmed, cleared, or converted to a different vegetation type (e.g., forest to herbaceous), habitat would be altered and degraded (affecting wildlife use) and water quality and flood and storage capacity functions would be reduced by changing natural hydrologic flows and reducing the wetland’s ability to impede and retain stormwater and floodwater. On a watershed level, any permanent wetland loss or alteration could reduce the capacity of regional wetlands to provide wetland functions. Short-term wetland impacts may occur from construction activity that crosses or is adjacent to wetlands, such as rutting, compaction, and mixing of topsoil and subsoil. Where construction leads to unvegetated or otherwise unstable soils, precipitation events could erode soils, resulting in sedimentation that could affect water quality in nearby wetlands, as well as alter wetland functions if sediment loads are high (e.g., adverse habitat impacts from burying vegetation). The extent of wetland impacts would depend on specific construction activities and their proximity to wetlands. These impacts would occur primarily during construction and decommissioning; impacts during O&M would only occur if new ground disturbance was required, such as to repair a buried component. BOEM anticipates that onshore project components from other offshore wind projects would likely be sited in disturbed areas (e.g., along existing roadways), which would avoid and minimize wetland impacts. In addition, BOEM expects the offshore wind projects would be designed to avoid wetlands to the extent feasible. Offshore wind projects would be required to comply with federal, state, and local regulations related to the protection of wetlands by avoiding or minimizing impacts. Impacts from land disturbance on wetlands would be moderate because permanent wetland impacts would likely occur and compensatory mitigation would be required.

Cable emplacement and maintenance: Atlantic Shores South is anticipated to install export cables in the geographic analysis area. Atlantic Shores North and Ocean Wind 2 could also propose installation of export cables in the geographic analysis area. The wetland impact types and mechanisms would be similar to those described for the land disturbance IPF, and impacts on wetland functions (i.e., water quality, habitat, and hydrology) would be similar. Most tidal wetlands in the geographic analysis area are non-wooded tidal wetlands (e.g., saline marsh). Installation of cable would be unlikely to cause permanent wetland impacts because it would be unlikely that a permanent facility (e.g., substation) would be constructed in tidal wetlands and trenchless cable installation methods (HDD) would likely be used to avoid and minimize impacts. Affected wetlands would be restored to pre-existing conditions per permitting requirements. BOEM also anticipates the offshore wind projects would be designed to avoid wetlands (including tidal wetlands) to the extent feasible. Offshore wind projects would be required to comply with federal, state, and local regulations related to the protection of wetlands by avoiding or minimizing impacts. Impacts from cable emplacement on tidal wetlands would be minor because wetland impacts are anticipated to be short term and would not require compensatory mitigation.

3.22.3.3. Conclusions

Impacts of the No Action Alternative. Under the No Action Alternative, existing environmental trends and ongoing activities would continue, and wetlands would continue to be affected by natural and human-caused IPFs. Land disturbance from onshore construction periodically would cause short-term and permanent loss of wetlands. All activities would be required to comply with federal, state, and local regulations related to the protection of wetlands by avoiding or minimizing impacts. If impacts would not be entirely avoided or minimized, mitigation would be anticipated for projects to compensate for lost wetlands. Ongoing activities, especially land disturbance, would likely result in moderate impacts on wetlands. Therefore, the No Action Alternative would result in **moderate** impacts on wetlands.

Cumulative Impacts of the No Action Alternative. Planned activities could cause impacts that would be similar to those of the Proposed Action. Currently, there are no future offshore wind activities proposed in the geographic analysis area. If any were to occur, they would have some potential to result in temporary disturbance and permanent loss of wetlands. All activities would be required to comply with federal, state, and local regulations related to the protection of wetlands, thereby avoiding or minimizing impacts. If impacts would not be entirely avoided, compensatory mitigation would be anticipated for projects that result in permanent impacts, resulting in moderate impacts. Considering the IPFs and regulatory requirements for avoiding, minimizing, and mitigating impacts on wetlands, BOEM anticipates that the cumulative impacts of the No Action Alternative would be **moderate**, primarily through land disturbance.

3.22.4 Relevant Design Parameters & Potential Variances in Impacts

This EIS analyzes the maximum-case scenario; BOEM expects any potential variances in the proposed Project build-out within the range of the PDE to result in similar or lesser impacts than those described in the sections below. The following proposed PDE parameters (Appendix E) would influence the magnitude of the impacts on wetlands:

- The onshore export cable routing variants within the Onshore Project area

An onshore export cable route with less wetlands within or adjacent to the right-of-way would have less potential for direct and indirect impacts on wetlands.

Ocean Wind has committed to measures to minimize impacts on wetland resources. To the extent practicable, Ocean Wind would use appropriate installation technology designed to minimize disturbance to the seabed and sensitive habitat (such as beaches and dunes, wetlands and associated buffers, streams, hard-bottom habitats, seagrass beds, and the near-shore zone); avoid anchoring on sensitive habitat; and implement turbidity reduction measures to minimize impacts on sensitive habitat from construction activities (GEN-08). Ocean Wind is also coordinating wetland mitigation options with state and federal agencies and may identify a mix of banking and onsite restoration, depending on agency preference and availability (TCHF-03) (COP Volume II, Table 1.1-2; Ocean Wind 2023). Ocean Wind proposes to purchase wetland credits from the Great Bay Wetland Mitigation Bank through Evergreen Environmental, LLC, the mitigation banker. The proposed wetland impacts are entirely within the Geographic Service area of the Great Bay Wetland Mitigation Bank. The Great Bay Wetland Mitigation Bank is a federally approved mitigation bank with available credits.

3.22.5 Impacts of the Proposed Action on Wetlands

3.22.5.1. Impacts of the Proposed Action

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park, which is described in Section 3.22.7, *Impacts of Alternative E on Wetlands*.

The Proposed Action could affect wetlands through accidental releases, land disturbance, and cable emplacement and maintenance. The land disturbance IPF discusses impacts on freshwater/non-tidal wetlands landward of the mean high water line. The cable emplacement and maintenance IPF discusses impacts on tidally influenced wetlands below the mean high water line.

Accidental releases: Onshore construction activities would require heavy equipment use and HDD activities, and potential spills could occur as a result of an inadvertent release from the machinery or during refueling activities. Ocean Wind would develop and implement a Spill Prevention, Control, and Countermeasure Plan to minimize impacts on water quality (prepared in accordance with applicable regulations such as NJDEP Site Remediation Reform Act, Linear Construction Technical Guidance, and Spill Compensation and Control Act). In addition, all wastes generated onshore would comply with applicable federal regulations, including the Resource Conservation and Recovery Act and the Department of Transportation Hazardous Material regulations. Therefore, BOEM anticipates the Proposed Action would result in minor and temporary impacts on wetlands as a result of releases from heavy equipment during construction and other cable installation activities.

Land disturbance: Construction impacts on wetlands and related functions would be similar to those described in Section 3.22.3.2. Construction of the Oyster Creek and BL England onshore substations and the onshore export cables via typical trenching and open-cut methods would result in excavation, rutting, compaction, mixing of topsoil and subsoil, and potential alteration due to clearing at handhole and manhole locations. These impacts would be mostly short term in non-wooded wetlands, as restoration would be conducted in accordance with applicable USACE and NJDEP permit requirements. Following installation of export cables within wetlands, topography would be restored and soils would be decompacted to avoid long-term impacts on soils and hydrology. Appendix I contains figures showing wetlands in the Oyster Creek and BL England Onshore Project areas.

Long-term changes from wooded to herbaceous wetlands could occur if clearing is required in wooded wetlands. Ocean Wind has estimated that up to 4.98 acres of long-term disturbance would occur within wooded wetlands. Loss of wetland could occur if permanent placement of fill is required in wetlands. Placement of fill within a wetland or permanent conversion of wooded wetlands to herbaceous or shrub/scrub wetlands within the permanent easement would constitute a permanent impact on wetlands. Other long-term impacts on wetlands would include clearing wooded wetlands within the temporary workspace. While these would be allowed to revert to forested wetland condition, the recovery is expected to take more than 3 years. Table 3.22-3 quantifies the impacts based on NJDEP's wetland mapping and the cable route options as described in COP Volume I (Ocean Wind 2023).

Approximately 0.53 acre of short-term wetland impacts could potentially occur as a result of cable burial at BL England, and 20.04 acres of short-term and long-term impacts could potentially occur as a result of cable burial at Oyster Creek. Wetland impacts for the PDE were calculated for each indicative route (using a 50-foot-wide corridor and the necessary workspace) that had the highest wetland impact for each wetland type. For example, the Farm Property reroute was the only route with impacts on mixed scrub/ shrub wetlands (coniferous), so for that wetland type the impacts associated with the Farm Property reroute were included in Table 3.22-3. The Nautilus route would result in the highest impact on mixed wooded wetlands (coniferous), so the impacts associated with this route were included in Table 3.22-3. Finally, impacts from additional workspaces for these wetlands types were added; additional workspace for Oyster Creek was added to the Farm property landfall and the workspace at Island Beach State Park. Additional workspace was also added for the landfall at Bay Parkway, Lighthouse Drive, and Nautilus Drive, and for potential HDD areas west of Route 9. The PDE includes two crossings of Island Beach State Park, where the offshore export cable would make landfall for a short distance and then enter Barnegat Bay. Both would cross wetlands, including deciduous scrub shrub, mixed scrub shrub, and saline marsh (south crossing only), but the southerly crossing would avoid wetland impacts due to the proposed use of HDD that would avoid wetlands (see Section 3.22.7 below).

Following construction, these wetland impact areas would be restored to pre-existing conditions, and herbaceous vegetation would become reestablished (GEN-13; see COP Volume II, Table 1.1-2; Ocean Wind 2023). Trenchless technology methods may be used along portions of the onshore export cable routes to avoid impacts on wetlands or other sensitive and unique habitats. Construction laydown areas would be located in previously disturbed areas where possible. The BL England and Oyster Creek substation sites have been selected within already disturbed and developed areas to minimize impacts on habitat. Permanent and temporary workspace for substation construction would be sited to avoid wetlands to the extent practicable. Depending on the site selected, it may be necessary to locate an access road within these resources.

NJDEP-regulated adjacent transition areas may also be affected by clearing and soil disturbance. Water quality within wetlands could be affected by sedimentation from nearby exposed soils. Ocean Wind would use erosion and sedimentation controls and BMPs and develop and implement a SWPPP to avoid and minimize impacts during onshore construction (GEN-11; see COP Volume II, Table 1.1-2; Ocean Wind 2023). Additionally, during onshore construction, dewatering may be required. BMPs would be used during dewatering activities, such as diversion, filtering, and energy dissipation devices. Dewatering activities would be short term, and water drawdown would be minimal.

Normal O&M activities are not expected to involve further wetland alteration beyond periodic woody vegetation removal. The permanent right-of-way around handholes and manholes would be maintained in an herbaceous state during the operational life of the Project. The onshore cable routes generally would have no maintenance needs unless a fault or failure occurs. Decommissioning of the onshore Project components would have similar impacts as construction.

Impacts on wetlands would be avoided and minimized by locating substations, cable routes, and work areas within upland areas. For impacts that are unavoidable, compensatory mitigation would be necessary to replace the loss of wetlands and associated functions. Ocean Wind will identify compensatory mitigation based on the requirements of USACE and NJDEP. Ocean Wind is coordinating wetland mitigation options with state and federal agencies and may identify a mix of banking and onsite restoration, depending on agency preference and availability (TCHF-03).[1] In summary, potential adverse impacts on wetlands would be short term and long term, and localized. The impacts of land disturbance on wetlands resulting from the Proposed Action would be moderate, because although impacts on wetlands would be minimized, compensatory mitigation would likely be necessary because of unavoidable permanent impacts.

Table 3.22-3 Wetland Impacts Along Onshore Export Cable Routes – Proposed Action

Wetland Community	Impact (Acres)	% Relative to Wetlands in GAA	Duration
BL England			
Tidal			
Phragmites dominant coastal wetlands	0.35	0.05	Short term (<3 years)
Saline marsh (low marsh)	0.18	<0.01	Short term (<3 years)
BL England Subtotal	**0.53**	**--**	**--**
Oyster Creek			
Freshwater			
Deciduous scrub/shrub wetlands	1.53	0.33	Short term (<3 years)
Deciduous wooded wetlands	0.96	0.14	Long term (>3 years)
Herbaceous wetlands	0.08	0.02	Short term (<3 years)
Mixed scrub/shrub wetlands (coniferous dominant)	0.81	0.27	Short term (<3 years)
Mixed scrub/shrub (deciduous dominant)	1.55	0.37	Short term (<3 years)
Mixed wooded wetlands (coniferous dominant)	0.87	0.06	Long term (>3 years)
Vegetated dune communities	0.53	0.03	Short term (<3 years)
Atlantic white cedar wetlands	2.39	0.14	Long term (>3 years)
Coniferous scrub/shrub wetlands	0.40	0.11	Short term (<3 years)
Coniferous wooded wetlands	0.42	0.03	Long term (>3 years)
Managed wetland in built-up maintained recreation area	0.48	0.68	Short term (<3 years)
Mixed wooded wetlands (deciduous dominant)	0.34	0.04	Long term (>3 years)
Total Freshwater	10.36	--	--
Tidal			
Saline marsh (high marsh)	2.54	0.55	Short term (<3 years)
Saline marsh (low marsh)	2.72	0.01	Short term (<3 years)
Phragmites dominant coastal wetlands	5.25	0.74	Short term (<3 years)
Disturbed tidal wetlands	0.05	0.15	Short term (<3 years)
Total Tidal	9.68	--	--
Oyster Creek Subtotal	**20.04**	**--**	**--**
Total: BL England and Oyster Creek	**20.57**	**--**	**--**

Source: Ocean Wind 2023.

[1] USACE's Public Notice NAP-2017-00135-84 states that Ocean Wind proposes to purchase a total of 2.05 wetland credits from the Great Bay Wetland Mitigation Bank through Evergreen Environmental, LLC, the mitigation bank sponsor.
NJDEP Application Number 0000-21-0008.2 LUP22001 states that Ocean Wind intends to purchase wetland mitigation credits from a mitigation bank that services the area.

GAA = geographic analysis area

Cable emplacement and maintenance: Submarine cable transition to an onshore cable (cable landfall) would require connections at TJBs at the BL England and Oyster Creek landfall sites. Export cables would be installed at the landfall sites using open cut (i.e., trenching) or HDD, which would affect wetlands through compaction and excavation. Temporary work areas at landfall sites would also affect wetlands through compaction and the placement of fill material. Following installation of export cables within wetlands, topography would be restored and soils would be decompacted to avoid long-term impacts on soils and hydrology. At BL England, HDD would be used to transition from submarine cable to the landfall point. The onshore route to reach the BL England substation would traverse upland road right-of-way, but may affect tidal wetlands adjacent to Roosevelt Boulevard. At Oyster Creek, the northernmost landfall option in the PDE would be in tidal wetlands and, after cable landfall, the onshore cable route would traverse tidal wetlands. Although HDD would also be used for the Oyster Creek export cable route for the transition from submarine cables to the landfall point, tidal wetlands are more extensive in this location and there are two cables. Emplacement of cables in tidal wetlands would affect 0.53 acre of wetland at BL England and 9.68 acres at Oyster Creek (Table 3.22-3). Construction impacts on these wetlands and related functions would be similar to those described in Section 3.22.3.2.

Normal O&M activities are not expected to involve further wetland alteration beyond periodic woody vegetation removal. The permanent right-of-way around TJBs would be maintained in an herbaceous state during the operational life of the Project. The onshore cable routes generally would have no maintenance needs unless a fault or failure occurs. Decommissioning of the onshore Project components would have similar impacts as construction.

Impacts on tidal wetlands would be avoided and minimized by the proposed use of HDD at export cable landfalls and to cross waterbodies and the associated wetlands such as Oyster Creek and Crook Horn Creek/Peck Bay. For impacts that are unavoidable, compensatory mitigation would be necessary to replace the loss of wetlands and associated functions. Mitigation would likely include a combination of onsite restoration of wetlands temporarily affected during construction and mitigation banking credit purchase.[2] Wetland impacts would be primarily short term because the wetlands are non-wooded and impact areas would be restored to pre-existing conditions, and herbaceous vegetation would become reestablished (GEN-13; see COP Volume II, Table 1.1-2; Ocean Wind 2023). The impacts of cable emplacement on wetlands resulting from the Proposed Action would be moderate, because although impacts on wetlands would be minimized, compensatory mitigation would likely be necessary because of unavoidable permanent impacts.

3.22.5.2. Cumulative Impacts of the Proposed Action

The cumulative impacts of the Proposed Action considered the impacts of the Proposed Action in combination with other ongoing and planned activities. Ongoing and planned non-offshore wind activities related to onshore development activities would contribute to impacts on wetlands through the primary IPFs of accidental releases, land disturbance, and cable emplacement and maintenance. The construction, O&M, and decommissioning of onshore infrastructure for offshore wind activities in the geographic analysis area would also contribute to the primary IPF of land disturbance. Temporary disturbance and

[2] USACE's June 17, 2022, Public Notice NAP-2017-00135-84 states, "The proposed project, including the Oyster Creek and BL England components, will result in a proposed permanent disturbance to 0.028 acres of tidal, emergent wetlands and 2.013 acres of non-tidal, emergent wetlands dominated by common reed and mowed turfgrass. In order to compensate for the unavoidable impacts, the applicant proposes to purchase a total of 2.05 wetland credits from the Great Bay Wetland Mitigation Bank through Evergreen Environmental, LLC, the mitigation bank sponsor."

permanent loss of wetland may occur as a result of offshore wind development. BOEM is not aware of any future offshore wind activities other than the Proposed Action that would overlap the geographic analysis area for wetlands. However, if wetland alteration or loss is anticipated, it would likely be minimal, the overall scale of impacts is expected to be small, and any activities that would result in these impacts would be required to comply with federal, state, and local regulations related to the protection of wetlands by avoiding or minimizing impacts.

Accidental releases: The Proposed Action would contribute an undetectable increment to the cumulative accidental release impacts on wetlands. Impacts would likely be short term and minor due to the low risk and localized nature of the most likely spills, the use of an Oil Spill Response Plan for projects, and regulatory requirements for the protection of wetlands. These impacts would occur primarily during construction, but also during operation and decommissioning to a lesser degree. Given the low probability of these spills occurring, BOEM does not expect ongoing and planned activities, including offshore wind, to contribute to impacts on wetlands resulting from accidental releases.

Land disturbance: The Proposed Action would contribute noticeable incremental impacts to the cumulative land disturbance impacts. Impacts would likely be short term to long term and moderate due to the permanent wetland impacts that would require compensatory mitigation. Impacts due to onshore land use changes are expected to include a gradually increasing amount of wetland alteration and loss. The future extent of land disturbance from ongoing and planned non-offshore wind activities over the next 35 years is not known with as much certainty as the extent of land disturbance that would be caused by the Proposed Action, but based on regional trends is anticipated to be similar to or greater than that of the Proposed Action. Some information is available for Atlantic Shores South, which has a similar geographic analysis area to that of Ocean Wind 1 and would result in approximately 2.76 acres of temporary wetland impacts and 0.13 acre of permanent wetland impacts (Atlantic Shores 2021). If other future projects were to overlap the geographic analysis area or even be co-located (partly or completely) within the same right-of-way corridor that the Proposed Action would use, then the impacts of those future projects on wetlands would be of the same type as those of the Proposed Action alone; the degree of impacts may increase, although the location and timing of future activities would influence this. For example, repeated construction in a single right-of-way corridor would be expected to have less impact on wetlands than construction in an equivalent area of undisturbed wetland.

Cable emplacement and maintenance: The Proposed Action would contribute noticeable incremental impacts to the cumulative cable emplacement and maintenance impacts. Impacts due to onshore land use changes are expected to include a gradually increasing amount of tidal wetland alteration and loss. Impacts would likely be short term to long term and moderate due to the permanent wetland impacts that would require compensatory mitigation. The future extent of tidal wetland disturbance from ongoing and planned non-offshore wind activities over the next 35 years is not known with as much certainty as the extent of disturbance that would be caused by the Proposed Action but, based on regional trends, is anticipated to be similar to or greater than that of the Proposed Action. Some information is available for Atlantic Shores South, which has a similar geographic analysis area to that of Ocean Wind 1 and would result in only 215 square feet of temporary tidal wetland impacts (Atlantic Shores 2021). If other future projects were to overlap the geographic analysis area or even be co-located (partly or completely) within the same corridor that the Proposed Action would use, then the impacts of those future projects on tidal wetlands would be of the same type as those of the Proposed Action; the degree of impacts may increase, although the location and timing of future activities would influence this. For example, repeated construction in a single corridor would be expected to have less impact on tidal wetlands than construction in an equivalent area of undisturbed wetland. All earth disturbances from construction activities would be conducted in compliance with the New Jersey Pollutant Discharge Elimination System General Permit for Stormwater Discharges associated with Construction Activities and the approved SWPPP for the Project. Any work in wetlands would require a CWA Section 404 permit from USACE or

NJDEP and a Section 401 Water Quality Certification from NJDEP; any wetlands permanently lost would require compensatory mitigation.

3.22.5.3. Conclusions

Impacts of the Proposed Action. The Proposed Action may affect wetlands through short-term or permanent disturbance from activities within or adjacent to these resources. Considering the avoidance, minimization, and mitigation measures required under federal and state statutes (e.g., CWA Section 404), construction of the Proposed Action would likely have **moderate** impacts on wetlands.

Cumulative Impacts of the Proposed Action. BOEM anticipates that the cumulative impacts on wetlands in the geographic analysis area would be moderate. The incremental impacts contributed by the Proposed Action to the cumulative impacts on wetlands would be noticeable. BOEM anticipates that the impacts associated with the Proposed Action when combined with the impacts on wetlands from ongoing and planned activities including offshore wind would likely be **moderate**. The Proposed Action would contribute to the cumulative impact rating primarily through short-term and permanent impacts on wetlands from cable landfall and onshore construction activities. Measurable impacts would be relatively small and the resource would likely recover completely when the affecting agent (e.g., temporary construction activity) is gone and remedial or mitigating action is taken.

3.22.6 Impacts of Alternatives B, C, and D on Wetlands

Impacts of Alternatives B, C, and D. The impacts of Alternatives B, C, and D would be similar to those of the Proposed Action because these alternatives differ only with respect to offshore components, and offshore components of the proposed Project have no potential impacts on wetlands. The impacts resulting from land disturbance, accidental releases, and cable emplacement and maintenance associated with onshore construction under Alternatives B, C, and D on wetlands are expected to be the same as those of the Proposed Action.

Cumulative Impacts of Alternatives B, C, and D. The cumulative impacts on wetlands would be moderate for the same reasons described for the Proposed Action. The incremental impacts contributed by the action alternatives to the cumulative impacts on wetlands would be the same as described under the Proposed Action.

3.22.6.1. Conclusions

Impacts of Alternatives B, C, and D. The expected **moderate** impacts associated with the Proposed Action would not change under Alternatives B, C, and D because the alternatives only differ in offshore components, and offshore components would not contribute to impacts on wetlands; the same construction and installation, O&M, and conceptual decommissioning activities would still occur.

Cumulative Impacts of Alternatives B, C, and D. The incremental impacts contributed by Alternatives B, C, and D to the cumulative impacts on wetlands would be the same as those of the Proposed Action: noticeable. Because the impacts of the Proposed Action would not change under Alternatives B, C, and D, BOEM anticipates that the cumulative impacts of Alternatives B, C, and D would be the same as described for the Proposed Action. Therefore, the cumulative impacts of Alternatives B, C, and D would be **moderate**.

3.22.7 Impacts of Alternative E on Wetlands

BOEM identified a combination of Alternative A (the Proposed Action) and Alternative E as the Preferred Alternative. The analysis of the impacts of the Preferred Alternative would be the same as that for the Proposed Action except for the export cable route across Island Beach State Park.

Impacts of Alternative E. The impacts on wetlands from Alternative E would be similar to those of the Proposed Action. While Alternative E would cross less wetlands than the southern crossing option on Island Beach State Park, the southern crossing would completely avoid wetlands because wetlands would be bored under with HDD. Therefore, Alternative E may have slightly greater wetland impacts compared to the Proposed Action (if Ocean Wind elected to use the southern crossing option under the Proposed Action) because the trenching method would be used to install the onshore cable for the northern crossing of Island Beach State Park (Figure 3.22-2). Impacts from accidental releases, land disturbance, and cable emplacement and maintenance would still remain small, impacts would primarily occur in existing rights-of-way, mitigation measures (e.g., Spill Prevention, Control, and Countermeasure Plan and SWPPP) would be implemented, and compliance with federal and state regulations (e.g., CWA Section 404) for protection of wetlands would be required.

Cumulative Impacts of Alternative E. The cumulative impacts on wetlands would be moderate for the same reasons described for the Proposed Action. The incremental impacts contributed by Alternative E to the cumulative impacts on wetlands would be the same as those of the Proposed Action. While Alternative E may have slightly greater wetland impacts compared to the Proposed Action (if Ocean Wind elected to use the southern crossing option under the Proposed Action), the impact rating would not change.

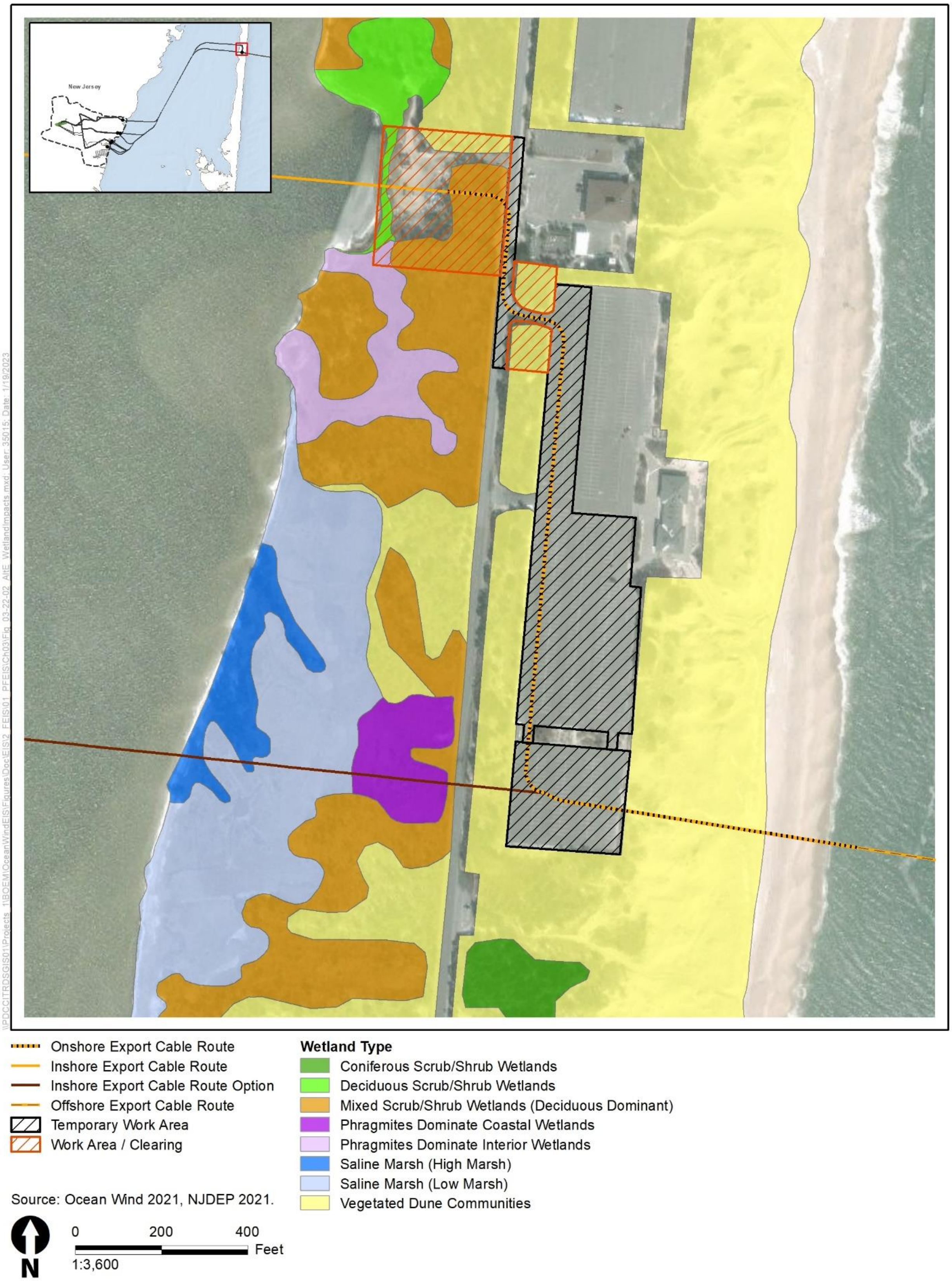

Figure 3.22-2 Wetlands at Alternative E Crossing of Island Beach State Park

3.22.7.1. Conclusions

Impacts of Alternative E. Alternative E would have the same **moderate** impacts on wetlands as the Proposed Action. The impacts on wetlands would not be materially different because land disturbance would remain small, and implementation of mitigation measures and regulatory compliance would minimize impacts related to onshore ground disturbance.

Cumulative Impacts of Alternative E. The incremental impacts contributed by Alternative E to the cumulative impacts on wetlands would be the same as those of the Proposed Action: noticeable. Because the impacts of the Proposed Action would not change substantially under Alternative E, BOEM anticipates that the cumulative impacts associated with Alternative E would be the same as described for the Proposed Action. Therefore, cumulative impacts of Alternative E would be **moderate**.

3.22.8 Proposed Mitigation Measures

No additional measures to mitigate impacts on wetlands have been proposed for analysis.